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Please read this disclaimer before proceeding:

22AI001

AI in Blockchain

Batch/Year: 2022-2026/IV

Created by:

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Assistant Professor / CSE(CS)/
RMKCET

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Course Objectives

Course Objectives

22AI001 AI IN BLOCK CHAIN

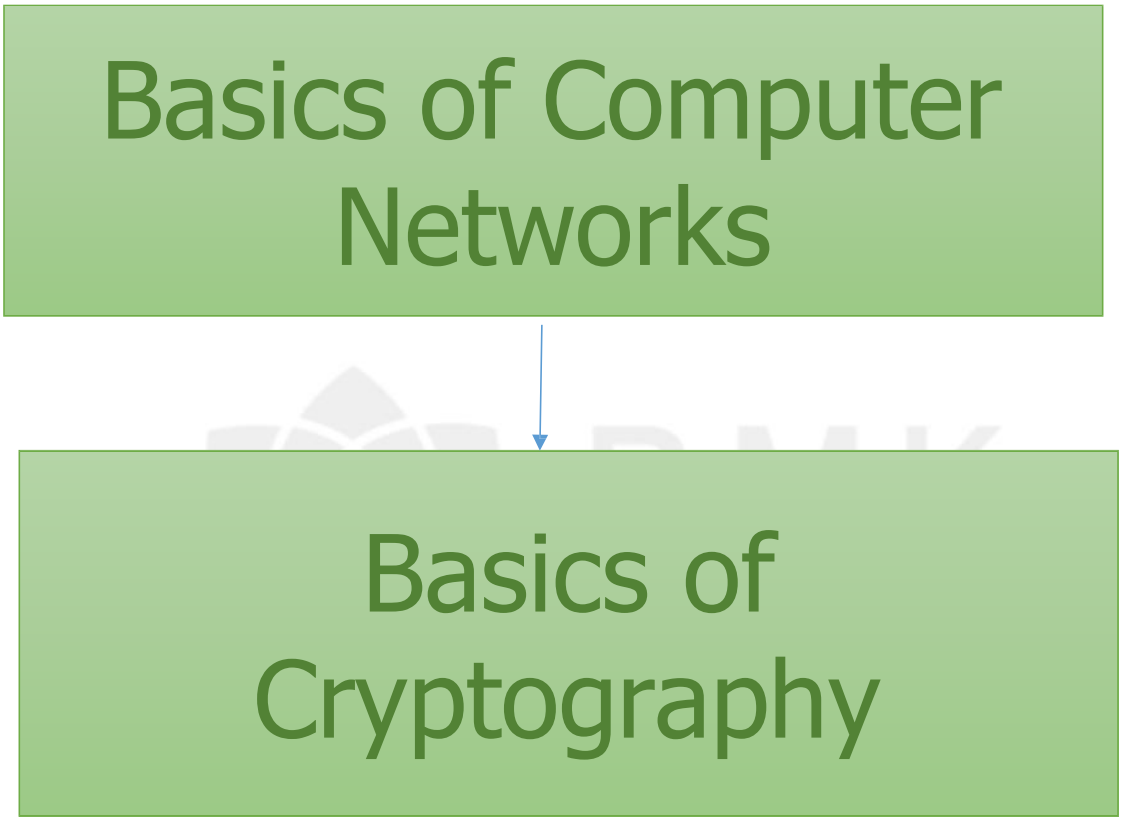
L	T	P	C
3	0	0	3

OBJECTIVES:

- To acquire knowledge in Blockchain Technologies.
- To Understand how block chain and AI can be used to innovate.
- To explain Cryptocurrencies and AI.
- To develop applications using blockchain.
- To understand the limitations and future scope of AI in Blockchain.

PRE REQUISITES

Prerequisites



Syllabus

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OPEN ELECTIVE (Offered to Other Departments by ADS)

22AI001	AI in BLOCK CHAIN	L	T	P	C
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UNIT I	INTRODUCTION TO BLOCKCHAIN	9

Overview – Blockchain vs Distributed Ledger Technology vs Distributed Databases – Public vs private vs permissioned blockchains – Privacy in blockchains – Blockchain platforms - Hyperledger – Hashgraph, Corda – IOTA - Consensus Algorithms – Building DApps with blockchain tools.

UNIT II	BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE	9

Introduction to the AI landscape - AI and Blockchain driven Databases – Centralized vs Distributed data – Blockchain data – Big data for AI analysis – Global databases – Data Management in a DAO - Benefits of combining blockchain and AI – Aicumen Technologies -Combining blockchain and AI to humanize digital interactions.

UNIT III	CRYPTOCURRENCY AND AI	9

Bitcoins – Ethereum - Role of AI in cryptocurrency – cryptocurrency trading – Making price predictions with AI – Market making – future of cryptocurrencies.

UNIT IV	DEVELOPING BLOCKCHAIN PRODUCTS	9

Development Life Cycle of a DIApp – Designing a DIApp – Developing a DIApp – Testing – Deploying – Monitoring – Implementing DIApps.

UNIT V	LIMITATIONS AND FUTURE OF AI WITH BLOCKCHAIN	9

Technical Challenges – Business Model Challenges – Scandals and Public perception – Government Regulation – Privacy Challenges for Personal Records – Convergence of AI with Blockchain – Future – Enterprise.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students will be able to:

CO1: Acquire knowledge in Blockchain Technologies.
CO2: Understand how block chain and AI can be used to innovate.
CO3: Elaborate Cryptocurrencies and AI.
CO4: Develop applications using blockchain.
CO5: Understand the limitations and future scope of AI in Blockchain.
CO6: Elaborate the various applications of AI in Blockchain.

TEXT BOOKS:

1. Ganesh Prasad Kumble, Anantha Krishnan, "Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies", Packt Publications, 2020.
2. Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015.

REFERENCES:

1. Daniel Drescher, "Block Chain Basics", Apress; 1st edition, 2017.

Course Outcomes

Course Outcomes

CO#	COs	K Level
CO1	Acquire knowledge in Blockchain Technologies	K1
CO2	Understand how block chain and AI can be used to innovate.	K2
CO3	Explain Cryptocurrencies and AI.	K2
CO4	Develop applications using blockchain.	K4
CO5	Understand the limitations and future scope of AI in Blockchain.	K4

Knowledge Level	Description
K6	Evaluation
K5	Synthesis
K4	Analysis
K3	Application
K2	Comprehension
K1	Knowledge

CO – PO/PSO Mapping

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CO – PO /PSO Mapping Matrix

CO #	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	3	3	2	1	1	-	-	-	2	-	-	2	3	2	-
CO2	3	2	2	2	2	-	-	-	2	-	-	2	3	2	-
CO3	3	3	2	2	2	-	-	-	2	-	-	2	3	2	-
CO4	3	2	2	2	2	-	-	-	2	-	-	2	3	3	-
CO5	3	2	2	2	2	-	-	-	2	-	-	2	3	2	-
CO6	2	2	1	1	1	-	-	-	2	-	-	2	3	2	-

Lecture Plan

Unit II

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Lecture Plan – Unit 2 – BLOCKCHAIN AND ARTIFICIAL INTELLIGENCE

Sl. No.	Topic	Number of Periods	Proposed Date	Actual Lecture Date	CO	Taxonomy Level	Mode of Delivery
1	AI and BlockChain driven Databases –	1			CO2	K2	Chalk & Talk
2	Centralized vs Distributed data –	1			CO2	K2	Chalk & Talk
3	Blockchain data – Big data for AI analysis –	1			CO2	K2	Chalk & Talk
4	Global databases –	1			CO2	K2	Chalk & Talk
5	Data Management in a DAO.	1			CO2	K3	Chalk & Talk
6	Data Management in a DAO.	1			CO2	K3	Chalk & Talk
7	Benefits of combining blockchain and AI – Aicumen Technologies -	1			CO2	K2	Chalk & Talk
8	Combining blockchain	1			CO2	K3	Chalk & Talk
9	Combining blockchain and AI to humanize digital interactions.	1			CO2	K3	Chalk & Talk

Activity Based Learning

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Activity Based Learning

Activity: Designing a Data Autonomous Organization (DAO)

Objective: To help students understand the principles of Data Autonomous Organizations and the decentralized decision-making process.

Materials Needed:

Whiteboard or large paper

Markers or pens

Sticky notes

Timer

Access to online collaborative tools (optional)

Steps:

Introduction (10 minutes):Briefly explain the concept of Data Autonomous Organizations (DAOs), emphasizing their decentralized nature, blockchain-based governance, and decision-making through smart contracts.

Group Formation (5 minutes):Divide the students into small groups, ensuring each group has a mix of roles: "Members," "Smart Contract Developers," and "Governance Experts."

DAO Design Proposal (15 minutes):Each group is tasked with designing a proposal for a Data Autonomous Organization. The proposal should include:

Purpose and goals of the DAO.

Specific use cases for data governance within the organization.

Identification of key data-related decisions that the DAO will make autonomously.

Smart Contract Development (20 minutes):The "Smart Contract Developers" within each group work on designing the smart contracts that will govern the decision-making process of the DAO.

Emphasize the importance of transparency, fairness, and security in the smart contract design.

Governance Structure (15 minutes):The "Governance Experts" within each group design the governance structure of the DAO, including voting mechanisms and the criteria for decision-making.

Discuss the importance of inclusivity and diversity in decision-making.

Presentation Preparation (10 minutes):Each group prepares a brief presentation outlining their DAO design, including the purpose, use cases, smart contracts, and governance structure.

DAO Simulation (30 minutes):Groups take turns presenting their DAO designs to the class. After each presentation, the class acts as the decentralized network of participants and votes on whether to approve the presented DAO.

Reflection and Discussion (15 minutes):Facilitate a class discussion on the challenges and advantages of DAOs in data governance.

Discuss the implications of decentralized decision-making in managing sensitive data.

Debriefing (10 minutes):Conclude the activity with a debriefing session. Ask students to share insights gained from the activity and discuss real-world applications of DAOs in data governance.

Lecture Notes – Unit 2

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UNIT – II

Introduction

AI – key concepts

- AI is the intelligence and capability exhibited by a computer to perceive, learn, and solve problems, with minimal probability of failure.
- The ability of AI to compute and achieve results within a shorter period of time than humans has made computers the cornerstone of automation across various industries.
- The computational work of humans is often prone to errors, is time-consuming, and exhibits diminishing accuracy as the problem gets harder to solve. However, computers have been able to fill this role for a long time, from the early beginnings of automation that can be observed in many passive forms in our daily life.
- One of the best examples of such automation is the introduction of Optical Character Recognition (OCR), which converts embedded text in an image or document into a text source ready for computation. Computers enabled with OCR devices are more accurate and consume less time in reproducing the content than humans.
- Similarly, barcode scanners have led the way to faster checkout times at retail shops.

History of AI

- Numerous depictions of AI in the form of robots, artificial humans, or androids can be observed in art, literature, and computer science dating back to as early as the 4th century BC in Greek mythology.
- AI research and development gained mainstream progress in the early 20th century. The phrase artificial intelligence was coined

during a summer workshop held at Dartmouth College in 1956 in New Hampshire.

- The workshop was called the Dartmouth Summer Research Project on Artificial Intelligence and was organized by Prof. John McCarthy, one of the mathematics professors at Massachusetts Institute of Technology (MIT).
- This workshop led to the development of AI as a special field within the overlapping disciplines of mathematics and computer science.
- However, it is also notable that two decades before the Dartmouth workshop, the British mathematician Alan Turing had proposed the concept of the Turing machine, a computational model that can process algorithms, in 1936.
- He later published the paper Computing Machinery and Intelligence (https://www.csee.umbc.edu/courses/471/papers/turing.pdf) in which he proposed the concept of differentiating the response of machine intelligence from a human. This concept is widely known as the Turing test today.
- Almost a decade after the summer workshop at Dartmouth College, the first chatbot, named ELIZA, was showcased by AI researcher Joseph Weizenbaum at MIT in 1966. It was one of the first few chatbots to attempt the Turing test. After the invention of ELIZA, a new range of expert systems and learning patterns evolved over the next two decades until the 1980s.

AI winter

AI winter is a term used by many in the IT industry to define a period of time when AI researchers faced many challenges, leading to severe cuts in funding and the slowdown of AI as a specialized field.

During the early 1970s, academic research and development in the field of AI were suddenly halted by the US and British governments, due to

some unreasonable speculations about AI and the criticisms that followed. It is commonly observed that AI winter started in the early 1970s, but ended nearly two decades later due to research failures, setbacks in motivation, and consensus among government bodies, as well as the collapse of some of the original foundational goals set prior to the commencement of a few research programs.

Types of AI

There are several forms of AI, each conceived to solve different problems.

AI can be categorized and classified by various different criteria, including the theoretical approach used to design it and the application domain for which it is intended to be used.

Efforts at categorization were directly influenced by some parameters such as the ability to learn a particular task without supervision, obtaining cognitive abilities, and the ability to perform reasoning similar to humans.

Based on these and a complex set of expectations, we will look into the three basic types of AI.

Weak AI

- Also generally known as narrow AI, weak AI can be used to execute narrow and repetitive tasks.
- Weak AI functions are based on a preexisting combination of logic and data.
- User inputs are processed based on the same logic, and hence, weak AI lacks self-consciousness and aggressive learning abilities.
- Some prominent examples of weak AI implementations are voice assistants, chatbots, and linguistic expert systems.
- Due to the narrow implementation of logic, weak AI is suitable for scenarios where the user's inputs and expected outputs are well defined.

- Chatbots receive textual inputs from a user and process the input data to identify the information required to convert the textual input into some form of action. Chatbots are generally applied in the areas of e-commerce and support where human intervention may not be necessary all the time.
- In the case of online shopping, the presence of a chatbot provides a personal touch to the user and provides the user with a traditional way of communicating with the system instead of conventional searching. Similarly, in the case of support, the application of chatbots can reduce the per capita cost of maintaining a support team for a product.
- It is also important to realize that newer generations of users are more prone to communicating via messaging over conventional phone calls. Chatbots can leverage this cultural shift and also reduce the potential friction involved in the support process.

Strong AI

- Also generally known as Artificial General Intelligence (AGI), strong AI can be used to apply aggressive learning abilities to solve problems with multivariate range.
- Strong AIs are capable of perception, being conscious of the given problems and aided by its cognitive abilities.
- Strong AI has been one of the more prominent fields of research due to its potential ability in cutting down operational costs in existing processes, as well as exploring applications in uncharted territories.
- Due to the capabilities of strong AI to reason and make optimal judgments, applications of strong AI can be observed in the business landscape.

- Expert systems, machine learning, and deep learning techniques are some of the most renowned manifestations of strong AI.
- These manifestations are commonly used by businesses due to their ability to predict and reason based on given data points.
- Some other examples of strong AI applied across various industries include Computer Vision (CV), Natural Language Processing (NLP), Natural Language Understanding (NLU), and Reinforcement Learning (RL).
- For example, NLP can be used to adapt a system according to the user's mood and help the system to communicate with the user more effectively compared to weak AI implementations.
- Similarly, strong AI can also be applied for efficient language translation with greater accuracy in the conversion between languages

Super AI

- Super AI, or Artificial Super Intelligence (ASI), is the hypothetical ability of a computer to surpass the consciousness of the human mind.
- It is speculated by many experts that an AI may achieve this stage after reaching the singularity.
- It is also widely believed that super AI would ultimately lead to the technological dominance of computers over human thinking.
- Although super AIs are nonexistent, there are a handful of institutions and organizations preparing for the leap from AGI to super AI, with extraordinary focus on genetic engineering, artificial digital neurons, and quantum computing. The application of super AI is surprisingly unclear at the moment, as few can comprehend what could be achieved after the singularity.

- However, a few primitive variants of super AI are expected to help in exploring space, creating new languages, and predicting unintended consequences in war. Singularity is a hypothetical situation proposed by John von Neumann wherein the AI's cognitive capabilities surpass that of a human mind.
- As a result, it is believed that singularity could lead to a varied range of outcomes in which the extinction of the human race is considered a probable outcome.
- With the preceding understanding of weak AI, strong AI, and super AI on a theoretical basis, let's now examine how AI is manifested practically in various forms.

Forms of AI and approaches

- Implementations of AI have come in various forms due to the varying nature of the intended application and the technology available for the solution.
- Hence, AI has been manifested in code in various forms, utilized by a wide range of developers in different domains for respective problems

Statistical and expert systems

- Statistical systems were one of the most primitive forms of AI, dating back to the late 1960s.
- As the name suggests, statistical approaches used a huge amount of data to arrive at the most desirable result.
- However, it was soon recognized that the results were virtually unrelated to real-world scenarios and produced output only based on the AI’s rational decision-making ability.
- These limitations led to the decline of statistical AI, paving the way for expert systems in the early 1980s

In the following Venn diagram, we can see various forms of AI:

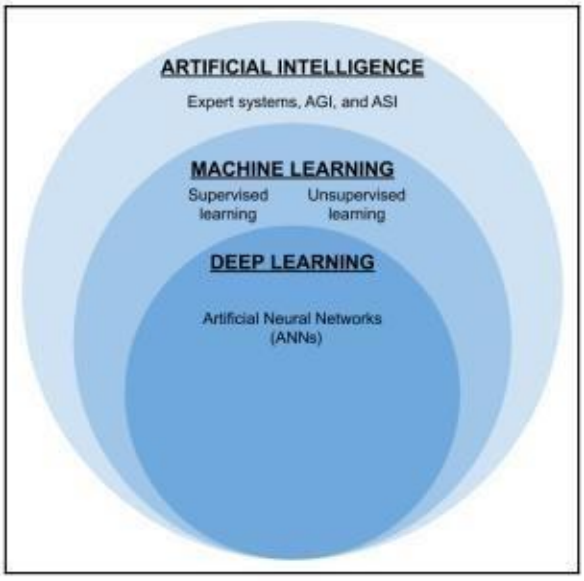


Fig 2.2: Relationships between forms of AI

Expert systems

- They were a mature form of strong AI with the ability to mine datasets and derive answers that were more related to the context of the problem.
- This leap was aided by information theory, combined with new abilities in hardware.
- Although expert systems were developed in the early 1960s, they only became affordable during the 1980s thanks to the PC revolution.
- Unlike the scientific approaches used by statistical AIs, expert systems leveraged semantic and linguistic programming to arrive at the expected outputs with high probability

Machine learning

- Machine learning is a form of AI that depends on a preexisting dataset as input, with or without a variation in the expected output to produce human-like thinking based on applying a mathematical model on the given data.

- The term was coined in 1959 by Arthur Samuel, one of the pioneers of AI research at IBM.
- If a particular machine learning algorithmic system aims to extrapolate a result based on the given forecast data, it is called predictive analytics, which is used in various emerging fields of computer applications.
- Although similar forms of AI existed before machine learning, it is believed that most of the research has now been consolidated under this label since the early 1990s, also known as the golden age of machine learning.
- Some of the earliest applications of the concepts of machine learning were CV, email spam filtering, and operation optimizations.
- There are three approaches to machine learning algorithms that have been observed in use very consistently in the recent pasts.

Supervised learning Models

- In this approach directly depend on the datasets that serve as the input for training data, and also on the expected outputs.
- The model uses the input data in the training phase by itself, learning outcomes associated with a few ranges of inputs in the form of labeled samples.
- Such samples are fed into the algorithm model to be able to successfully achieve the expected result. Usually, the expected outcomes are either in the form of classification, regression, or prediction.

Unsupervised learning

- Under this approach, the models are provided with the training data as the input, but lack any expected output to be specified by the end user.

- This approach is justified as the intended outcome of this practice is to gain visibility on the unexplored rational commonalities present within the data.

Reinforcement learning

- This is a reward-based learning approach used to achieve all-round optimization by enforcing a wide range of techniques in rewarding successful agents in a cumulative manner.

Neural networks An Artificial Neural Network (ANN),

- It is also called deep learning, is a group of synthetic neurons forming a circuit to solve difficult problems. This is a specialized form of AI.
- However, unlike machine learning algorithms, the heuristics and execution patterns in ANNs are not linear, and hence this kind of AI can be found in a wide range of applications such as autonomous driving, textual and facial pattern recognition, decision-making software for trading, digital art, and drug formulation.
- The following diagram is a general representation of a neural network, along with the basic relationship between the three layers—Input, Hidden, and Output:

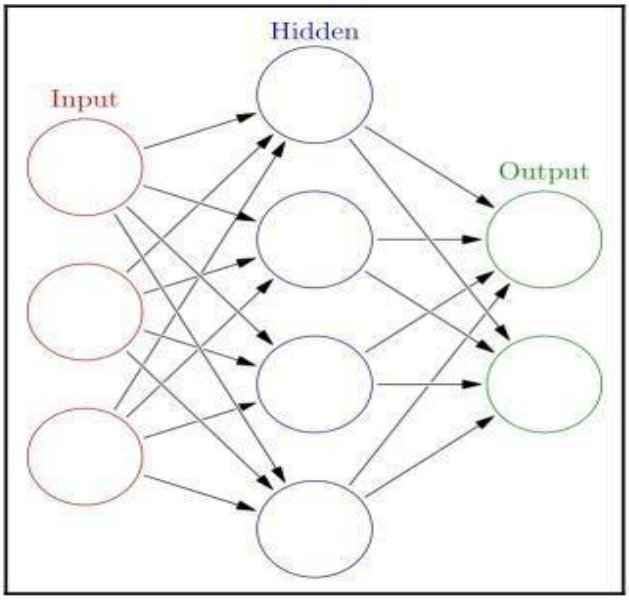


Fig 2.4: Pictorial representation of a typical neural network

Evolutionary computation

- Evolutionary computation is a sub-field of artificial intelligence (AI) and is used extensively in complex optimization problems and for continuous optimization.
- It has long been identified as a key enabler for the future of biotechnology.
- Evolutionary AI in forms such as genetic algorithms have also been one of the early fields of research in this domain.
- AI has been helpful in analyzing, simulating, and predicting the behavior of mutations in our bodies.
- It is also notable that some AI practices in genome research have been actively criticized, fearing severe repercussions for the future of mankind in the process of experimentation.

Swarm computation

- Apart from behaving in a centralized manner, AI is also significantly known to have disrupted the functioning of distributed and collaborative computer systems. Swarm

intelligence is the capability of a group of systems to achieve a common goal by cooperating in an ordered manner.

- Swarm intelligence is leveraged to understand group behaviors and optimize processes wherever possible.
- Multiple agents work together based on a set of heuristics to consume vast amounts of data and produce meaningful results based on the coordination between one or more computing devices.
- Applications of swarm AI can be observed in robotics, logistical automation such as truck platooning, and so on

AI platforms and tools

- One of the major signs of maturity in an AI ecosystem is identified by the application of new tools and frameworks. Other indicators such as innovation, interoperability, and accuracy also play a major role in identifying the maturity of an AI ecosystem and its tools. In the following sections, we can see a short list of a few AI platforms and tools that are leveraged by many engineers around the world

TensorFlow

- TensorFlow is an open source project anchored by internet giant Google.
- It is a sophisticated framework used for machine learning projects.
- It offers a wide ecosystem with comprehensive toolkits, libraries, and documentation that enable researchers and developers to easily design, build, and deploy machine learning-powered applications.
- Find out more about the tools at https://www.tensorflow.org.

Microsoft Cognitive Toolkit

- The Microsoft Cognitive Toolkit (CNTK) is an open source toolkit for commercial-grade distributed deep learning.

- It describes neural networks as a series of computational steps by using a directed graph. Find out more about the toolkit on GitHub, at https://github. com/Microsoft/CNTK.

  IBM Watson
- It is an open source, multi-cloud platform that lets you build powerful models and deploy them with a smoother, more streamlined experience.
- This IBM suite offers enterprise-ready AI services, applications, and tooling with rich support.

2.6 The benefits of combining blockchain and AI

Simply put, the business benefit of using AI is the reduction of costs, and the business benefit of using blockchain is that transparency is enabled in processes. When both technologies are used together, you can apply a new class of solutions to a wide variety of problems in today's world that lack transparency and cost efficiency.

- **Authenticity**

  Blockchain's digital record offers insight into the framework behind AI and the provenance of the data it is using, addressing the challenge of explainable AI.
- This helps improve trust in data integrity and, by extension, in the recommendations that AI provides.
- Using blockchain to store and distribute AI models provides an audit trail, and pairing blockchain and AI can enhance data security.
- **Augmentation**

  AI can rapidly and comprehensively read, understand and correlate data at incredible speed, bringing a new level of intelligence to blockchain-based business networks.

- By providing access to large volumes of data from within and outside of the organization, blockchain helps AI scale to provide more actionable insights, manage data usage and model sharing, and create a trustworthy and transparent data economy.

Automation

AI, automation and blockchain can bring new value to business processes that span multiple parties removing friction, adding, speed and increasing efficiency.

For example, AI models embedded in smart contracts executed on a blockchain can recommend expired products to recall, execute transactions such as re-orders, payments, or stock purchases based on set thresholds and events, resolve disputes, and select the most sustainable shipping method.

- **Impact of AI & Blockchain on Healthcare**

Definitely, the introduction of AI Blockchain has revolutionized the operations of the healthcare sector. AI in healthcare will help to manage customized medicines and treatment plans. AI has the potential to enhance almost every side of the healthcare industry.

In addition, it will help us to improve the process of disease detection and diagnosis. Meanwhile, Blockchain will help to easily safeguard the historical records of the patient's medical data. In simple terms, deep insights to improve treatment along with electronic data records can effectively help to enhance the healthcare industry.

- **Merge of Artificial Intelligence and Blockchain technology in Retail**

Both AI and Blockchain technology offer new opportunities to users in the retailing sector. Combining Blockchain and AI will increase the utilization of AI in retail processes.

It will encourage retailers to effectively record detailed insights into the customer's data in immutable locks. Therefore, this results in detecting the involved factors at the time of any inconvenience effectively. Furthermore, the merging of Blockchain & AI will also update the payment processes and reduce the possibility of any fraud in the process.

- **Utilizing AI & Blockchain in Democracy**

Evidently, the implementation of AI Blockchain will surely transform the way a government functions. Improving the government system with the latest technologies can benefit the country in various ways. The introduction of AI in Blockchain will help us to reshape the functioning of government more democratically and securely.

The modern Blockchain AI will add a layer of transparency and security along with increased access to data to wide groups. In addition, the integration of Blockchain & AI in e-voting procedures will effectively benefit managing the process with immutable data while making the results available to all citizens in real-time.

- **Artificial intelligence crypto merges path with Finance**

Blockchain & AI together can greatly help to transform financial services by providing improved transactions to users. The introduction of Artificial

Intelligence crypto or crypto AI will help to streamline the complex process in the finance sector.

AI can help us to detect and prevent multiple financial crimes easily. On the other side, Blockchain will benefit to decentralize the entire process. Hence, making the system more secure and efficient than the traditional system.

Case studies

IPwe

- It uses AI and blockchain to discover and transact IP
- IPwe has created the Global Patent Registry (GPR), the world's first blockchain-powered patent platform to manage intellectual property, increasing visibility and flexibility for both buyers and sellers.

Heifer International and IBM aiding coffee and cocoa growers

- Blockchain technology from IBM Food Trust and powerful AI from the IBM Watson Decision Platform for Agriculture are improving farm-level decision-making and speeding transactions.

2.2 Centralized versus distributed data

- Databases have been primarily consumed in a centralized manner since their earliest applications, dawning in the mid-1960s.
- Databases were meant to provide **direct access to the information** requested by either users or client applications.
- This centralized approach was influenced majorly by the **client-server architecture** introduced in the early days.
- This design paradigm was popularly followed by the market with successful products in commercial- and consumer-level databases such as **DB2 and dBASE,** respectively.

- Relational Database Management System (RDBMS)-based databases followed the client-server model.
- These centralized databases managed data redundancy by making regular copies of the data on disks and magnetic tapes.
- However, the dawn of **NoSQL** in the 2000s is credited with distributed databases that scale horizontally, with higher tolerance to failures and less chance of data corruption.
- NoSQL databases are able to manage data **without schemas** and facilitate operations between clients, along with reasonable data consistency maintained across multiple nodes.
- In contrast, RDBMSes needed schemas and maintained a point-to-point relationship between the client and the server. Backups were not visible to the clients, and rollbacks had to be initiated by database administrators to read any potentially lost data.
- Newer NoSQL-based databases such as MongoDB addressed some of these issues.
- NoSQL-based databases could also power pseudo-decentralized projects by persisting business data on a network of computers hosted by all the stakeholders of an initiative, but the main limitation of such a setup is that such databases lack transparent record keeping.
- In addition, these databases do not allow the voting and execution of business logic with cryptographic security inherent to the network.
- These capabilities must be built externally in order to compete with blockchains.

Motivations for using decentralized databases

- Over the past three decades, most user data on the internet has been stored in either a centralized or a distributed fashion.

- The common issue with both approaches is that very few stakeholders administer, manage, and sometimes own all the data.
- Recent events of breaches and data abuse at some of the reputed social networking sites and online aggregator services highlight the fact that we are no longer in control of our own data.
- Careless administration of data can lead to such detrimental events and create panic among users and business stakeholders
- In the past few years, multiple accounts of data breaches and abuse have called for fundamental innovation in how data can be defined, stored, accessed, and managed. This has motivated many individuals and organizations across the world to build decentralized databases in the past decade.

Some of the common properties of decentralized databases are detailed as follows:

- Allow anybody to store and access information across boundaries
- Allow anybody to participate in persisting the data
- Persist the updated data and record the changes made to the data in a traceable manner
- Allow all users to control and manage their data by facilitating the persistence of encrypted data. These values are well represented and contrast with traditional databases, as shown in the following diagram

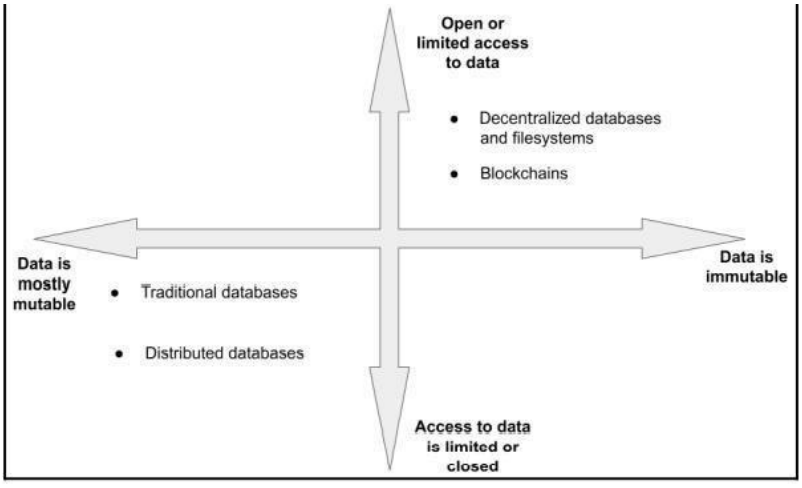


Fig 4.1: Comparing the values of traditional database patterns with decentralized database patterns

- In the preceding diagram, we can observe the y axis representing the modes of accessing the business data or user data.
- Along the x axis, the mutable properties of the data are represented.
- The first quadrant defines whether the data is immutable and accessible to the general public.
- The third quadrant defines whether the data is mutable and inaccessible to the masses.
- Decentralized databases and filesystems fall under the first quadrant.
- Most traditional and distributed databases fall under the third quadrant.

  Note: Immutability does not mean permanence—decentralized databases offering immutability may not store all the versions of changes forever. The data might get garbage collected and recent changes may be persisted.

Contrast and analysis

Decentralized databases organize information in a new manner that offers control back to the users, by allowing users to specify where data can be stored, along with effective governance.

	Centralized database	Distributed database	Decentralized database
Ownership	Owned and hosted by one company.	One or more than one company can host the database.	Anyone with sufficient system resources can join and host the database.
Data definition	Most of the centralized databases are RDBMS-based, hence data definition is mandatory. Schemas are required to store data.	Most distributed databases are NoSQL-based, hence data definition is not mandatory. Schemas are optionally used.	Most decentralized databases use content addressing, hence there is no need for schemas to store data.
Failure	Single point of failure. The point-to-point connection between the app and the database will not work, and the app cannot function until the database is fixed.	There is no single point of failure. Apps can read from another node if the database fails to provide information from one node.	There is no single point of failure. Apps can read from another node if the database fails to provide information from one node.
Redundancy management	Backups of the data are stored on disks and magnetic tapes, securely stored in a physical location.	Replication of data is fixed, and all the nodes may comply with the replication policy set by the database admin.	There is no replication policy in public networks. There is a guarantee of replication upon incentivization only. However, policies can be built for permissioned decentralized databases used in consortiums.
Access and transparency	The connection to the database is closed. Only dedicated applications can access the database with credentials.	The connection to the database is neither closed nor open, but it is permissioned. Only permitted apps can access the database.	Users can access the data openly, with just a hash of the file or data. Users who care about privacy need to encrypt their data before storing it.

With the contrasts made in the preceding table, the analysis continues as follows.

- In the second generation of Web (Web 2.0), applications have predominantly depended on centralized and distributed databases to leverage the new fuel in the market, which is user information.
- After multiple breaches, scandals, and reports of data abuse, the

- internet citizen is warier about where data should reside, and what degree of control should go back to applications.
- As we are entering Web 3.0, most decentralized applications may not consider using traditional databases, as they do not support the properties of decentralized databases.
- Also, it is important to realize that some of the legacy applications in various domains running on Web 2.0 are considering using decentralized databases, to ensure that new demands from conscious users are met.

2.3 Blockchain data – big data for AI analysis

Blockchains generate enormous amounts of data due to their transactional nature.

Prominent blockchain networks is as follows:

Blockchain	Total size of the blockchain (approx. in GB)
Bitcoin	323
Ethereum	4,233

- Some experts in the industry have speculated that the size of blockchains will soar 10 times more, due to an increase in the number of users and the adoption of public networks in the business-to-business (B2B) landscape.
- The growing size of blockchain data enables new avenues of growth for data science.
- The application of AI and analytical practices on this giant heap of transactional data in the blockchain can create a large impact on most of the current blockchain products.
- Analytics derived from qualified data sources such as blockchain can also lead to new digital transformation projects.

- In order to facilitate this, we need a secondary source of information that can persist user data, business data, and the transactional data generated by the blockchain.
- Decentralized databases can persist this data in a cryptographically secure and verifiable manner.

The following diagram depicts how AI models can leverage decentralized databases:

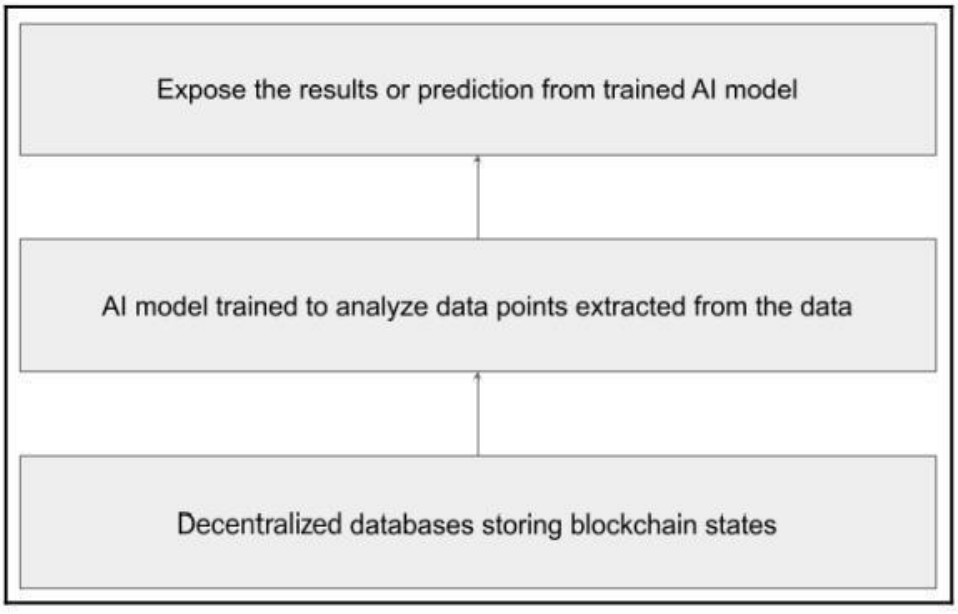


Fig 4.2: Generic illustration of AI modeling using decentralized databases

- As shown in the preceding diagram, data residing on the decentralized databases is qualified to be used for training suitable AI models.
- Most of the transactional data stored on the decentralized databases is inherently valid to be considered a data point, meaning that the transactions are signed by the user wallet with an intent.
- Hence, such transactions are not trivial in their nature. When suitable AI models are trained using this transactional data, they can produce better results.

- The results generated by training AI models with such qualified data can be used in systems and applications of various sorts.

Improvements that may be possible through using decentralized databases

Building better AI models using decentralized databases

- With more data about to reside on the blockchain, it is safe to assume that AI modeling becomes easier and more ethically aligned.
- Training AI can be enhanced by transactional data confirmed with private keys and fees paid by users.
- Such data need not be inherited from third parties but, instead, could be accessed from blockchains such as Ethereum and secondary decentralized database networks such as the InterPlanetary File System (IPFS).
- This also empowers current models, such as predictive analytics models, in detecting fraudulent attempts and Sybil attacks in an effective manner.

Immutability of data – increasing trust in AI training and testing

- Clean and structured data has been in demand by data science for almost a decade now.
- In the midst of data scandals, getting legitimate access to perfect data is almost always complicated, due to compliance issues in following some of the cross-border data-harboring rules.
- By using blockchain, a Public Key Infrastructure (PKI) inherently comes to our rescue, protecting the privacy of user data with a joint signature between data vendors and users.

- This may serve as proof of consent and maintains accountability in the AI industry to build accurate but ethical models.

Better control of data and model exchange

- Projects such as Ocean Protocol have been proactive in establishing fair and open markets for data providers as well as consumers.
- Blockchain enables these transactions or the purchase of data in an ethical manner, without consciously giving away privacy elements.

Blockchain analytics

- Blockchain analytics **aims at identifying, clustering, and representing data stored on blockchains**. More and more companies operating with cryptocurrencies are using Blockchain analytics tools to analyze transactions and assess the level of risks to meet regulatory requirements worldwide.
- Most applications on public blockchains derive value based on the transactional transparency achieved by the network.
- Lately, this supporting feature has been leveraged by various institutions, ranging from for-profit entities to law enforcement agencies, to track user behavior.
- While some of the analytical capabilities have helped society, many others are considered as strategic Intellectual Property (IP) by corporations of all sizes to acquire market share by using these smart algorithms for better User Experience (UX).
- In retrospect, blockchain analytics practices have also attracted unwelcomed criticism on how they affect the privacy of the user by mining too deep into the transactions.
- Chainanalysis, Neutrino, and Elliptic are some of the early movers in this space that have an active community and customers.

In the following diagram, we can observe the application of blockchain oracles and decentralized databases to effectively run models:

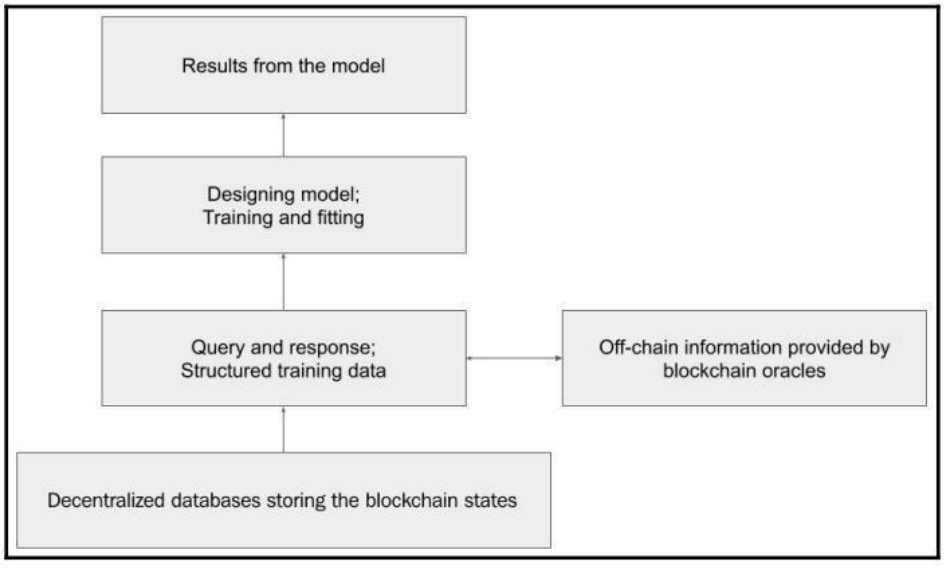


Fig 4.3: Blockchain data analytics with oracle

2.4 Global databases

- Decentralized databases use innovative cryptographic and networking techniques to address some of the key issues such as censorship, surveillance, and permissioned access to confidential information.
- Several efforts are being made by the projects outlined next to bring a new order to how data can be treated in the public sphere as well as the enterprise sphere.

Some of the top global decentralized databases are:

IPFS

- IPFS is a distributed filesystem that allows users to host and receive content in a peer-to-peer (P2P) manner, eliminating any need for intermediaries, for storing or accessing data from any corner of the world.

- IPFS allows users to store and serve data in a censorless manner.
- The data remains persisted in the network as long as somebody in the network values the data.
- Although there may not be a monetary incentive for users who persist the data on their computers, the data may be valuable and reusable for other users in the network.
- Hence, data on IPFS can be virtually hosted forever, as long as the need for the data exists in the network.
- Notably, IPFS has been considered as one among the many de facto decentralized databases by DApp developers for their applications.
- Content accessed by anybody on IPFS is cryptographically verified, ensuring that information has not been tampered with.
- IPFS has been used in many cases to circumvent transparency challenges, where access to global information was inhibited.

Some of the notable uses of IPFS as a global database are listed as follows:

Filecoin:

- A decentralized storage network, uses IPFS to leverage unused storage space in computers and incentivizes users to host data for a fee.
- Fees are collected from users in the form of micropayments to serve smaller chunks of data from the hosted computer using the Filecoin token.
- These tokens are paid to the owner of the computer hosting the data with the help of smart contracts. Reportedly,
- Filecoin was one of the largest Initial Coin Offerings (ICOs) ever, grossing USD 250 million.

Wikipedia

It was mirrored on IPFS when access to the online encyclopedia

It was restricted in Turkey on April 29, 2017.

The following diagram depicts the internal components of IPFS and the dependencies among them to provide storage and access to data:

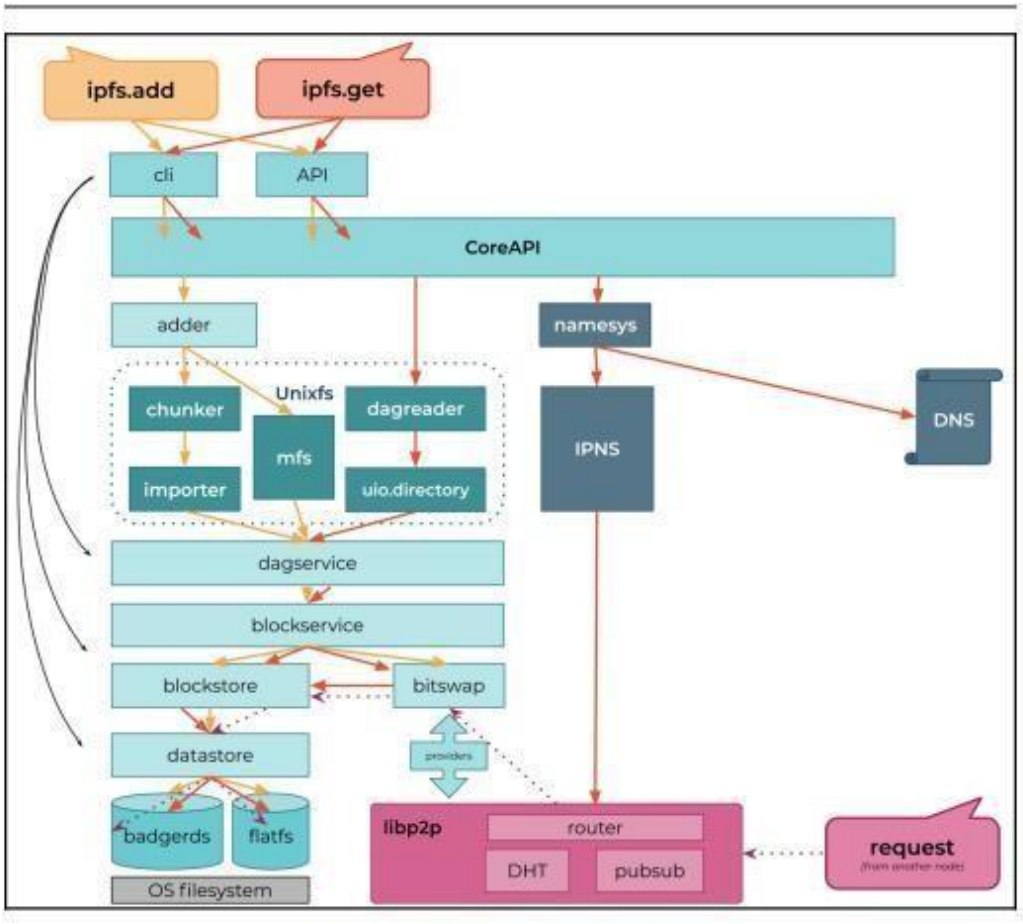


Fig 4.5: All the internal components and dependencies of IPFS

MóiBit

- MóiBit is a personal decentralized secure storage network with the power of immutability and provenance of blockchain systems.
- It offers software-defined decentralized file storage services and groundbreaking measures to reduce the unneeded cost of storing

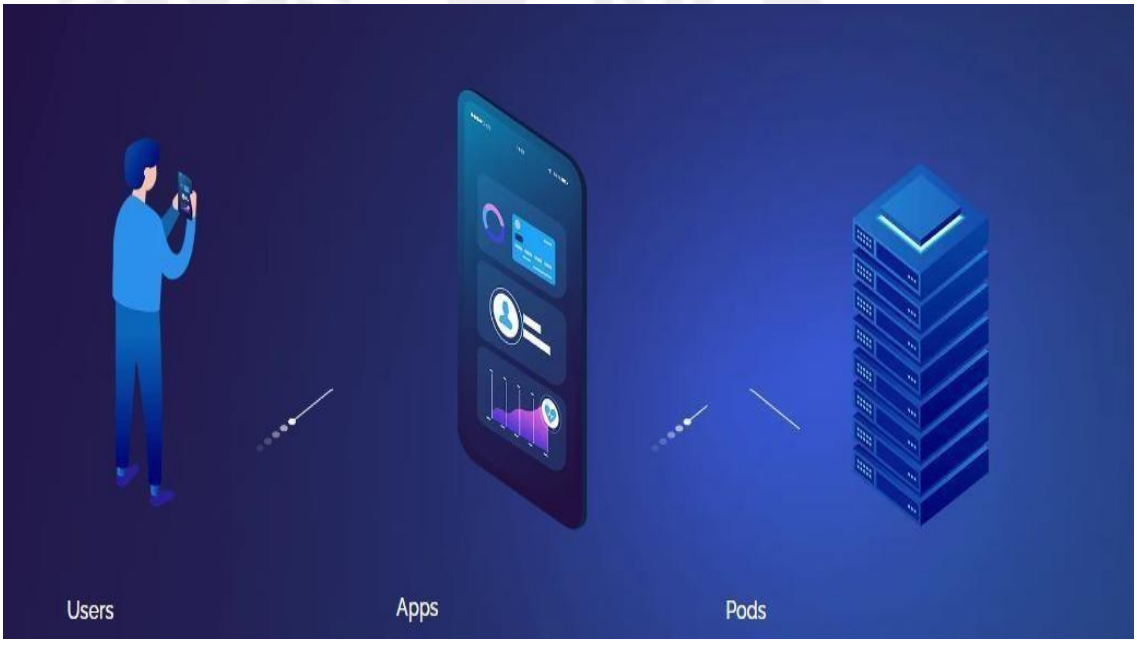
data on a blockchain, yet apps can store their data in a reliable and secure environment provided by IPFS.

- MóiBit extends some of the enterprise features to IPFS, thereby enabling swift development and integration of apps into MóiBit, in just the way you would integrate an app with a cloud database.
- Unlike IPFS, MóiBit offers permissioned networks by deploying a group of nodes that cannot be discovered and used by public networks.
- This allows enterprises to dedicate an infrastructure and enjoy the technical benefits of IPFS with their stakeholders in a federated manner.
- MóiBit also supports client-level encryption and many other flexible features through its Software Development Kit (SDK).

Solid

- Solid is a clever combination of the three powerful words in the age of the internet—social linked data.
- The project is led by Sir Tim Berners-Lee.
- Solid's aim to give back users control of their data is made possible by the powerful combinations of P2P networking and linked data.
- All data pertaining to a user is stored in a decentralized data store called as **Personal Online Datastore (POD).**
- PODs can be hosted on a PC, an on-premises server, or a Virtual Machine (VM) managed in the cloud.
- Pods are like secure personal web servers for data.
- Any kind of data can be stored in a Solid Pod, from structured data to regular files.
- People can grant or revoke access to any slice of their data as needed.

- All data in a Solid Pod is stored and accessed using standard, open, and interoperable data formats and protocols.
- Solid uses a common, shared way of describing things and their relationships to one another that different applications can understand. This gives Solid the unique ability to allow different applications to work with the same data.
- Anyone or anything that accesses data in a Solid Pod uses a unique ID, authenticated by a decentralized extension of OpenID Connect. Solid's access control system uses these IDs to determine whether a person or application has access to a resource in a Pod.
- Applications depending on the user's information need active consent from the user to access personal data. Some examples of personal data are health records, financial information, and so on.



Users

Users control which entities and apps can access their data.

Apps

Apps can access rich stores of data from any Pods, with user permission.

Pods

Pods store user data in an interoperable format and provide users with permissioning controls.

Solid offers:

True data ownership — Users should have the freedom to choose where their data resides and who is allowed to access it. By decoupling content from the application itself, users are enabled to do so with Solid-compliant apps.

Modular design — Because applications are decoupled from the data they produce, users will be able to avoid vendor lock-in, seamlessly switching between apps and personal data storage servers, without losing any data or social connections.

Reusing existing data — Developers will be able to innovate by creating new apps or improving current apps, all while reusing existing data that was created by other apps.

The Solid specification consists of the following components:

POD Provider — POD Providers are similar to cloud storage services like Dropbox and Microsoft OneDrive. The Provider hosts the physical or virtual servers on which the user's resource data is stored.

Resource Storage — Consists of both non-RDF data (e.g. jpeg or pdf files) as well as RDF data stored as JSON-LD. All data are stored as files. Data is sourced from and used by any Solid-compatible applications the user loads.

Linked Data Platform (LDP) — PODs contain code enabling them to work with Linked Data. PODs can contain both "private" and "public"

LDP containers, each with different ACL rules established by the user that determine what data is shared and what data is private.

WebID — A web authentication protocol. This is Solid's decentralized and openly extensible identification system.

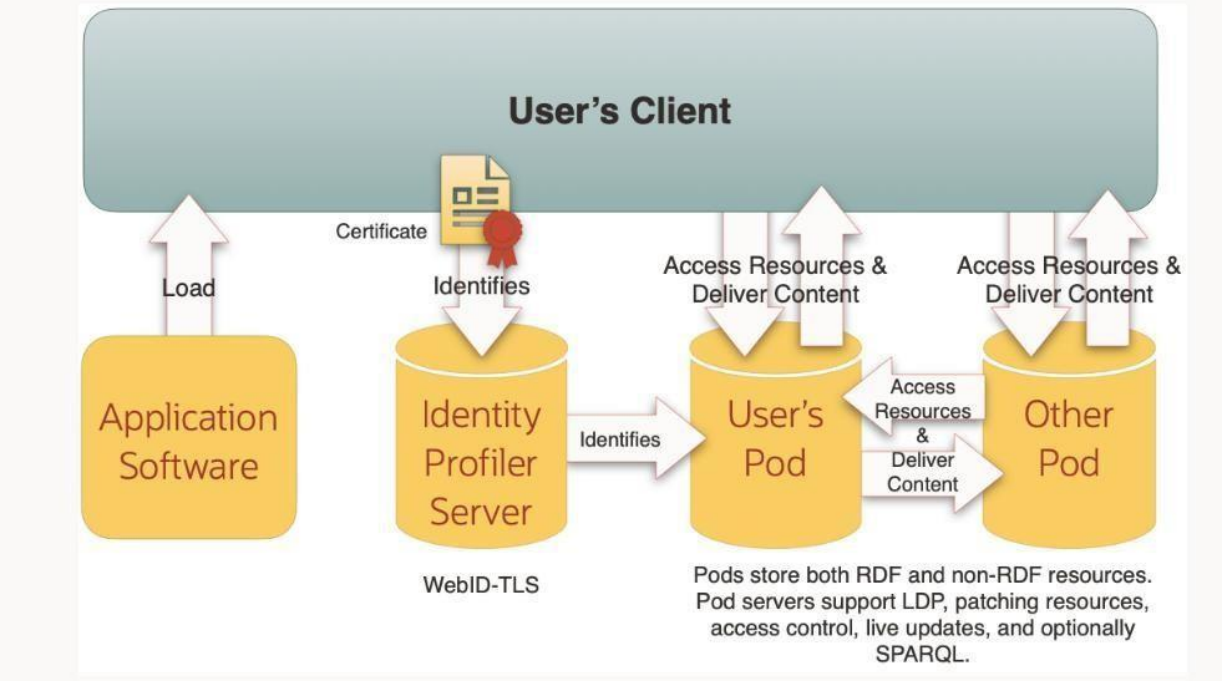
Notification Support — Software within PODs that alert users to changes in either content or access

Patch Update — Patch capabilities allow software running in Solid PODs to be updated by authorized parties.

Access Control List (ACL) — ACLs are files that keep track of who has access to what data and when. ACL support enables PODs to keep track of who has been authorized to access the user's data.

HTTP — Solid uses HTTP to transmit data securely over the web as well as between components within the PODs themselves

REST — This enables Linked Data to be created, retrieved, updated, and deleted over HTTP.



Application data in Solid is stored in documents that are identified by a Uniform Resource Identifier (URI).

Solid distinguishes between structured data represented using the Resource Description Framework (RDF), and unstructured data can be of any type (e.g., videos, images, Web pages, etc.).

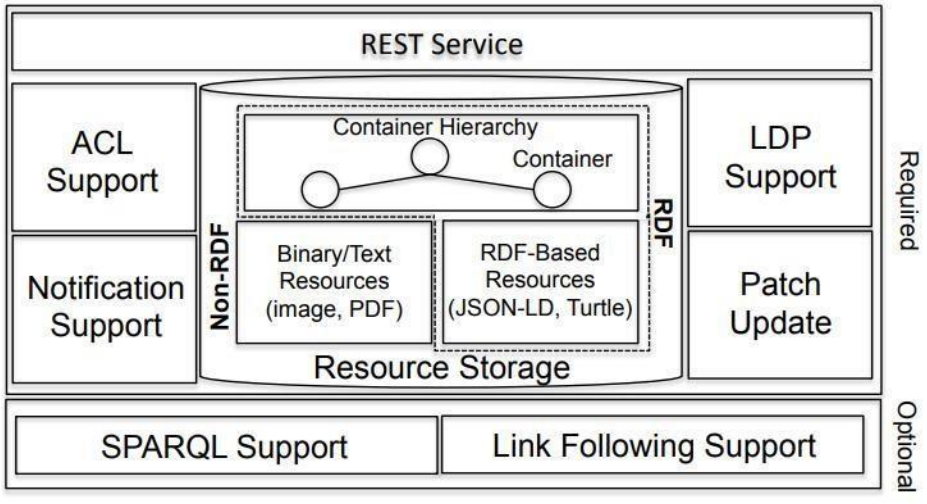
This allows structured data to be parsed and serialized in various syntaxes like Turtle, JSONLD (JSON with a ”context”), or RDFa (HTML attributes).

RDF follows the REST principles in which resources have individual URIs. Solid applications read and write data stored in users’ pods via RESTful HTTP operations.

Besides LDP support, Solid servers may offer optional SPARQL support. Servers that support SPARQL allow applications to express complex data retrieval operations, including operations that require server-to-server communication via link-following SPARQL.

This simplifies Solid application development, since it enables a developer to delegate complex, multi-pod data retrieval operations to the server.

Pod Architecture



A pod stores RDF and non-RDF resources. Pods use LDP to organize data into containers that group together resources, giving each container and resource their own URI. A pod server supports patching resources, access control lists (ACLs), live updates, and optionally SPARQL.

Ocean Protocol

- Ocean Protocol is founded in 2017, it uses blockchain technology to connect data providers and consumers.
- Ocean is an open-source protocol that aims to allow businesses and individuals to exchange and monetize data and data-based services.
- Ocean Protocol is a decentralized protocol with services for users to consume storage and compute.
- The protocol exhibits a trust framework that offers services to share user data in a safe manner, enabled by traceability and privacy.
- Users are offered granular control over their personal data. In simple terms, users can provide access to their data and earn revenue, and consumers access data by buying the data.
- Notably, Ocean Protocol also offers a wide range of third-party marketplaces and services that allow users to commercialize their data. This means that interested nodes can become a data provider by consent and earn revenue from data consumers.
- All these commercial activities are made possible through keeper smart contracts. The data marketplace and services are enabled by a tokenized layer that offers compute, storage space, and consented user data for sale.
- Built on top of the Ethereum blockchain, the Ocean protocol uses 'datatokens' to gate access to data sets. The tokens are then redeemed by users who need access to the information.

- Ocean is seeking to make the data sets on its platform available to startups and researchers, without the data having to leave the hands of those who store it.
- Ocean's software is built to facilitate this data exchange, linking users who need data or do not have resources to store it, with those who have resources to spare. In return for their work, providers are awarded OCEAN, Ocean's native cryptocurrency.
- The OCEAN token (sometimes referred to as OCEAN coin or OCEAN crypto) is designed to be multipurpose, and is used to validate the best datatokens and to allow users to both participate in governance and buy and sell data.
- Further, Ocean enables marketplaces to implement its protocol to connect parties and facilitate transactions between them. For example, Ocean Market, created by the Ocean team, is a place where datatokens are publicly available for trade.

The following are the main components of Ocean Protocol:

Ocean Network: The Ocean Network is a decentralized network of nodes that run the Ocean Protocol software. The network is designed to enable secure and decentralized data sharing, storage, and processing.

Ocean Marketplace: The Ocean Marketplace is a decentralized marketplace that connects data providers with data consumers. It provides a platform for publishing, discovering, and consuming data assets.

Ocean Token (OCEAN): OCEAN is the native token of the Ocean Protocol. It is used as a means of payment for data services and as a governance token for the Ocean DAO, which is responsible for managing and governing the protocol.

Data Providers: Data providers are individuals or organizations that publish data assets on the Ocean Marketplace. They can earn OCEAN tokens by selling their data assets to data consumers.

Data Consumers: Data consumers are individuals or organizations that purchase data assets from the Ocean Marketplace. They can use the data assets to train machine learning models, conduct research, or create new products and services.

Compute-to-Data: Compute-to-Data is a feature of the Ocean Protocol that enables data processing to be performed on encrypted data without revealing the data itself. This allows data providers to maintain control over their data while still allowing data consumers to perform computations on it.

Using this method, datatokens allow consumers to leverage certain portions of a dataset to run specific computing jobs, thus supporting the development of research or artificial intelligence, while keeping certain user information private.

Providers can therefore keep datasets on their own servers, and sell portions of it to specific parties, or for particular use cases.

Ocean Compute-to-Data Marketplace: The Ocean Compute-to-Data Marketplace is a decentralized marketplace that enables data consumers to access compute services from data providers without revealing the underlying data. It provides a platform for securely and privately performing machine learning and data analytics on sensitive data

The Ocean Market is an automated market maker (AMM) that was built to facilitate the minting and exchange of datatokens.

Automated market makers use a collection of liquidity pools, similar to Uniswap and Balancer, that allow each trade to settle through a set of smart contracts.

When a provider seeks to mint and publish a datatoken, they specify several fields to inform consumers about their product, including a title, description, price, and a URL where the data can be found, which is then encrypted and stored on Ethereum.

Ultimately, when consumers decide to redeem a datatoken, the data is decrypted and subsequently downloadable directly from the wallet connected to the marketplace.

How does Ocean Protocol work?

The Ocean Protocol uses custom programs called smart contracts to ensure each datatoken can be exchangeable across Ethereum's blockchain and within its decentralized applications.

Storj

- Storj, pronounced as storage, is a decentralized cloud-storage platform.
- Storj is a cryptocurrency blockchain platform powering a decentralized system for digital file storage.
- The Storj network is powered by computers worldwide called nodes and requires the Storj (STORJ) digital currency for payment.
- Storj was founded in 2014 and operates with more than 10,000 active nodes with more than six petabytes of available storage capacity.
- Users pay for storage space with the Storj token, an ERC-20 token that works on the Ethereum blockchain.

- Use cases include video storage and streaming, software distribution, backups, and cloud-native apps.
- The Storj cryptocurrency operates on the Ethereum network, which means that anyone with an Ethereum wallet can buy, sell, or exchange the Storj token.
- Storj is a unique cryptocurrency designed to solve problems with cloud data storage.
- Use cases include video storage and streaming, software distribution, backups, and cloud-native apps.
- Like other cloud storage solutions, users can pay to upload their files beyond a free tier.
- Files are stored in an encrypted format on nodes across the region you choose, such as the United States, European Union, or Asia Pacific.
- Node owners must meet specific minimum performance requirements to participate. Node owners are paid in Storj tokens to compensate for the storage space, network bandwidth, and other costs related to running a node.

- The Storj platform serves normal users as well as developers through the Storj API.
- The platform is powered by the Storj protocol, a P2P storage smart contract wherein a vendor willing to share an unused amount of storage can lend their system's storage to any Storj customer for a price, without having to know each other.
- The contract, once signed on a mutually agreeable price for the storage, regularly monitors whether the information is still available in the host.
- The storage host can respond along with verifiable cryptographic proof to ensure the contract that data is made available, as agreed.

- If the response is valid, the user pays the node owner, all of which is automated through a smart contract. Storj also has a network of nodes that are willing to help the storage host by replicating and serving the same data in the expectation of a reward. This opens up huge potential for a free market for smaller storage providers.
- Similar to other cloud data service providers, Storj also provides an API for developers to integrate their applications with Storj in order to store application and user data for a fraction of the price in a flexible manner, compared to complicated lock-in contracts from a majority of the traditional vendors.

Swarm

- Swarm is an Ethereum native distributed data storage platform.
- The intention of the Swarm project is to facilitate the persistence of Ethereum's historic public data and enable storage for DApps.
- Similar to the Ethereum network, Swarm also allows anyone to participate in the network by pooling storage resources.
- In return, the individuals hosting nodes in the Swarm network will be incentivized with Ether (ETH) tokens, in return for dedicating their infrastructure. Swarm claims its P2P storage network to be Distributed Denial of Service (DDoS)- resistant and fault-tolerant, as well as censorless.

2.5 Data management in a DAO

- A Decentralized Autonomous Organization (DAO) is a computer program representing a group of stakeholders and entities and is not influenced by external environments.
- A DAO is programmed by a set of rules and governance protocols to ensure that transactions occur between parties without the chance of any conflict.

- A decentralized autonomous organization (DAO) is an emerging form of legal structure that has no central governing body and whose members share a common goal to act in the best interest of the entity. Popularized through cryptocurrency enthusiasts and blockchain technology, DAOs are used to make decisions in a bottom-up management approach.
- Dash and BitShares are some of the earliest implementations of a DAO. In the past few months, many more DAOs have been launched on blockchains such as Ethereum and Bitcoin.

What Is a Decentralized Autonomous Organization (DAO)?

- A decentralized autonomous organization is an entity structure in which tokenholders participate in the management and decision-making of an entity.
- There is no central authority of a DAO; instead, power is distributed across tokenholders who collectively cast votes.
- All votes and activity through the DAO are posted on a blockchain, making all actions of users publicly viewable.
- One of the first DAOs named The DAO was an organization created by developers to automate decisions and facilitate cryptocurrency transactions.
- A DAO must ensure security is prioritized, as exploits can leave a DAO drained of millions of dollars of its treasury savings.

What Is the Purpose of a DAO?

DAO is intended to improve the traditional management structure of many companies. Instead of relying on a single individual or small collection of individuals to guide the direction of the entity, a DAO intends to give every member a voice, vote, and opportunity to propose initiatives. A DAO also strives to have strict governance that is dictated by code on a blockchain.

Components of DAO:

- **No central legal entity:** In DAO, there is no central legal entity, this means that no single entity is responsible for regulating the project.
- **Self-enforcing code:** Smart contracts are created and extensively tested to make sure important details are not overlooked.
- **Token acts as an incentive for validators:** Tokens are used in DAO for validators to motivate them and to ensure active, fair, and quick participation.

Steps For Launching a DAO

There are three major steps for launching a DAO:

- **Smart Contract Creation:** In this step, a developer or a group of developers create a smart contract behind the DAO. It is very important for the developer to extensively test the smart contracts before launching to make sure that they do not overlook important details. After launch, only the rules set can be changed through the governance system.
- **Funding:** After smart contracts are created and launched, the DAO needs to determine a way to receive funding. Sometimes, the tokens are sold to raise funds. These tokens give holders voting rights.
- **Deployment:** Once everything is set up and on track, the DAO needs to be deployed on the blockchain. From this point onwards, stakeholders decide the future of the organization. The developers who created the smart contracts, no longer influence the project.

How DAOs Work

- DAOs rely heavily on smart contracts.

- These logically coded agreements dictate decision-making based on underlying activity on a blockchain.
- The rules of the DAO are established by a core team of community members through the use of smart contracts.
- These smart contracts lay out the foundational framework by which the DAO is to operate. They are highly visible, verifiable, and publicly auditable so any potential member can fully understand how the protocol is to function at every step.
- For example, based on the outcome of a decision, certain code may be implemented to increase the circulating supply, burn of a select amount of reserve tokens, or issue select rewards to existing tokenholders.
- Once these rules are formally written onto the blockchain, the next step is around funding: the DAO needs to figure out how to receive funding and how to bestow governance.
- This is typically achieved through token issuance, by which the protocol sells tokens to raise funds and fill the DAO treasury.
- In return for their fiat, token holders are given certain voting rights, usually proportional to their holdings. Once funding is completed, the DAO is ready for deployment.
- For example, one user that owns 100 tokens of the DAO will have twice the weight of voting power over a user that owns 50 tokens.
- At this point, once the code is pushed into production, it can no longer be changed by any other means other than a consensus reached through member voting. That is, no special authority can modify the rules of the DAO; it is entirely up to the community of token holders to decide.
- The voting process for DAOs is posted on a blockchain. Users must often select between mutually-exclusive options. Voting power is often distributed across users based on the number of tokens they hold.

How to get DAO membership

There are various categories to get DAO membership. Membership can conclude the working procedure of voting and other crucial roles of the Decentralized autonomous organization.

Token-based membership

- Primarily on a decentralized trade, these tokens can be exchanged for permissionless trade. Depending on the type of token, members can acquire full permission for all activities. At the same time, others need to offer contributions in liquidity or any other proof for credibility. Either way, simply having a token offers you access to voting. This is commonly employed to regulate vast decentralized strategies and tokens themselves.

Share-based membership

- Share-based membership is more restrictive yet quite open. All interested members are allowed to enrol into DAO, usually by providing valuable contributions in the form of a task or tokens. Having shares gives members unrestrained ownership and voting rights. Group members are free to exit anytime with their earned share of the profit.

Benefits of DAOs

- There are several reasons why an entity or collective group of individuals may want to pursue a DAO structure. Some of the benefits of this form of management include:
- **Decentralization**. Decisions impacting the organization are made by a collection of individuals as opposed to a central authority that is often vastly outnumbered by their peers. Instead of relying on the actions of one individual (CEO) or a small collection of individuals (Board of Directors), a DAO can decentralize authority across a vastly larger range of users.

- **Participation.** Individuals within an entity may feel more empowered and connected to the entity when they have a direct say and voting power on all matters. These individuals may not have strong voting power, but a DAO encourages token holders to cast votes, burn tokens, or use their tokens in ways they think is best for the entity.
- **Publicity.** Within a DAO, votes are cast via blockchain and made publicly viewable. This requires users to act in ways they feel is best, as their vote and their decisions will be made publicly viewable. This incentivizes actions that will benefit voters' reputations and discourage acts against the community.
- **Community.** The concept of a DAO encourages people from all over the world to seamlessly come together to build a single vision. With just an internet connection, tokenholders can interact with other owners wherever they may live.

Limitations of DAOs

- **Speed.** If a public company is guided by a CEO, a single vote may be needed to decide a specific action or course for the company to take. With a DAO, every user is given an opportunity to vote. This requires a much longer voting period, especially considering time zones and prioritizes outside of the DAO.
- **Education.** A single CEO is much easier to keep comprised of company developments, while tokenholders of a DAO may have ranging educational backgrounds, understanding of initiatives, incentives, or accessibility to resources. A common challenge of DAOs is that while they bring a diverse set of people together, that diverse set of people must learn how to grow, strategize, and communicate as a single unit.

- **Inefficiency.** DAOs run a major risk of being inefficient. Because of the time needed to administrative educate voters, communicate initiatives, explain strategies, and onboard new members, it is easy for a DAO to spend much more time discussing change than implementing it. A DAO may get bogged down in trivial, administrative tasks due to the nature of needing to coordinate much more individuals.
- **Security.** An issue facing all digital platforms for blockchain resources is security. A DAO requires significant technical expertise to implement; without it, there may be invalidity to how votes are cast or decisions made. Trust may be broken and users leave the entity if they can't rely on the structure of the entity.

How to use DAO?

- Here are some examples of how one can use a DAO:
- **In charitable organizations:** By using DAO, you can approve membership and contributions from people around the world, and the respective organization can decide on how they can spend these donations.
- **In freelancer business:** Another excellent example of DAO use is creating a network of contractors who are willing to combine their funds for office areas and software subscriptions.
- **Pool investment:** One can establish a venture fund that merges investment capital and counts on enterprises to support it. Later on, refunded money can be distributed again among each and every DAO member.

Leading Decentralized Autonomous Organizations

Uniswap

The most popular decentralized crypto exchange globally, Uniswap, has taken the throne as the biggest Decentralized Autonomous Organization today. Uniswap launched its

governance token in September 2020 and became a legitimate DAO.

BitDAO

BitDAO is one of the largest decentralized autonomous organizations determined to develop an ecosystem with a decentralized tokenized economy. The organization invests funds for the growth and support of other projects and partners in the DeFi space. The organization also facilitated several initiatives with the potential to benefit the industry.

DAO	Traditional Firms
Entirely autonomous – all decisions are based on votes	Follows a hierarchy system which is often referred to as the organisation structure
Voting is required on all matters	Usually, the majority is held by key players calling the shots. Most of the internal policies are not subjected to voting.
A smart contract manages the voting and its results, ensuring complete transparency	Voting is conducted manually
Usually, the voters decide the services offered and the investments made and are fully automated	Core services are not entirely transparent, and processes are susceptible to human error or manipulation
All activities are 100% transparent	Only the parts mandated by the law are reported.

Aragon

- Aragon is an open source DAO running on the Ethereum blockchain network.
- Aragon is a popular decentralized autonomous organization that allows other platforms to introduce their DAOs. Aragon functions to empower clients to connect with anybody from any location globally within a DAO infrastructure. Today, Aragon has almost 1500 decentralized autonomous organizations
- Aragon leverages Solidity smart contracts for business logic, and IPFS for decentralized files and governance record management,

thereby creating a truly P2P operating system for a whole new generation of organizations, called aragonOS.

- Users can perform operations and govern their DAOs using the Aragon Network Token (ANT).
- Aragon has integrated IPFS very closely into its command-line interface (CLI) program. The IPFS daemon can be initiated through Aragon's CLI and manages pinning operations to ensure the reliable storage of critical components and files.
- Aragon is an open-source software used to maintain and create decentralized autonomous organizations (**DAOs**) on the **Ethereum blockchain**.
- The Aragon network software has three main offerings:
- **Aragon client** – a toolkit for developers to create customizable online organizations that aim for more transparent group participation.
- **Aragon network** – an organization that supports the interactions between the platform's community of DAOs.
- **Aragon Association** – a non-profit that manages and allocates the funds raised from Aragon's token sale.

Central to managing the DAOs on its platform is ANT, Aragon's native **cryptocurrency**, which grants owners the ability to vote on key decisions about the project's future.

How Does the Aragon Network Work?

- To create a DAO, developers first use AragonOS, a smart contract framework.
- Modules available through AragonOS allow users to raise funds, incentivize contributors to join their community and make decisions with group participation.

Every Aragon DAO uses three pre-installed features:

- **Finance** – Assists in managing the resources of an organization. Participants can submit transactions, access the transaction history and view the DAO's asset balance.
- **Tokens** – Crypto assets used to manage membership and structure within an DAO.
- **Voting** – Used for token holders to raise issues, cast votes and examine outcomes.

It consists of several components that work together to provide a comprehensive framework for decentralized governance.

1. Aragon Client - This is the main user interface for interacting with Aragon DAOs. It is a web-based application that provides users with access to all of the tools they need to manage their organization, including voting, budgeting, and member management.
2. Aragon App Center - This is a marketplace of third-party apps that can be integrated into Aragon DAOs. It includes a range of apps for tasks such as accounting, project management, and communication.
3. Aragon Network - This is a decentralized network of organizations that use the Aragon platform. It provides a way for these organizations to collaborate, share knowledge, and make decisions together.
4. Aragon Court - This is a decentralized dispute resolution system for Aragon DAOs. It allows members to resolve disputes using a peer-to-peer arbitration process.
5. Aragon SDK - This is a software development kit that allows developers to create custom DAO templates and apps for the Aragon platform.
6. Aragon Association - This is a non-profit organization that oversees the development of the Aragon platform and provides support to the Aragon community. It is funded by the Aragon Network and governed by a board of directors.

Bisq

- Bisq is a DAO running on the Bitcoin blockchain network.
- It offers a P2P cryptocurrency exchange service with no company or institution in control.
- Users and contributors vote on proposed updates. Governance decisions are made to the DAO by the BSQ token holders. A Bisq DAO is made sustainable by the following two approaches: **Revenue distribution by sharing trading fees with contributors with the BSQ token.**
- This makes the contributors a partial owner of the network and balances the power between traders and contributors.

  Decision-making through voting by the owners of the BSQ tokens—the traders and contributors. Since they are both in charge of the issuance collectively, there are no centralization vectors that can help either side achieve a majority.
- Bisq community was making initial efforts in using the decentralized storage IPFS for hosting software binaries, documentation, network, and trading statistics.

- It is run by the members of the Bisq community who hold the native Bisq token (BSQ). BSQ holders have the right to vote on important decisions related to the development and management of the Bisq network, including software updates, changes to the Bisq protocol, and allocation of funds for development and marketing.

- The Bisq DAO is unique in that it is completely decentralized and autonomous. There is no central authority or leadership that controls the network or makes decisions on behalf of the community. Instead, all decisions are made through a transparent and democratic voting process that is open to all BSQ holders.

- Proposals were also made on storing the governance proposal data to ensure that the access to DAO information is consistently available without a single point of failure.

BSQ token

BSQ is used as a means of exchange and as a form of collateral for traders to secure their trades. It is also used to pay for Bisq trading fees and to vote on important decisions related to the development and governance of the Bisq DAO.

BSQ is a unique token in that it is issued through a DAO-based issuance mechanism that involves community members contributing to the development and maintenance of the Bisq platform. The issuance of BSQ is limited to a maximum supply of 2.6 million tokens.

The Bisq DAO has several core functions that are critical to the functioning of the decentralized exchange.

Some of the key functions of the Bisq DAO include:

1. Governance: The Bisq DAO is responsible for making decisions related to the development and maintenance of the Bisq platform. This includes deciding on new features, making changes to existing features, and ensuring that the platform is running smoothly.
2. Funding: The Bisq DAO is responsible for funding the development and maintenance of the Bisq platform. This is done through the issuance of BSQ tokens, which are used to pay developers, fund marketing efforts, and support other operational costs.
3. Arbitration: The Bisq DAO has a built-in arbitration system that is used to resolve disputes between traders on the platform. The arbitration system is designed to be fair and impartial, and it is operated

by community members who are selected based on their reputation and experience.

4. Community building: The Bisq DAO is responsible for building and nurturing the Bisq community. This involves hosting events, engaging with community members on social media and other platforms, and generally promoting the use and adoption of the Bisq platform.

The Bisq architecture consists of several key components:

1. The Bisq desktop application: This is the main interface for users to access the exchange. It is a standalone application that users can download and run on their own computers.
2. The Bisq network: This is the network of Bisq nodes that communicate with each other to facilitate trades. The network is decentralized, meaning that there is no central server that controls the exchange.
3. The Bisq DAO: This is the decentralized autonomous organization (DAO) that governs the Bisq project. The DAO is responsible for making decisions about the direction of the project and managing the funds that are used to support its development.
4. The Bisq API: This is the interface that developers can use to build applications that interact with the Bisq network.
5. The Bisq protocol: This is the set of rules and standards that govern how trades are executed on the Bisq network. The protocol is designed to be secure, private, and decentralized.

2.7 Aicumen Technologies

- Aicumen Technologies (www.aicumen.com) is a leading digital innovation studio with a vision to empower value creation in the digital economy by building trusted Decentralized Intelligent

Applications (DIApps) using blockchain and AI, and was established in 2017.

- One of the key challenges in delivering solutions using emerging technologies is the ability to implement meaningful solutions to real-world problems.
- This challenge is more pronounced in step-changing technologies such as blockchain and AI. To address this challenge, Aicumen has developed a unique digital reimagination process that is both innovative and viable, to deliver meaningful, valuable business solutions using disruptive technologies such as blockchain and AI.
- The digital reimagination process is a bottom-up process that is technically defined by cohesive layers of protocols, decentralized networks, intelligent transports, and adaptable applications.
- The protocol developed and consumed throughout the process is the Krama Intelligent Protocol (KIP).
- Decentralized networks such as MóiBit and MoiFi are built on top of KIP, embedding intelligent transports such as Social Trust Quotient (STQ) to create DIApps such as FINETs, Tracy, and REBECA.
- This process can also be customized and reused for other blockchain and AI technologies that together form a digital reimagination technology stack.

Krama Intelligent Protocol (KIP)

- It is a blockchain-based protocol that aims to improve the efficiency and scalability of decentralized applications (dApps). KIP uses a unique consensus mechanism called Proof of Intent (PoI), which is designed to reduce the energy consumption and computational resources required for blockchain consensus.

- The KIP protocol is built on top of the Ethereum blockchain and is compatible with the Ethereum Virtual Machine (EVM). This makes it easy for developers to create and deploy dApps on the KIP platform using the Solidity programming language.

- One of the key features of KIP is its ability to support cross-chain interoperability. This means that dApps built on KIP can interact with other blockchain networks, such as Bitcoin and Litecoin, through atomic swaps and other cross-chain communication protocols.

- KIP also offers a range of tools and services for developers, including a smart contract development kit, a decentralized storage solution, and an identity management system. These tools are designed to make it easy for developers to build secure and scalable dApps on the KIP platform.

Some of the key components of KIP include:

1. Proof of Intent (PoI) Consensus Mechanism: KIP uses a unique consensus mechanism called Proof of Intent (PoI), which reduces the energy consumption and computational resources required for blockchain consensus. PoI uses reputation-based voting to determine consensus, with nodes being incentivized to act in the best interest of the network.
2. Cross-Chain Interoperability: KIP enables dApps built on its platform to interact with other blockchain networks, such as Bitcoin and Litecoin, through atomic swaps and other cross-chain communication protocols.
3. Smart Contract Development Kit (SDK): KIP provides a comprehensive SDK that includes a range of tools and services for developers to build, test, and deploy smart contracts on the KIP

platform. The SDK also includes a user-friendly interface that simplifies the development process.

4. Decentralized Storage Solution: KIP offers a decentralized storage solution that allows developers to store data securely on the blockchain. The storage solution is built on IPFS (InterPlanetary File System) and uses a distributed network of nodes to ensure high availability and data redundancy.
5. Identity Management System: KIP provides an identity management system that enables users to create and manage their identities on the blockchain. The system ensures that identities are secure, private, and can be used across different dApps.
6. KIP Token: KIP has its own native cryptocurrency called KIP token, which is used as the primary medium of exchange on the platform. KIP tokens can be used to pay for transaction fees, smart contract deployment, and other services on the KIP platform.

2.8 Combining blockchain and AI to humanize digital interactions

As several implementations of blockchain and AI models are helping the world to get better, there has always been a spirit in the decentralized software community of striving to design the most efficient decentralized protocols, networks, and software.

Current issues with digital interactions

Scalability:

Most decentralized networks are expected to operate in large numbers. Hence, the ability of a network to operate in its best form is hampered by a growing number of nodes in the network.

Lack of context:

Although most blockchain protocols and frameworks are inspired by the decentralization movement, they fail to capture the context needed to gauge the value generated by the network. This has created a barrier in understanding and interpreting the value of the tokens created by most of the traditional blockchain networks.

Application is limited by the network:

The behavior of the network severely limits the scope of the application. This limitation has discouraged a lot of large-scale adoption of blockchain, due to the rigid structure.

Applying AI and blockchain to document management

Documents and paper trails have become necessary in recent times for establishing authenticity, provenance, and legal precedence.

Although the majority of business operations are now carried out online, we need to identify ways to achieve immutable and verifiable mechanisms that can protect us from hacks or leakages of sensitive business data.

The following diagram depicts the stakeholders in a document and knowledge management system:

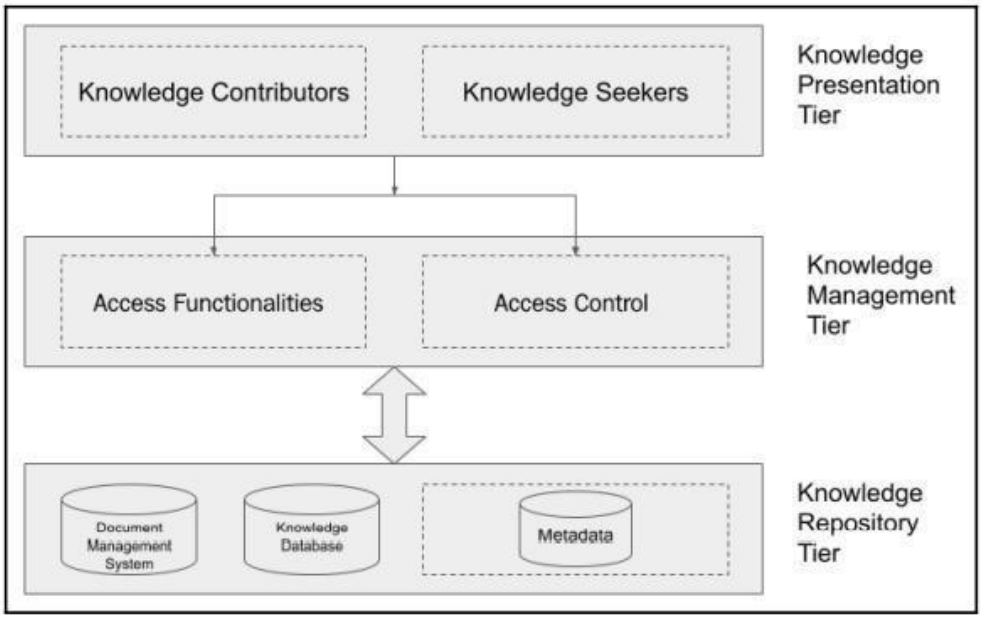


Fig 3.6: Stakeholders in document and knowledge management systems

As shown in the preceding diagram, document management mostly consists of users who contribute content, and another set of users who seek this content.

These functionalities are managed by access control and are then stored in a database.

ISSUES IN THE DOMAIN

The following are the top two issues that are faced in document management:

Permission management:

Although there are several applications that can provide proof of existence for a document, very few can customize access to the document.

This is largely due to the nature of blockchain, wherein the data is accessible to everyone.

Reporting:

Access to sensitive business data must be reported accurately after it's been shared. Monitoring this access and looking for anomalies is still an

open problem in companies who may suffer from data leaks from their own employees as part of corporate espionage.

Emerging solutions in document management

Signy is a blockchain and AI-based application suite that allows users to submit any type of application form, digitally sign and cosign certificates, create and customize their own smart-certificates, and share digital certificates with complete security and an audit trail.

It leverages blockchain for the transparency, safety, and security of documents, certificates, and assets.

It also uses AI and ML technologies to create innovative products and services and augment its blockchain solutions to make them more adaptive and intelligent.

Retrospective

Although the pace of adoption for decentralized document management is picking up, there is a need to provide fine-grained control to business owners.

The design paradigm of blockchain alone does not provide enough capabilities to build such systems. Integrating these technologies with existing Identity and Access Management (IAM) systems is the key to integration and growth going forward.

Applying AI and blockchain to information security

Most of the digital identity and interactions are persisted online today compared to your offline relationship with the world.

Calling this a seismic shift in humanity is not an over-exaggeration. Hence, we must pay attention to keeping our information safe and secure.

Over the course of a few decades, we have observed many inefficient architectures that have failed to protect our identities and our interactions online.

This can be rectified today with the application of AI as it can be used to closely monitor any backdoor vulnerabilities in systems.

But fundamentally, the ownership of data mostly remains with the vendors. This has to change and, thanks to blockchain, we can easily establish some of the ground rules regarding the privacy of information and its ownership.

Issues in the domain

Top issue that's faced by the information security industry

Storing, reading, changing, and persisting information comes at a cost. Most blockchains and decentralized file storage services today use volatile cryptocurrencies to charge fees for the data you manage. This means several users have a high barrier to entry, either because the volatility affects their budget to persist information or the usage of cryptocurrency is severely limited or strictly prohibited in a few countries. Hence, we must find a way to offer a decentralized file storage service that can charge users in a traditional manner with fiat currencies, but also provide full control of the data they own.

Emerging solutions in information security

Let's take a look at a special application of IPFS that addresses the issue we mentioned earlier. MóiBit provides a personalized and decentralized secure storage network, powered by the immutability and provenance of blockchain systems. Moi in French means me. Bit is an amalgamation of two words – binary digit, which refers to a unit of data. MóiBit offers enterprises and DApp developers the ability to use all the benefits of a blockchain and a decentralized filesystem in a predicted cost environment.

Retrospective

Although MóiBit and other solutions have addressed this problem, the barrier is the cheap cost of centralization versus the duplication or replication of data in decentralization.

Efforts are being made to customize the control of data replication both at the application level and also at the network level by making these operations more atomic to walled systems.

Applying AI and blockchain to royalty management

Content creators and publishers spend a vast amount of time creating various forms of novel art such as music, videos, and games, among others.

Users access this content through applications but often do not pay the content creators directly.

Although this is not expected, companies pay on behalf of all the users for their consumption on a periodic basis. As you may be able to tell, the middleman here is the app facilitating the content over a platform.

However, there is no surety that these platforms are paying royalties to the content creators in a justifiable manner

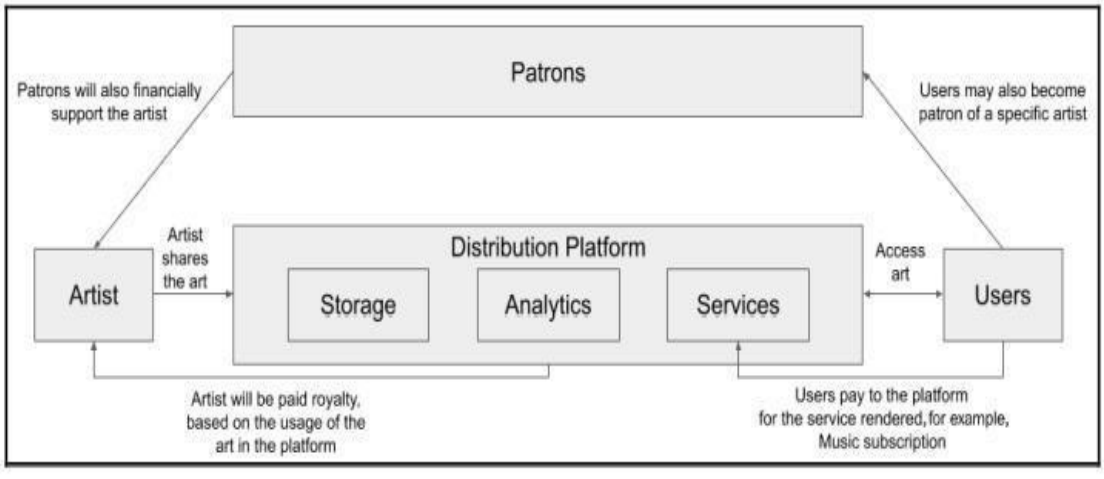


Fig 3.5: Stakeholders in the royalty sector

As shown in the preceding diagram, artists get paid in royalty when users access their artwork through a distribution platform. It is evident that users and patrons are sources of income for artists.

Issues in the domain

Content creators do not get full visibility of the sales statistics if the organization is not public.

Products may not provide a complete reconciliation or justify the amount all the time, keeping contributors or content creators in the dark.

Emerging solutions in royalty management

The Microsoft corporation, partnered with Ernst and Young (EY), has developed a blockchain-based solution that allows Xbox game publishers to access their royalty statements in near real-time, without having to wait for days of reconciliation.

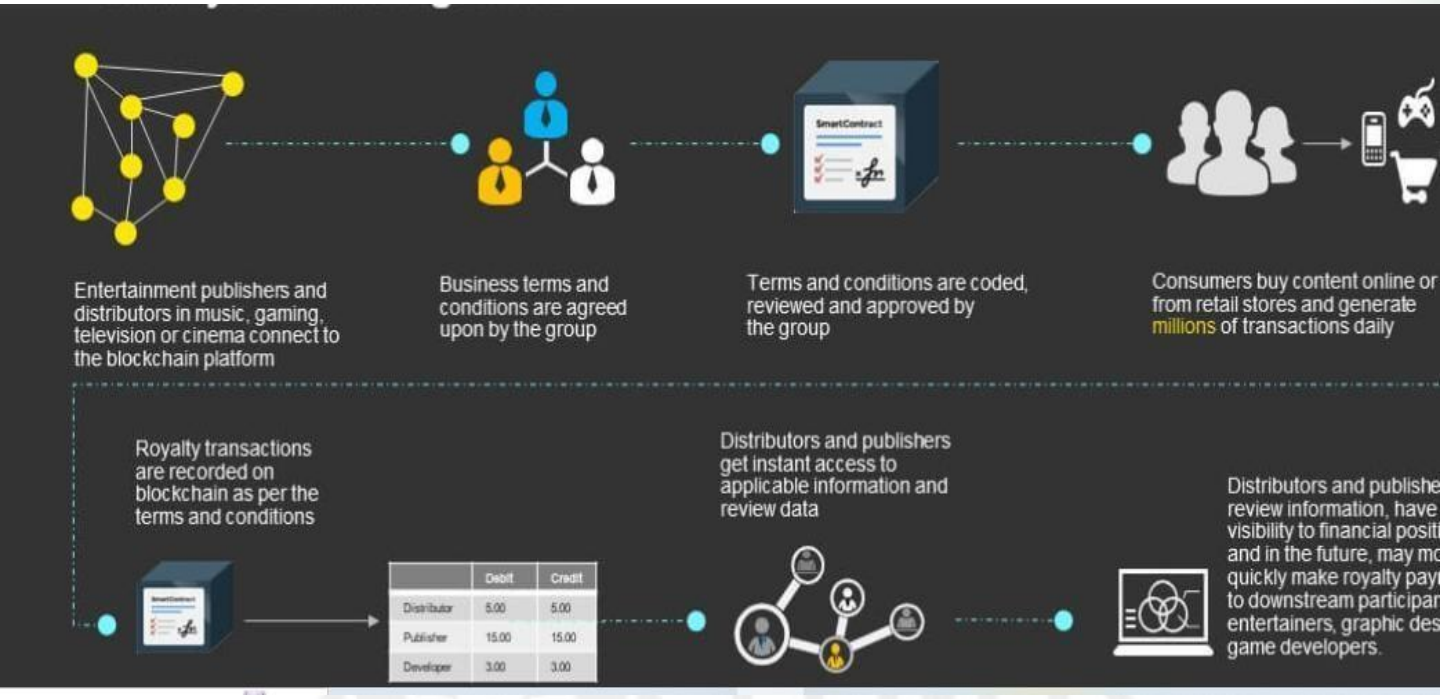
This solution uses Microsoft Azure, Azure Blockchain Service, Azure Cosmos DB, and Microsoft Power BI.

Retrospective

Over the past few years, we have seen an uptick in people subscribing to on-demand content services such as Hulu, Netflix, and Amazon Prime. Some estimate the total market size of on-demand content services will grow up to 100 billion USD in the next 5 years.

This significant shift means the end user's perception of content, such as music and video, has drastically moved from free to paid. Although users are ready to pay for these services, we are yet to see major reform in how the content creators and artists will be paid on the platform.

AI and Blockchain in royalty management by Microsoft corporation & Ernst and Young



- One of the largest production implementations of a blockchain-based financial system of record
- Manages Microsoft's end-to-end process for rights and royalties to its Xbox gaming partners, using machine learning to digitize and onboard contracts
- Designed to deliver transparency, faster payment processing and near real-time calculation of royalty payments, with integrated data visualization for insights across contracts, statements, invoices and accounting records

With its expanded blockchain, Microsoft is able to:

- Accelerate contract digitization for faster contract creation using artificial intelligence (AI), based on Microsoft Azure

- Seamlessly generate and integrate statements and invoices with enterprise resource planning (ERP) applications to process and record royalties with increased speed and greater visibility and transparency
- Generate accounting entries from the blockchain platform into existing ERP applications for improved efficiency and accounting capabilities
- Incorporate the controls and compliance standards required to meet the criteria for the solution to function as a financial system of record

In the media and entertainment industry, the intellectual property of creators (authors, songwriters, game developers, etc.) is licensed to third parties who pay royalties to the creators.

The transactions, like someone buying a song on iTunes, a video game on Steam, or an e-book on Amazon, equate to billions of dollars per month in royalties that need to be paid.

In today's systems, the royalty calculations are mostly manual and managed through offline data sources.

In response, EY and Microsoft have launched a blockchain solution for content rights and royalty management that streamlines today's costly and time-intensive process.

The new system will increase transparency while eliminating costly manual reconciliation and partner reviews in royalties management.

Built on Quorum blockchain protocol and Microsoft's Azure cloud and blockchain tech, the solution will provide real-time visibility of sales transactions to participants, while allowing for real-time calculations of creator and licensor's royalty positions.

The almost instant availability of royalty info will allow parties to react more quickly and effectively to the market by better seeing content purchases.

Instead of the current process which can take up to 45 days or more, the smart contract blockchain solution gives network participants near-instantaneous transaction visibility. As such, partners will now be able generate accounting accruals on a daily basis.

"The scale, complexity and volume of digital rights and royalties transactions makes this a perfect application for blockchains," remarked Paul Brody, EY Global Innovation Leader, Blockchain. "A blockchain can handle the unique nature of each contract between digital rights owners and licensors. Contracts can be handled in a scalable, efficient manner with an audit trail for the participants."

Applying AI and blockchain to real estate

Over the past few decades, India's growing economy has resulted in the rise of many metropolitan cities and an active market for new purchases. However, there have been cases of aggressive land-grabbing, among other serious issues, due to bad record-keeping practices and/or corruption. Verifying titles is a cumbersome process before transacting on any piece of real estate. We can also observe some historic cases

where ethnic clashes persist to this day regarding claiming land in some places in India.

Issues in the domain

The following are two of the top issues faced by the real estate industry: Inconsistency in land records: A sale or transfer of rights pertaining to property involves several departments. Unfortunately, these departments work as silos, thereby making way for discrepancies if the same data is not available to all the authorities. This can lead to complicated legal positions for landowners.

Lack of instant traceability:

If a buyer wishes to buy a specific property, there must be a method to trace the transfer of ownership through the title deeds or any other complying documents within seconds. Today, the services offered by local authorities usually take some time and may come at a considerable cost.

Emerging solutions in real estate

emBlock, uses blockchain in order to address some of the issues mentioned earlier: Based on Hyperledger Fabric, emBlock is a solution that was built out of eMudhra's emLabs. emBlock was built for enterprises and governments to benefit from immediate consensus, real-time information sharing, and smart contracts. eMudhra was established in 2008 and is a Certifying Authority in India and Mauritius for issuing digital signature certificates. They are a market leader in India that have worked with large banks, financial services companies, and several Government agencies in India to implement digital signature-based solutions. This solution proposes recording sale deeds so that they're stored on a blockchain, thus allowing various government bodies to access it, such as registration and stamp revenue departments, survey

and settlement departments, revenue departments, and courts, along with business entities such as banks.

emBlock

emBlock which is based on a Hyperledger Fabric has the following business blockchain components:

a) Registration and Stamp Revenue Department

b) Survey and Settlement Department

c) Revenue Department

d) External Agencies like Banks, Courts etc

The following information will be accessible to all the participants on the blockchain:

a) Registered sale deed between the seller and the buyer

b) Transfer or change of title of property

c) Updated land related data and maps (as provided by the survey & settlement department)

d) Data pertaining to the revenue collected

e) Banks can view land records and buyer's credit worthiness before issuing loans

emBlock which is based on a Hyperledger Fabric has the following business blockchain components: • Consensus Layer - Responsible for generating an agreement on the order and confirming the correctness of the set of transactions that constitute a block.

• **Smart Contract Layer** - Responsible for processing transaction requests and determining if transactions are valid by executing business logic.

• Communication Layer - Responsible for transporting peer-to-peer messages between nodes that participate in a shared ledger instance.

• **Data Store Abstraction -** Allows different data-stores to be used by other modules.

• **Identity Services -** Enables the establishment of a root of trust during setup of a blockchain instance, enrolment and registration of identities or system entities during network operation, and the management of changes like drops, adds, and revocations. It also provides authentication and authorization

• **Policy Services** - Responsible for policy management of various policies specified in the system, such as the endorsement policy, consensus policy or group management policy.

It interfaces and depends on other modules to enforce various policies. emBlock will have the following identities :

a. Certifying Authority System: A client-server system which is responsible for identity management and supports features such as registration of user and node identities, issuance of enrolment certificates and certificate lifecycle management.

b. Peers/Nodes: Peers play a vital role in performing any transaction, from storing a copy of the ledger; they can also take part in endorsing the transactions based on defined consensus logic. Peers have a logical association to the organization and each organization will need to possess an anchor peer through which other peers communicate.

c. Admin: Each organization will have an admin (a super user who is responsible for user management). The roles and entitlements of the admin or other super users can be created to mimic existing approval workflows within and across organizations.

d. Channels: Channels provide logical access control and can be defined based on use case to restrict participant access. For ex: Channel 1 could run a land records management use case while Channel 2 could run a KYC use case.

e. Ledger: The ledger is a sequenced, tamper-resistant record of all state transitions in the fabric.

Retrospective

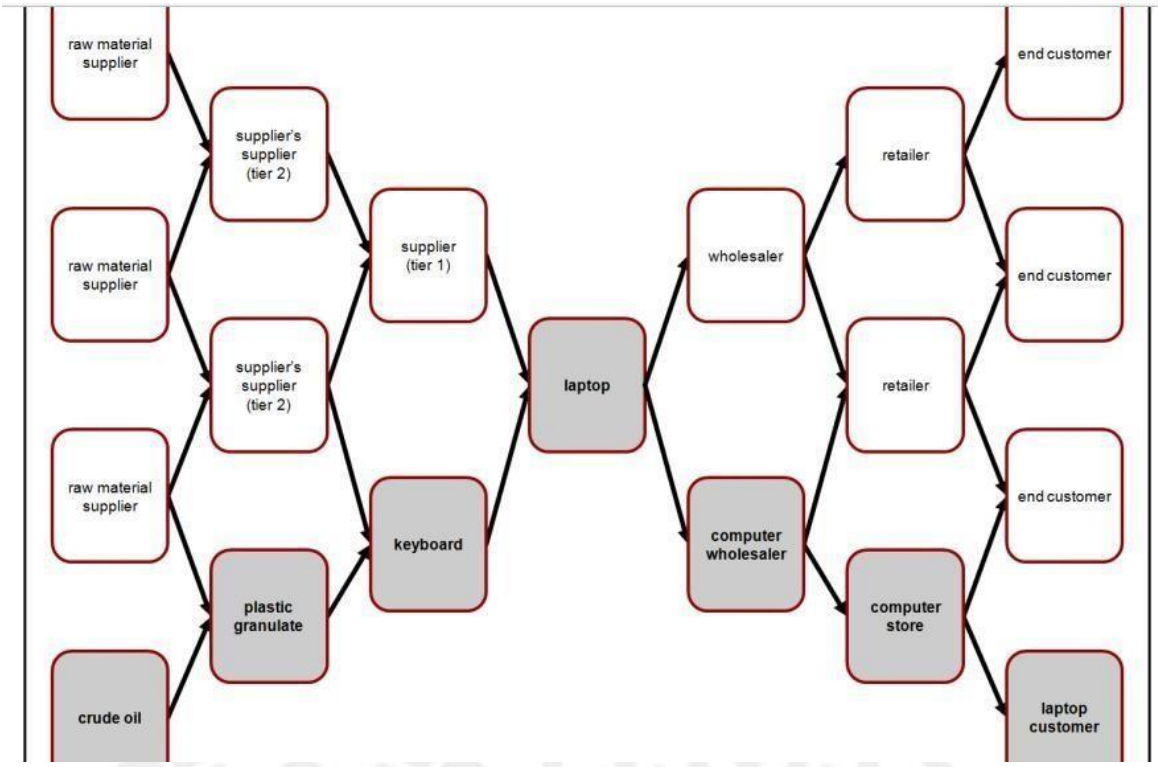
Although there are a few blockchain-based solutions that may be conforming to the existing requirements, AI should also be used to recognize potential frauds or sense any corruption of data. Also, government agencies and concerned regulatory authorities must be encouraged to use these new technologies in the form of pilot projects. Some Indian states have embraced this change in technology but required broader thinking to establish a proper digital strategy to move toward a 100% digital record-keeping practice.

Applying AI and blockchain to supply chains

Supply chain management is crucial to the success of many industries and growing economies around the world; some consider supply chains to be the nervous system of trade.

Managing a supply chain is an operation-oriented practice that requires efficiency and effectiveness, from the early phases of planning, procurement, and warehousing, to the logistics of shipping goods from producers to consumers.

The following sample diagram identifies the stakeholders involved in the supply chain management of a laptop:



Issues in the domain

The following are three of the top issues faced by the supply chain industry: Operational costs and risks:

A high proportion of the supply chain is still in paperwork mode. This means that data across the system is highly vulnerable to being tampered with.

The data in supply chains is crucial for identifying the value of the products, including its basic attributes such as validity and shelf life.

If the paperwork of the shipment has been tampered with, there could be a large gap across the value chain.

Manual paperwork-based supply chains can also attract financial glitches due to potential scenarios such as double billing, thereby creating more audit problems and confusion among the stakeholders.

Although relatively newer supply chain solutions have been effective in digitally transforming the paperwork nature of a few supply chain

transactions, there are fewer systems technically capable of handling potential data loss or forgery in the process. Blockchain can alleviate these problems with the help of smart contracts and can automate several critical processes.

Security and authenticity:

Although the end-to-end processes of the supply chain are digitally connected using traditional enterprise software, they are loosely defined and coupled among themselves. This means that data integrity is not treated as a first-class feature.

This can be resolved with blockchain technologies based on the immutability concepts and ensure that no records can be stolen, withdrawn, or replaced with inaccurate data. Since transactional data on the blockchain is open, relevant stakeholders can access information and verify the single source of truth.

Real-time visibility:

Transactions on native digital platforms that are closely coupled to traditional finance can also invite other business challenges, such as delays in settlements. Businesses in the supply chain heavily rely on working capital, and the major source for capital is either through loans or the revenue for their services. Enabling real-time payments across the value chain can enable faster payment processing at relatively lower costs compared to traditional finance. This is a game-changer for the industry.

Emerging solutions in the supply chain industry

Here are some of the applications that either use blockchain or AI in order to address some of the issues mentioned earlier:

IBM Sterling Supply Chain Suite:

Powered by IBM Watson, this cloud-based digital business network provides real-time intelligence and actionable recommendations.

This suite offers a wide range of features across supplier management, inventory management, and order management.

It is also notable that the suite offers an open platform and a developer hub for building tailored solutions in the supply chain using blockchain and AI.

OpenText:

With the aim of making supply chains more connected, collaborative, intelligent, and secure, OpenText is working on an autonomous and intelligent supply chain that can be used to apply AI, IoT, and blockchain.

Retrospective

Although AI and blockchain are being used to track orders and manage inventory more effectively, there are many business gaps that need to be filled. It is important to lower the bar of entry to bring in a diverse set of stakeholders across the globe so that they can participate in a globally verifiable supply chain network with a vision to increase quality and efficiency and promote transparency.

This can happen by exposing APIs so that not all vendors have to be running on the same blockchain or network; instead, they could simply exchange trustworthy data and record them as cross-transactions across the networks for better compatibility. Effort must be made to make these products interoperable so that it becomes easier for the global supply chain economy to thrive on the diversity offered by the blockchain.

Applying AI and blockchain to knowledge management

Most of us gained exposure to the internet through open source knowledge bases such as Wikipedia.

Things are moving fast in this generation and some content in this book could also possibly become outdated by the time it reaches your hands or devices. In this rapid world of changes, agility is very important in maintaining the accuracy of any documented knowledge base on the internet.

This is a huge problem if the knowledge base consists of multiple topics and each topic is maintaining several sub-topics and articles.

Issues in the domain

There is one top issue that's faced in knowledge management, known as accuracy of information.

Maintaining the accuracy and relevance of any outdated information across articles in Wikipedia requires a huge amount of time and several rounds of manual effort by human editors.

With millions of articles stored and served by one of the largest encyclopedias on the planet, Wikipedia also has to maintain factual correctness. Also, this open information should not become susceptible to fake news or propaganda over time.

Emerging solutions in knowledge management

Let's look at an example of an application that either uses blockchain or AI in order to address some of the issues mentioned earlier.

A group of researchers at the Computer Science and Artificial Intelligence Laboratory (CSAIL) of Massachusetts Institute of Technology (MIT) have created an automated text generating system that can pinpoint and replace specific information in Wikipedia sentences, wherever required, while preserving human grammar and styles.

A system created by MIT researchers could be used to automatically update factual inconsistencies in Wikipedia articles, reducing time and effort spent by human editors who now do the task manually.

Wikipedia comprises millions of articles that are in constant need of edits to reflect new information. That can involve article expansions, major rewrites, or more routine modifications such as updating numbers, dates, names, and locations. Currently, humans across the globe volunteer their time to make these edits.

The researchers describe a text-generating system that pinpoints and replaces specific information in relevant Wikipedia sentences, while keeping the language similar to how humans write and edit.

Behind the system is a fair bit of text-generating ingenuity in identifying contradictory information between, and then fusing together, two separate sentences. It takes as input an "outdated" sentence from a Wikipedia article, plus a separate "claim" sentence that contains the updated and conflicting information. The system must automatically delete and keep specific words in the outdated sentence, based on information in the claim, to update facts but maintain style and grammar. That's an easy task for humans, but a novel one in machine learning.

For example, say there's a required update to this sentence (in bold): "Fund A considers **28 of their 42** minority stakeholdings in operationally active companies to be of particular significance to the group." The claim sentence with updated information may read: "Fund A considers **23 of 43** minority stakeholdings significant." The system would locate the relevant Wikipedia text for "Fund A," based on the claim. It then automatically strips out the outdated numbers (28 and 42) and replaces them with the new numbers (23 and 43), while keeping the sentence exactly the same and grammatically correct. (In their work, the researchers ran the system on a dataset of specific Wikipedia sentences, not on all Wikipedia pages.)

The system was trained on a popular dataset that contains pairs of sentences, in which one sentence is a claim and the other is a relevant Wikipedia sentence. Each pair is labeled in one of three ways: "agree," meaning the sentences contain matching factual information; "disagree," meaning they contain contradictory information; or "neutral," where there's not enough information for either label. The system must make all disagreeing pairs agree, by modifying the outdated sentence to match the claim. That requires using two separate models to produce the desired output.

The first model is a fact-checking classifier — pretrained to label each sentence pair as "agree," "disagree," or "neutral" — that focuses on disagreeing pairs. Running in conjunction with the classifier is a custom "neutrality masker" module that identifies which words in the outdated sentence contradict the claim. The module removes the minimal number of words required to "maximize neutrality" — meaning the pair can be labeled as neutral. That's the starting point: While the sentences don't agree, they no longer contain obviously contradictory information. The module creates a binary "mask" over the outdated sentence, where a 0 gets placed over words that most likely require deleting, while a 1 goes on top of keepers.

After masking, a novel two-encoder-decoder framework is used to generate the final output sentence. This model learns compressed representations of the claim and the outdated sentence. Working in conjunction, the two encoder-decoders fuse the dissimilar words from the claim, by sliding them into the spots left vacant by the deleted words (the ones covered with 0s) in the outdated sentence.

In one test, the model scored higher than all traditional methods, using a technique called "SARI" that measures how well machines delete, add, and keep words compared to the way humans modify sentences. They used a dataset with manually edited Wikipedia sentences, which the model hadn't seen before. Compared to several traditional text-generating methods, the new model was more accurate in making factual updates and its output more closely resembled human writing. In another test, crowdsourced humans scored the model (on a scale of 1 to 5) based on how well its output sentences contained factual updates and matched human grammar. The model achieved average scores of 4 in factual updates and 3.85 in matching grammar.

Removing bias

The study also showed that the system can be used to augment datasets to eliminate bias when training detectors of "fake news," a form of propaganda containing disinformation created to mislead readers in order to generate website views or steer public opinion. Some of these detectors train on datasets of agree-disagree sentence pairs to "learn" to verify a claim by matching it to given evidence.

Retrospective

The practice of knowledge management systems is being rethought, with constant innovation being made on the cloud. I think that now is a prime period to also inculcate the effectiveness of blockchain technologies and AI techniques to enrich the user experience, reduce overall costs, and to keep the data safe.

Applying AI and blockchain to identity management

Prior to the advent of the internet, the only proof of identity we probably had was a government-issued photo ID, which was used to avail a few services such as rationing and so on.

In the second generation of the internet, most of the digital services we use are linked to our email ID. This alleviated the need for photo IDs but did not become independent of it.

Since traditional IDs and digital versions of our IDs are being abused in one way or the other, it becomes extremely difficult today for users to manage this. This issue of managing identities and tying it to a Decentralized Identifier (DID) has been one of the cutting-edge research areas in the past few years. DID is a new type of identifier that offers verifiable digital identity.

These identifiers are of self-sovereign nature, meaning that the digital identity is not dependent on a centralized identity provider. Hence, users control their own DIDs.

The following diagram depicts the stakeholders in the identity management domain of enterprise users

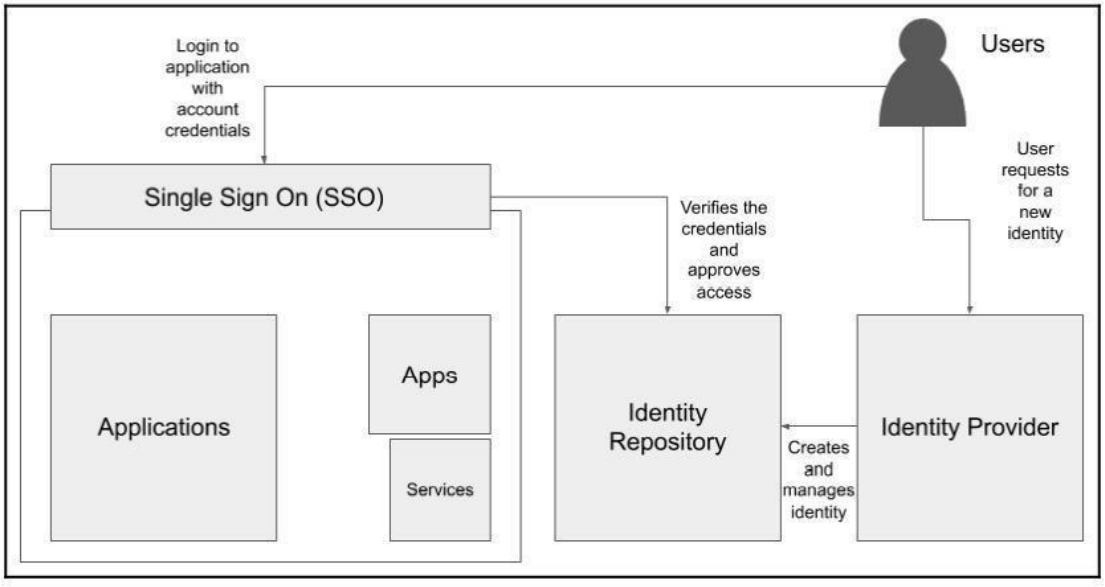


Fig 3.4: Stakeholders in the enterprise identity management domain

As shown in the preceding diagram, enterprise users such as employees, customers, and vendors generally access the application through an SSO authentication mechanism. This SSO requires an enterprise ID that originated from a set of whitelisted domains or providers. The will be managed by all the companies collaborating in the industry.

Issues in the domain

Most of us use cellphones and thus have used our photo IDs at some point to verify ourselves before we could get access to cellular services. Although this is required to maintain accountability and keep our society secure, some bad actors can misuse your identity proofs and act as imposters – without your knowledge.

Emerging solutions in identity management

Using DIDs, the Sovrin Network allows users to securely verify and issue their own digital credentials, control them, and manage them using a security standard called zero-knowledge proofs (ZKPs).

Let's assume that you were required to have more than 1,000 USD in your bank balance to enter a casino. Today, if there were such a rule, the only way to verify your balance to the casino is by showing your account's statement, which has also been attested by a bank manager. You probably do not want to do that because you are exposing your bank balance, which could lead to certain social and personal risks. ZKPs are used to solve the same problem, in an innovative way – you do not have to show your current balance, as long as you have more than 50,000 USD. You do not have to disclose your bank balance, but service providers, such as casinos in the preceding example, would still be able to verify the fact that you have more than 1,000 USD. This is a huge win for user privacy because sensitive data such as your current bank balance has not been shared. The same may apply to verifying residential addresses, birth dates, and so on.

Retrospective

Adoption is the key issue for DIDs and ZKPs. Issuers need to use ZKPs before users can try them at service providers who wish to verify them. Today, there are bottlenecks in all three levels of participation:

Issuer: Government agencies and authorities need to understand the benefits of using ZKP-based DIDs to reduce their own managed costs and potential data breaches.

User: User needs to be aware of privacy and start using some of the socially verifiable proofs that are available today.

Verifiers: Service providers should also be motivated to use these technologies and avert from data leaks on their end.

Combining blockchain and AI in pandemic management

In recent times, we have experienced a new pandemic called COVID-19 that has impacted many lives. The global economy is almost at a halt.

due to the fear of infection. In order to revive our economies, we need to manage current infections and prevent them from occurring again.

This is a challenging task for governments, authorities, and citizens who are expected to abide by a new class of rules in these uncertain times. Hence, pandemic management software is emerging as an important enabler to revive economies in a responsible manner.

Current issues in digital contact tracing

While governments and authorities are doing their best to manage the recent COVID-19 pandemic with the help of contact tracing applications, there are some key issues we can observe:

Lack of user privacy: Although contact tracing applications are helping in restoring normalcy, the privacy of the users is put at grave risk. This could result in data leaks in the short term and escalate to social inequality in the long term.

Low-quality data: Inefficiently designed contact tracing applications have led to poor-quality data. In some cases, we can also see that location spoofing and other forms of trickery are being executed in order to fool the authorities. This is possible because the users lack a Public Key Infrastructure (PKI) and the apps are using traditional client-server models.

Longer times for verification: With the unstructured data collected by such applications, it will take more time to decide whether a citizen or a community is at risk of infection. Without accurate and high-quality data points, it is difficult to arrive at a decision as to whether to quarantine an area or not. Delays or false negatives can further lead to devastating consequences and social unrest.

Case study: Tracy is a privacy-preserving app for pandemic management and safe movement that digitally enables governments, citizens, and medical professionals to live in an anxiety-free and risk-mitigated model. Tracy is customizable as per the needs of the local region.

Tracy is the **first blockchain enabled decentralized solution** which helps manage the privacy angle in contact tracing, quarantine management and finally restoring confident and free movement. Tracy also helps citizens gauge the likelihood of having come in contact with a person who has tested positive for COVID-19. It also allows collection of primary health symptom data from the citizen users from the app. An authorities app can interact through QR codes with other citizens in the real world to ascertain / confirm health status.

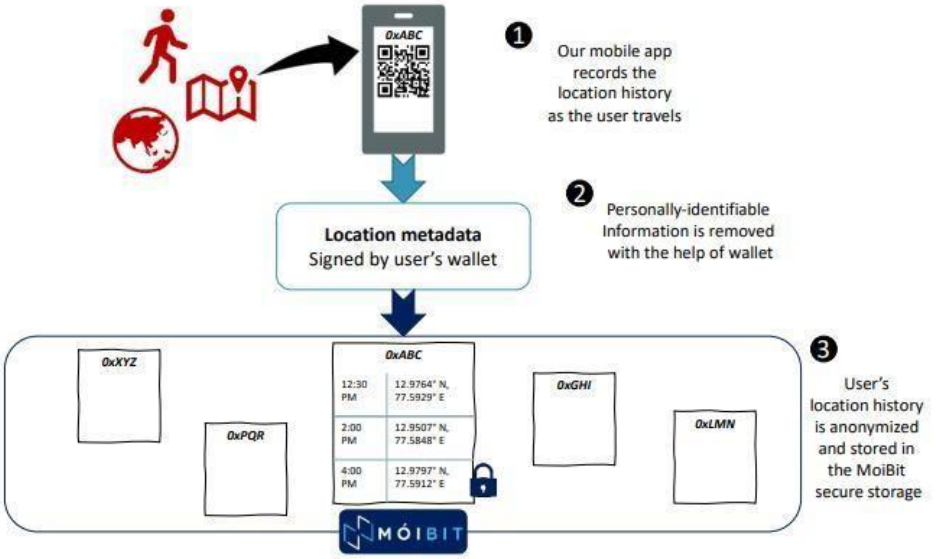
The app enables contact tracing, safe movement and helps health professionals manage pandemic response. It is built on top of MoiBit for saving privately and securely sharing location data

Tracy addresses privacy concerns by allowing people to safely and confidently share information without compromising privacy. Task forces get access to location data that is stripped of PII (personal identifier information) and can apply business rules to intervene in specific cases.

Uses location data to address pandemic management including quarantine / lockdown enforcement, contact tracing.

Tracy uses data sciences on top of decentralized private datastore, to enable intelligent enforcement between government and citizens, reduce social anxiety, and increase economic activity with targeted/private health support.

Information Design



As shown in the figure above, user will be installing the app and travel, as per the recommendations of the local governments. The app records the geo co-ordinates (latitude-longitude co-ordinates) for each minute. The frequency of recording location can be customized, ranging from minutes to hours. Once the location is recorded, the data is signed in the background by the app. The signed data is stored in MoiBit individually for each user.

About MoiBit

MoiBit is a personal decentralized secure storage network protocol with the power of immutability and provenance of Blockchain systems. We use MoiBit for storing the geo co-ordinates of all the places visited by the user. MoiBit leverages content addressability, cryptography and zero-knowledge proof to create a simple, but highly private and secure storage wallets attached to a decentralized identifier.

It is notable that MoiBit is not a centralized system. Unlike traditional Relational Database and Distributed Databases systems, data in MoiBit cannot be manipulated. If manipulated, the identifier of the data also changes, thus rendering the effort useless.

MoiBit also serves the purpose of storing the user's data in a pseudonymous way. All the inputs are signed by a wallet before changes are made and encrypted before writing it to MoiBit.

Converging AI and blockchain in healthcare

The healthcare industry has transformed from an institutional system into a service-driven system enabled by many technologies. Many healthcare services, including diagnosis, treatment, and preventive medication, have become digital and engage with patients in a personal manner. Healthcare devices such as fitness bands, trackers, and medication pumps are replacing some of the medical personnel we rely upon. This transformation at the customer level can also be enhanced with the help of new drugs. Let's understand some of the issues faced by the healthcare industry in becoming successful in manufacturing drugs.

Pharmacovigilance Pharmacovigilance (PV) can be defined as a group of activities that includes various processes such as drug formulation, testing the newly formulated drugs, assessing the risks, and finally preventing any side effects from a drug before it can be introduced to the market. The main focus of pharmacovigilance is to ensure drug safety for consumers

These activities are carried out by many personnel and also require cross-industry stakeholders, under the careful oversight of the local drug administration agency. Hence, there is a need for software that can facilitate these processes in a digital manner, reduce costs, and also identify any potential risks amid the testing based on the data available. Also, it is important that any adverse effect of using a drug is commonly reported to local drug administration authorities, as applicable. Pharmacovigilance software is being used to report such cases. At the time of writing, the global market size of pharmacovigilance software is expected to exceed an estimated USD 250 million by 2027.

As-is scenario The basic requirements of any pharmacovigilance software could be to collect and assess data pertaining to drug experimentation. Another notable requirement for such software is to automate some of the processes and complement the need for human personnel. Such software is also expected to prepare well-defined and structured reports that are applicable under local regulations and the rule of law. Most of the successful pharmacovigilance software today offers flexible features to facilitate most of these requirements and cut down costs. There are several phases through which the safety of the drug will be assessed. The software is used to collect the reaction data, analyze it, and report it to applicable drug administration authorities. The software may also provide the insights needed to make the drug safer and reduce associated costs in the process. The top issues faced by pharmacovigilance software are as follows:

Personal information of subjects: People subjected to a drug trial are usually referred to as subjects. While subjects are undergoing such a trial, they are instructed to consume a prescribed amount of a given drug. Drug consumption is monitored over a period of time to observe the reaction, understand more about the side effects, and gather useful information from the test. This information may be passed on to the drug formulation team to improve the product over the next iterations. During the course of testing, the subject may experience a number of adverse effects, including death. Local drug administration agencies may require the drug manufacturers to confirm such scenarios and debrief such adverse instances in a prescribed format detailing the cause. Due to the sensitivity attached to the personal information of the subject, not all the reporting data can be made accessible to the general public or other concerned authorities. The future of healthcare lies in the adoption of advanced transparency, which allows stakeholders to provide a larger

exposure to such adverse data regarding a drug that may already be on the market.

To-be scenario

In the future, the local drug administration authorities may encourage the publication of all the adverse effect data in an anonymized manner, wherein each adverse situation faced by the subject under the drugs trial is briefed, but the personal identity of all those subjects who have experienced side effects is anonymized. Here, blockchain can be used in pharmacovigilance software to establish transparency and provenance of the reports published by the respective stakeholders. AI can also be used to analyze critical data points from the reports and help confirm whether the adverse situations, such as the death of the subject, were caused by the drug alone, or other health conditions.

Possible solution

We can choose any suitable blockchain platform with the ability to handle the reporting of data in a public as well as a permissioned manner. There may be several reports strictly limited to a small number of stakeholders, thereby preventing the exposure of trade secrets. Similarly, we can use AI models to predict any side effects during drug trials, since a third of subjects may suffer from a side effect as a result of drug-to-drug interactions. The following diagram summarizes our approach in a compartmentalized reference structure to help you understand the solution better:

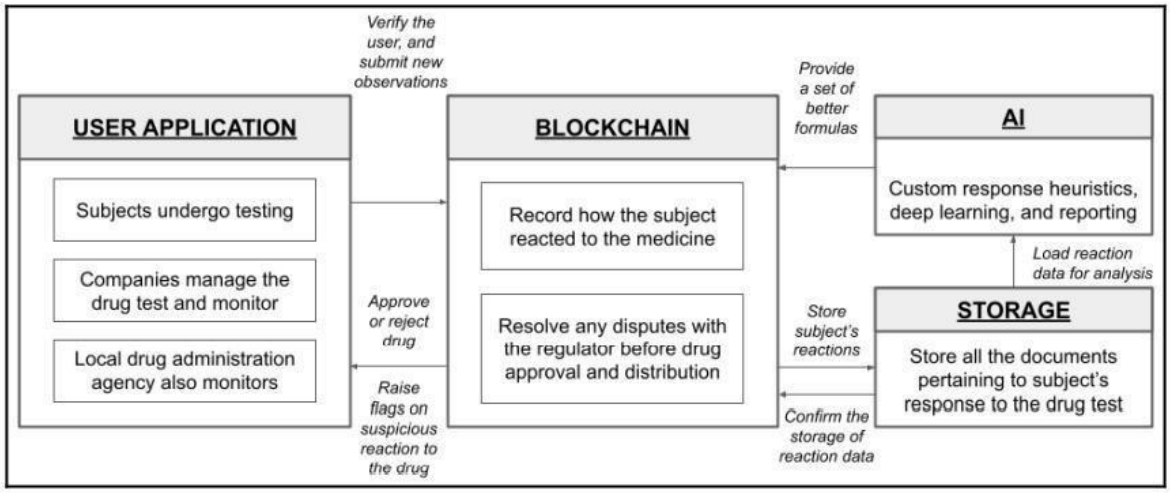


Fig 9.12: Reference solution architecture to enable efficient drug approval and transparency in pharmacovigilance

As shown in the preceding reference solution architecture diagram, the suggested solution is split across four components, namely:

User application:

One application can be used by the subjects in order to upload the reaction to the drug along with suitable photos or vital information prescribed by authorities. The information will be stored under a pseudonymous wallet, without giving away too much personal information to the public.

There could be another application used by drug companies to review the reactions submitted by the subjects. This data can be very helpful to companies in formulating a better drug with lesser, or no, side effects.

Finally, we may need a separate dashboard for the local drug agencies to monitor any critical cases, report fatalities during drug tests, and also to approve or reject a drug. **Blockchain:**

The blockchain network will provide wallets for all three actors: subjects, drug companies, and regulators.

The drug reaction data will be safely shared to all three wallets. Also, it is important to maintain an auditable provenance of all the tests

undergone by a drug. This may help future investigations and help identify the actors accountable.

We will also need a smart contract in the network to facilitate the approval of drugs through a smart contract. This smart contract could simply run under the vigilance of a regulator, or showcase the collective interest of the group by digitally signing on the approval request transactions collectively, using the private keys of more than one wallets in the network. This approach is often referred to as multisig.

Storage: We require a decentralized storage service that can store the exact unchanged version of the drug reaction from subjects.

AI: Now that the drug reaction data is made available on an IPFS-based network such as MoiBit, we need to be able to use deep learning techniques and drug reaction heuristics. If a serious injury or fatality is identified, we can use the models to regenerate the drug formula to address the side effects.

Applying AI and blockchain to financial services

The BFSI is the backbone of the economic operations of the whole world as we know it. With trillions of dollars of assets under management, managing money effectively at a digital scale has become a lucrative opportunity and hence needs to be revisited due to some inefficiencies in the current systems that generally rely on traditional methods. The following diagram depicts the relationship between stakeholders in the BFSI industry

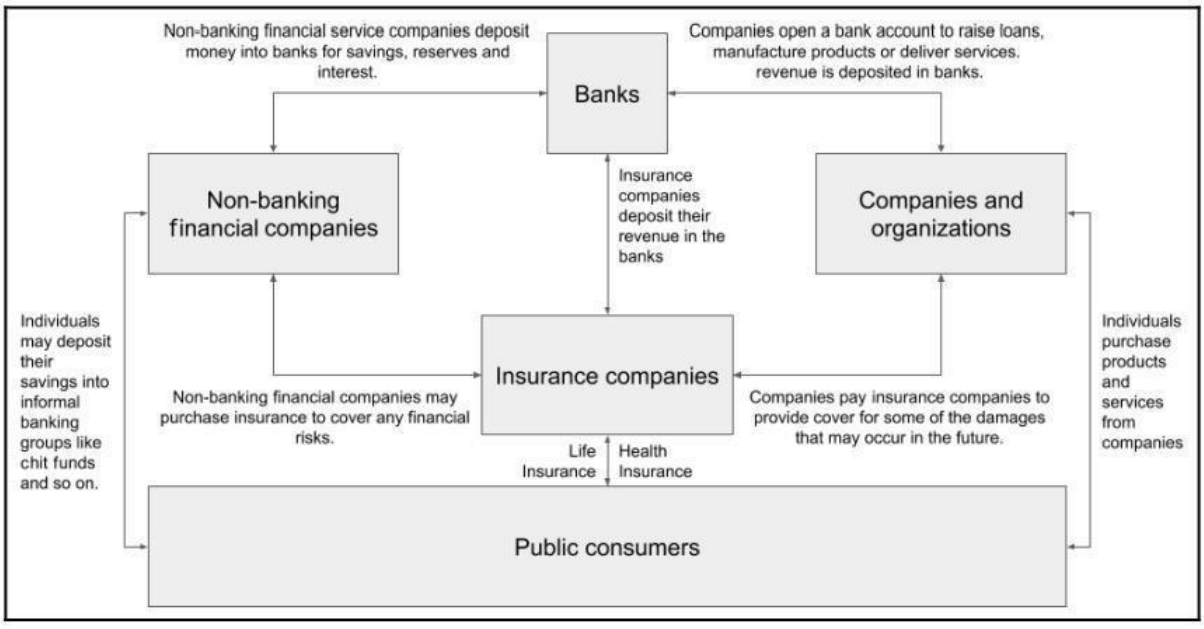


Fig 3.3: Stakeholders in BFSI

As shown in the preceding diagram, public consumers like you and me access capital and services through banks, insurance companies, and Non-Banking Financial Companies (NBFC). Also, note that companies and organizations that provide services to us also rely on these financial institutions.

Issues in the domain

The following are the top three issues faced by the BFSI industry:

Access to capital:

The unbanked and the underbanked are severely affected by the problem of eligibility criteria, thereby creating a gaping hole in the market, thus leading to informal economies. If accessing the capital is made easier, we can streamline the informal economy and maximize its potential.

Fraud and delinquency:

It's estimated that financial fraud and delinquency are affecting the global economy through a loss of 600 billion USD. This is a serious

problem plaguing the BFSI industry, especially in India due to the recent revelations about bad loans.

Lack of proper process automation:

Although numerous attempts have been made to secure and automate the BFSI sector, we need a better model that can bring about a striking balance between transparency in the industry but also preserves order among institutions. Hence, using blockchain to bring about transparency and using AI techniques to enable optimized workflows for automation could be the key to revolutionizing this industry.

Emerging solutions in BFSI

Here are some of the applications that either use blockchain or AI in order to address some of the issues in BFSI mentioned earlier:

Teradata:

Teradata is a California-based corporation well-known for its data analytics products for the financial services industry. There is an interesting case study where deep learning and AI were used to detect sophisticated fraud and reduce the false positives at a reputed bank. Compared to the traditional rules engine, which reportedly detects about 40 percent of total fraud, Teradata's analytic solution increased the rate to as high as 80 percent. The solution also drastically reduced the false positives by 60 percent and increased true positives by 50 percent. The champion/challenger method is used to ensure that the best deep learning model is used in real time for detecting fraud.

Nuo Network:

Nuo is a peer-to-peer network of lenders and borrowers that enable crypto-backed loans. Lenders can provide their cryptocurrencies for an interest rate, while borrowers can raise loans against collateral at a discounted price of the pledged asset, followed by a payment of a premium at the end of the loan's term. At the time of writing, the Nuo network has been used by many users to raise loans of up to 30 million USD. Also, it is important to note that Nuo Network is non-custodial.

meaning that the wallets with funds in them are not in direct or indirect control of the company. This is enabled by using the Ethereum blockchain, where smart contracts are used to trade Ethers (ETH) and ERC20 tokens.

Retrospective

A few emerging solutions have addressed the key issues in the BFSI industry. However, it is possible to achieve leaps in the solution space if we are able to connect the dots. AI solves optimization issues and blockchain enables transparency, but mostly, these technologies are deployed in individual silos that may not be able to carry value across the chain. Hence, it is imperative to connect these silos in a way that allows users and institutions alike to discover value beyond their own systems so that they can discover new potential and revenue streams.

Assignments

Topper: Explore the intersection of DAOs and decentralized finance. How do DAOs contribute to the development of DeFi platforms, and what roles do they play?

Above Average: Provide examples of real-world use cases for DAOs. How are DAOs being applied in different industries, and what problems do they address?

Average: Identify and analyze the challenges and risks associated with DAOs. Consider security vulnerabilities, regulatory concerns, and potential issues with decentralized decision-making.

Below Average: Compare and contrast different governance models used by DAOs. What are the advantages and disadvantages of each model?

Slow Learners: To explore the principles and challenges of decentralized databasesDefine what a DAO is and explain the fundamental principles behind a Decentralized Autonomous Organization. Discuss the key features that distinguish DAOs from traditional centralized organizations.

Part A – Q & A

Unit - II

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PART - A Questions

1. Define AI

AI is the intelligence and capability exhibited by a computer to perceive, learn, and solve problems, with minimal probability of failure.

2. AI winter

AI winter is a term used by many in the IT industry to define a period of time when AI researchers faced many challenges, leading to severe cuts in funding and the slowdown of AI as a specialized field.

3. What are the types of AI

Weak AI

Strong AI

Super AI

3. List the benefits of combining blockchain and AI

the business benefit of using AI is the reduction of costs, and the business benefit of using blockchain is that transparency is enabled in processes. When both technologies are used together, a new class of solutions to a wide variety of problems in today's world that lack transparency and cost efficiency can be applied.

4. What are the common properties of decentralized databases

Allow anybody to store and access information across boundaries

Allow anybody to participate in persisting the data

Persist the updated data and record the changes made to the data in a traceable manner

5. What are the improvements that may be possible through using decentralized databases

Building better AI models using decentralized databases

Immutability of data – increasing trust in AI training and testing

Better control of data and model exchange

6. Define **Blockchain analytics**

Blockchain analytics **aims at identifying, clustering, and representing data stored on blockchains**. More and more companies operating with cryptocurrencies are using Blockchain analytics tools to analyze transactions and assess the level of risks to meet regulatory requirements worldwide.

7. Name some decentralized databases

IPFS

Storj

Filecoin

7. Define **Solid**

Solid is a clever combination of the three powerful words in the age of the internet—social linked data. Solid's aim to give back users control of their data is made possible by the powerful combinations of P2P networking and linked data. All data pertaining to a user is stored in a decentralized data store called as **Personal Online Datastore (POD).**

8. Define POD

Personal Online Datastore (POD).

PODs can be hosted on a PC, an on-premises server, or a Virtual Machine (VM) managed in the cloud.

Pods are like secure personal web servers for data.

Any kind of data can be stored in a Solid Pod, from structured data to regular files.

9. Define **Ocean Protocol**

Ocean Protocol is founded in 2017, it uses blockchain technology to connect data providers and consumers.

Ocean is an open-source protocol that aims to allow businesses and individuals to exchange and monetize data and data-based services.

Ocean Protocol is a decentralized protocol with services for users to consume storage and compute.

10. Define the feature Compute-to-Data in ocean protocol

Compute-to-Data is a feature of the Ocean Protocol that enables data processing to be performed on encrypted data without revealing the data itself. This allows data providers to maintain control over their data while still allowing data consumers to perform computations on it.

11. How does Ocean Protocol work?

The Ocean Protocol uses custom programs called smart contracts to ensure each datatoken can be exchangeable across Ethereum's blockchain and within its decentralized applications.

12. Define Storj

Storj, pronounced as storage, is a decentralized cloud-storage platform.

Storj is a cryptocurrency blockchain platform powering a decentralized system for digital file storage.

The Storj network is powered by computers worldwide called nodes and requires the Storj (STORJ) digital currency for payment.

13. Define Swarm

Swarm is an Ethereum native distributed data storage platform.

The intention of the Swarm project is to facilitate the persistence of Ethereum's historic public data and enable storage for DApps.

14. Define DAO

A Decentralized Autonomous Organization (DAO) is a computer program representing a group of stakeholders and entities and is not influenced by external environments.

A DAO is programmed by a set of rules and governance protocols to ensure that transactions occur between parties without the chance of any conflict.

15. Define Aragon

Aragon is an open source DAO running on the Ethereum blockchain network. Aragon is a popular decentralized autonomous organization that allows other platforms to introduce their DAOs. Aragon functions to empower clients to connect with anybody from any location globally within a DAO infrastructure.

16. Define KIP

It is a blockchain-based protocol that aims to improve the efficiency and scalability of decentralized applications (dApps). KIP uses a unique consensus mechanism called Proof of Intent (PoI), which is designed to reduce the energy consumption and computational resources required for blockchain consensus.

17. List the issues in digital interaction

Lack of context

Application is limited by the network

18. How Does Decentralization Benefit Blockchain?

Decentralization in blockchain enhances security, reduces the risk of censorship, and fosters trust. It eliminates the need for intermediaries, allowing direct peer-to-peer transactions and making the system more resilient to attacks.

19. What Are Some Use Cases for DAOs?

DAOs are used in various contexts, including decentralized finance (DeFi), governance of decentralized applications (DApps), community-driven initiatives, and data governance in collaborative projects.

20. How Are Decisions Made in a DAO?

Decisions in a DAO are typically made through a voting mechanism. Members use their tokens to vote on proposals, and the outcome is determined based on the consensus reached among the token-holding community.

21. How Does a DAO Manage Data Governance?

DAOs manage data governance by allowing members to propose and vote on decisions related to data access, data sharing, privacy policies, and other aspects of data management.

22. How Does a DAO Operate?

DAOs operate through predefined rules encoded in smart contracts. Token holders, representing members, can propose and vote on decisions related to data management, governance policies, and other relevant activities.

23. What Challenges Do DAOs Face?

DAOs face challenges such as security vulnerabilities in smart contracts, potential for governance disputes, and legal uncertainties. Ensuring effective and secure decentralized decision-making is an ongoing challenge.

24. list benefits of combining AI and Blockchain

Data Integrity and Immutability:

Blockchain ensures data integrity by creating an immutable ledger. AI algorithms can benefit from a trusted and unchangeable historical record, ensuring the reliability of data used for training and decision-making.

Transparent and Auditable Decision-Making:

Blockchain's transparency facilitates the auditing of AI decision-making processes. Stakeholders can trace and verify the data sources, algorithms, and outcomes, promoting trust and accountability.

Part B – Questions

Part-B Questions

Q. No.	Questions	CO Level	K Level
1	Explain centralized databases and distributed database in detail	CO2	K2
2	Compare and contrast centralized databases and distributed database	CO2	K2
3	(i) Explain in detail about the improvements that may be possible through using decentralized databases	CO2	K2
4	(Explain how AI models can leverage decentralized databases.	CO2	K2
5		CO2	K2
6	Explain IPFS in detail. How IPFS replaces centralized database?	CO2	K2
7	Explain about the decentralized data store Solid in detail.	CO2	K2
8	Explain how Ocean protocol helps users to consume storage and compute in detail.	CO2	K2
9	Explain about the decentralized cloud storage platform Storj in detail.	CO2	K2
10	Explain Ethereum native storage platform Swarm in detail	CO2	K2
11	(Define blockchain analytics with an example in detail	CO2	K2

Part-B Questions

Q. No.	Questions	CO Level	K Level
11	Explain combining blockchain and AI in pandemic management	CO2	K2
12	Explain combining blockchain and AI in social finance	CO2	K2
13	Explain combining blockchain and AI to humanize digital interaction	CO2	K2
14	(i) Explain combining blockchain and AI to humanize digital interaction	CO2	K2
55	Explain Krama Intelligent protocol in detail.	CO2	K2
16	Expain Aragon DAO in detail.	CO2	K2
17	Explain data management in DAO in detail	CO2	K2
18	Explain the following in detail (i) Aragon (7) (ii) Bisq (6)	CO2	K2
19	What is DAO? Why it is needed? Explain the working of DAO in detail	CO2	K2
20	(Define blockchain analytics with an example in detail	CO2	K2
	Explain combining blockchain and AI in social finance		

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Supportive Online Certification Courses

Sl. No.	Courses	Platform
1	Blockchain Basics	Coursera
2	DeFi Decentralized Finance	Coursera
3	Blockchain	NPTEL
4	Blockchain and its Applications	NPTEL

Real time Applications in day to day life and to Industry

Decentralized Finance (DeFi)

What Is Decentralized Finance (DeFi)?

Decentralized finance (DeFi) is an emerging financial technology based on secure distributed ledgers similar to those used by cryptocurrencies.

In the U.S., the Federal Reserve and Securities and Exchange Commission (SEC) define the rules for centralized financial institutions like banks and brokerages, which consumers rely on to access capital and financial services directly. DeFi challenges this centralized financial system by empowering individuals with peer-to-peer digital exchanges.

DeFi eliminates the fees that banks and other financial companies charge for using their services. Individuals hold money in a secure digital wallet, can transfer funds in minutes, and anyone with an internet connection can use DeFi.

Centralized Finance

In centralized finance, money is held by banks and third parties who facilitate money movement between parties, with each charging fees for using their services. A credit card charge starts from the merchant and moves to an acquiring bank, which forwards the card details to the credit card network.

The network clears the charge and requests a payment from the bank. Each entity in the chain receives payment for its services, generally because merchants must pay for the use of credit and debit cards.1

All financial transactions are overseen in centralized finance, from loan applications to a local bank's services.

- Decentralized Finance
- Decentralized finance eliminates intermediaries by allowing people, merchants, and businesses to conduct financial transactions through emerging technology. Through peer-to-peer financial networks, DeFi uses security protocols, connectivity, software, and hardware advancements.3
- Wherever there is an internet connection, individuals can lend, trade, and borrow using software that records and verifies financial actions in distributed financial databases. A distributed database is accessible across various locations as it collects and aggregates data from all users and uses a consensus mechanism to verify it.4
- Decentralized finance eliminates the need for a centralized finance model by enabling anyone to use financial services anywhere regardless of who or where they are. DeFi applications give users more control over their money through personal wallets and trading services that cater to individuals.
- **How Does DeFi Work?**
- Decentralized finance uses the blockchain technology that cryptocurrencies use. A blockchain is a distributed and secured database or ledger. Applications called dApps are used to handle transactions and run the blockchain.6
- In the blockchain, transactions are recorded in blocks and then verified by other users. If these verifiers agree on a transaction, the block is closed and encrypted; another block is created that has information about the previous block within it.
- The blocks are "chained" together through the information in each proceeding block, giving it the name blockchain. Information in previous blocks cannot be changed without affecting the following blocks, so there is no way to alter a blockchain. This concept, along with other security protocols, provides the secure nature of a blockchain

Content Beyond Syllabus

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COINBASE

Coinbase is a well-known cryptocurrency exchange that makes it easy to buy, sell, and exchange cryptocurrency. Coinbase makes buying Bitcoin as easy as buying a stock through an online brokerage, but look out for the fees and poor customer service.

Pros

Easy to use for cryptocurrency beginners: The main Coinbase website and mobile app are very easy to use and allow you to buy, sell, and exchange cryptocurrencies quickly.

Support for a large number of cryptocurrencies: Coinbase currently supports over 200 currencies for trading, and the number grows regularly.

Opportunities to earn cryptocurrency: Earn interest on eligible balances, or get a small amount of a new currency through Coinbase Earn.

Cons

High transaction fees: Transaction fees are often expensive on the primary Coinbase platform.

Customer service issues: Coinbase gets poor marks for customer service, even when account holders witness serious security issues.

No access to trade many altcoins: While Coinbase supports an impressive list of currencies, many seem to be missing.

Introduction

- Coinbase is a cryptocurrency trading and investing platform that offers users the ability to buy, sell, and exchange over 200 tradable cryptocurrencies such as Bitcoin, Ethereum, and Dogecoin. Coinbase is a large company with over 108 million users and over $80 billion in assets on the platform

Company Overview

Coinbase was founded in 2012 as a place to send and receive Bitcoin. With more than 4,700 employees worldwide, the company has grown to support dozens of unique cryptocurrencies. Coinbase is a decentralized company with no main headquarters.

Coinbase operates with users in more than 100 countries, and customers trade approximately $159 billion per quarter.5

Coinbase manages a robust cryptocurrency ecosystem supporting 13,000 financial institutions.

Coinbase runs two separate trading platforms in addition to a standalone cryptocurrency wallet service. Between the suite of Coinbase products, you're likely to find anything you need to start and manage a cryptocurrency portfolio or trading plan.

Cryptocurrencies Available on Coinbase

Coinbase supports trading of over 200 cryptocurrencies and regularly puts new coins on the list. There are too many to list here, so here's a glance at some of the most popular digital currencies on Coinbase:

Bitcoin (BTC)

Ethereum (ETH)

Cardano (ADA)

Solana (SOL)

Polkadot (DOT)

Assessment Schedule (Proposed Date & Actual Date)

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Assessment Schedule

Assessment Tool	Proposed Date	Actual Date	Course Outcome	Program Outcome (Filled Gap)
Assessment I			CO1, CO2	
Assessment II			CO3, CO4	
Model			CO1, CO2, CO3, CO4, CO5	
End Semester Examination			CO1, CO2, CO3, CO4, CO5	

Prescribed Text Books & Reference

Prescribed Text & Reference Books

Sl. No.	Book Name & Author	Book
1	Ganesh Prasad Kumble, Anantha Krishnan, "Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies", Packt Publications, 2020. (unit 1-5)	Text Book
2	Melanie Swan, "Block Chain: Blueprint for a New Economy", O'Reilly, 2015. (unit 5)	Text Book
3	Daniel Drescher, "Block Chain Basics", Apress; 1st edition, 2017	Reference Book
4	Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, "Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer", Import, 2018	Reference Book

Mini Project Suggestions

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Topper: Create a DAO that enhances supply chain transparency by allowing participants to propose and vote on data-related decisions such as sharing supplier information, tracking product origin, and validating ethical practices.

Above Average: Create a DAO where individuals can tokenize ownership of their data. Users can propose data usage agreements, and the DAO members vote on whether to approve or reject the proposals.

Average: Build a DAO that focuses on maintaining data quality within an organization. DAO members can propose and vote on data quality standards, validation processes, and mechanisms for resolving data discrepancies.

Below Average: Design a DAO to ensure compliance with data privacy regulations. Implement smart contracts that govern data processing practices, allow users to request data erasure, and manage data access permissions.

Slow Learnrs: Design a DAO that facilitates secure and transparent sharing of data among participants. Implement smart contracts to govern access permissions and voting mechanisms for data-sharing proposals.

Thank you

Disclaimer: