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DOCTORAL THESIS ABSTRACT

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Artificial Intelligence for Business Transformation

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Table of contents

Chapter 1 Fundamentals of Artificial Intelligence 7
1.1 Introduction 7
1.2 Definition and Core Characteristics of AI 7
1.2.1 Key Features of AI Systems 7
1.3 Classifications of AI 7
1.3.1 Narrow AI (Weak AI) 8
1.3.2 Artificial General Intelligence (AGI) 8
1.3.3 AI Functional Classification 8
1.4 Machine Learning vs. Deep Learning 8
1.4.1 Machine Learning (ML) 8
1.4.2 Deep Learning (DL) 9
1.5 AI and Web3: Decentralization and Autonomy 9
1.5.1 AI and Blockchain Synergies 9
1.5.2 AI in DAOs (Decentralized Autonomous Organizations) 9
1.6 Public Perception and Ethical Considerations 9
1.6.1 AI in Popular Culture 9
1.6.2 Privacy, Bias, and Transparency 10
1.6.3 AI and the Workforce 10
1.7 The AI Landscape: Industry, Academia, and Decentralization 10
1.7.1 Traditional AI Leaders 10
1.7.2 Decentralized AI Platforms 10
1.7.3 AI and Geopolitics 10
Chapter 2 Decentralized Data Exchange Protocol 11
2.1 Introduction 11
2.2 Background: The Need for Secure Data Sharing in Manufacturing 11
2.2.1 Challenges in Traditional Data Exchange 11
2.3 Decentralized Data Exchanges: Principles and Benefits 12
2.3.1 How Decentralized Data Exchanges Work 12
2.3.2 Advantages of Decentralized Data Exchange 12
2.4 Ocean Protocol: A Framework for Decentralized Data Exchange 12
2.4.1 Key Features of Ocean Protocol 12
2.4.2 Architecture of Ocean Protocol 13
2.4.3 2.4.3 Data NFTs and Datatokens 13

2.5 Secure Data Access and Permissions 13
2.5.1 Role-Based Access Control (RBAC) 13
2.5.2 Privacy-Preserving Techniques 13
2.6 Building a Decentralized Data Marketplace 14
2.6.1 Steps to Implement a Data Marketplace 14
2.6.2 Benefits of Using Ocean Protocol for a Data Marketplace 14
2.7 Compute-to-Data: Enabling AI without Data Exposure 14
2.7.1 How Compute-to-Data Works 14
2.7.2 Applications in Manufacturing 15
Chapter 3 The Intersection of Cryptocurrency, Blockchain, and Sports 15
3.1 Introduction 15
3.2 Synergy Between Blockchain and Sports 15
3.2.1 Demographic Overlap 16
3.2.2 Rise of Fan Tokens and Digital Collectibles 16
3.3 Blockchain and Cryptocurrency in Sports Operations 17
3.3.1 Cryptocurrency as a Payment Method 17
3.3.2 Tokenization in Sports 17
3.3.3 Smart Contracts in Sponsorships and Player Agreements 18
3.4 Blockchain's Impact on Sponsorships and Partnerships 18
3.4.1 Cryptocurrency Sponsorship in Sports 18
3.4.2 Tokenized Sponsorship Models 18
3.5 Future Trends in Blockchain and Sports 19
3.5.1 Smart Ticketing and Anti-Fraud Measures 19
3.5.2 Decentralized Fantasy Leagues and eSports 19
3.5.3 Sports Media and Content Monetization 19
Chapter 4 Evolution of LLMs in Academia 20
4.1 Introduction 20
4.2 Evolution of LLMs in Academia 20
4.2.1 From Text Processing to Contextual Intelligence 20
4.2.2 Impact on Research and Education 20
4.3 Ethical Concerns of Using LLMs in Academia 21
4.3.1 Bias in AI-Generated Research 21
4.3.2 Academic Integrity and Plagiarism 21
4.4 Addressing Bias in LLM-Assisted Research 22
4.4.1 Case Study: Measuring Bias in LLM Outputs 22

4.4.2 Bias Mitigation Strategies 22
4.5 Academic Integrity in the Age of AI-Assisted Writing 22
4.5.1 Logistic Regression Model for AI Detection 22
4.5.2 Performance Evaluation 23
4.5.3 Ethical Implications 23
4.6 Future Considerations 23
4.6.1 Strengthening Ethical Guidelines 23
4.6.2 Advancements in Bias-Free AI Models 23
4.6.3 Responsible AI Integration in Academia 23
Chapter 5 Federated Learning in the Pharmaceutical Industry 24
5.1 Introduction 24
5.2 Data Management Challenges 24
5.2.1 Data Privacy and Compliance 24
5.2.2 Data Security and Cyber Threats 24
5.2.3 Data Integration and Interoperability 24
5.2.4 Data Quality and Reliability 25
5.2.5 Scalability and Big Data Analytics 25
5.3 Federated Learning for Data Management 25
5.3.1 How Federated Learning Works 25
5.3.2 Key Advantages 25
5.4 Implementing Federated Learning 25
5.4.1 Infrastructure and Security 25
5.4.2 Regulatory Compliance and Ethical Considerations 26
5.4.3 Future Research Directions 26
5.5 Compute-to-Data: A Privacy-Preserving Framework 26
5.6 Addressing Risks and Challenges 26
5.6.1 Data Heterogeneity and Bias 26
5.6.2 Security and Privacy Risks 26
5.6.3 Ethical AI and Governance 26
Chapter 6 ENS Domains and NFTs for Integrated Business Entities 27
6.1 Introduction 27
6.2 ENS Domains and NFTs 27
6.3 Creating a Business Entity with ENS Domains and NFTs 27
6.3.1 Establishing a Business ENS Domain 27
6.3.2 Linking the ENS Domain to a Wallet 28

6.3.3 Representing the Business Entity as an NFT 28
6.4 Ocean Protocol and Compute-to-Data 28
6.4.1 Introduction to Ocean Protocol 28
6.4.2 Compute-to-Data: A Privacy-Preserving Approach 28
6.4.3 Utilizing Ocean Protocol for Data Asset Creation 28
6.5 Integration of Algorithms as NFTs 29
6.5.1 Algorithm NFTs: Introduction and Benefits 29
6.5.2 Algorithm Development and Representation 29
6.5.3 Algorithm Execution Using Compute-to-Data 29
6.6 Centralizing Earnings and Intellectual Property 29
6.6.1 Monetization and Royalties Through NFTs 29
6.6.2 Intellectual Property Management and Protection 29
6.6.3 Enhancing Collaboration and Value Creation 29
6.7 Case Studies and Applications 30
6.7.1 Industry-Specific Use Cases 30
6.7.2 Real-World Implementations 30
6.8 Challenges and Future Directions 30
6.8.1 Legal and Regulatory Considerations 30
6.8.2 Scalability and Interoperability 30
6.8.3 Opportunities for Further Innovation 30
Chapter 7 Energy Performance of Residential Buildings: Web3 Use Case 31
7.1 Introduction 31
7.2 Web3 and Decentralized Data Sharing 31
7.3 Legislative Context and Data Standardization 31
7.4 Data Processing and Transformation 32
7.5 Machine Learning Model Development 32
7.5.1 User Interaction and Model Deployment 32
7.6 Publishing on Web3 Platforms 33
7.7 Business Case and Future Potential 33
Chapter 8 NFL Fantasy Football Predictions – Use Case 34
8.1 Data Analysis 34
8.2 Feature Engineering 34
8.3 Model Build 34
8.4 Leveraging the Data Challenge for Model Development 35
8.5 Best-Performing Model Selection 35

8.6 Final Predictions & Implementation 35
Chapter 9 Ocean Foam: Empowering Data Scientists 35
9.1 Overview of Ocean Foam 35
9.2 The Role of Ocean Foam in Innovation 36
9.3 Objectives and Goals 36
9.4 The Need for Ocean Foam 36
9.5 Vision and Mission 36
9.6 Brand Values 36
9.7 Target Audience 37
9.8 Problem-Opportunity Statement 37
9.9 Market Entry: Web3 Real Estate 37
9.10 Growth Strategy and Financial Projections 37
9.11 Final Thoughts 38
Chapter 10 Conclusions 38
10.1 General Conclusions 38
10.2 Original Contributions 39
10.3 Future Research Directions 39
10.3.1 Scaling Ocean Foam 39
10.3.2 Industry Expansion 40
10.3.3 Community Engagement 40
10.3.4 Emerging Technologies 40
References 40

Chapter 1 Fundamentals of Artificial Intelligence

1.1 Introduction

This chapter explores the fundamental concepts of AI, including its definition, scope, classifications, and key components. It also examines the intersection between AI and emerging technologies such as Web3 and decentralized governance. Furthermore, the chapter addresses public perception, ethical concerns, and the current landscape of AI, highlighting the role of major industry players and academic institutions in shaping its future.

1.2 Definition and Core Characteristics of AI

AI refers to computational systems that mimic cognitive functions such as learning, decision-making, and problem-solving. The National Intelligence Initiative Act of 2020 defines AI as machine-based systems that make predictions, offer recommendations, or make decisions influencing both real and virtual environments.

1.2.1 Key Features of AI Systems

AI systems generally exhibit the following characteristics:

- Perception: AI can process sensory input such as images, speech, and environmental data.
- Learning: Machine learning (ML) enables AI to improve its performance based on data patterns.
- Reasoning and Decision-Making: AI applies logical rules to analyze data and predict outcomes.
- Problem-Solving: AI optimizes solutions to complex challenges in logistics, medicine, and business analytics.
- Natural Language Processing (NLP): AI can understand and generate human language, facilitating chatbots and translation services.
- Adaptability: AI dynamically adjusts to new environments, crucial for applications like autonomous vehicles.

1.3 Classifications of AI

AI is categorized based on its capabilities and functions, ranging from task-specific systems to highly autonomous, human-like intelligence.

1.3.1 Narrow AI (Weak AI)

Narrow AI refers to systems designed for specific tasks, such as facial recognition, fraud detection, and voice assistants (e.g., Siri, Alexa). While highly efficient in their designated areas, they lack the ability to generalize knowledge beyond their training.

1.3.2 Artificial General Intelligence (AGI)

AGI, also called Strong AI, represents a theoretical system capable of performing any intellectual task that a human can do. AGI would demonstrate reasoning, problem-solving, and adaptability across multiple domains without requiring specific programming. However, AGI remains a long-term goal of AI research, as no current system exhibits human-like intelligence.

1.3.3 AI Functional Classification

AI is also categorized based on functionality:

- Reactive Machines: Simple systems that respond to stimuli without memory (e.g., IBM's Deep Blue).
- Limited Memory AI: Systems that use past experiences to inform decisions (e.g., self-driving cars).
- Theory of Mind AI (Theoretical): Future AI capable of understanding emotions and human intent.
- Self-Aware AI (Theoretical): Hypothetical AI with consciousness and autonomy, raising philosophical and ethical concerns.

1.4 Machine Learning vs. Deep Learning

Machine learning and deep learning are critical subfields of AI that enable autonomous learning and pattern recognition.

1.4.1 Machine Learning (ML)

Machine learning involves algorithms that enable systems to learn from data and improve performance. It is categorized into:

- Supervised Learning: Algorithms trained on labeled data (e.g., spam detection, credit scoring).
- Unsupervised Learning: Algorithms that identify patterns in unlabeled data (e.g., customer segmentation).

- Reinforcement Learning: AI systems learn by trial and error using rewards and penalties (e.g., game-playing AI).

1.4.2 Deep Learning (DL)

Deep learning, a subset of ML, uses artificial neural networks to process vast amounts of data. Unlike traditional ML, deep learning automatically extracts features from raw data, making it highly effective for image recognition, speech processing, and complex decision-making.

1.5 AI and Web3: Decentralization and Autonomy

Web3 represents the next stage of the internet, characterized by decentralized networks powered by blockchain technology. AI integration into Web3 offers enhanced security, transparency, and user sovereignty over data.

1.5.1 AI and Blockchain Synergies

- Decentralized Data Sharing: AI models can be trained on blockchain-based data marketplaces, ensuring privacy and security.
- Autonomous AI Agents: AI-driven smart contracts optimize decentralized finance (DeFi) applications.
- Privacy-Preserving AI: Technologies like zero-knowledge proofs enable AI computations without exposing sensitive data.

1.5.2 AI in DAOs (Decentralized Autonomous Organizations)

AI can enhance DAO governance by automating decision-making, resource allocation, and community voting processes.

1.6 Public Perception and Ethical Considerations

Public attitudes toward AI are shaped by media representation, ethical concerns, and real-world applications.

1.6.1 AI in Popular Culture

Media depictions of AI oscillate between utopian visions of technological progress and dystopian fears of job displacement and surveillance. This dual narrative influences how society perceives AI’s risks and benefits.

1.6.2 Privacy, Bias, and Transparency

- Data Privacy: AI-driven data collection raises concerns about surveillance and data security.
- Algorithmic Bias: AI can perpetuate biases present in training datasets, leading to ethical dilemmas in hiring, criminal justice, and financial services.
- Transparency: Many AI systems function as "black boxes," where decision-making processes are not easily interpretable.

1.6.3 AI and the Workforce

AI-driven automation is transforming industries, with projections indicating that millions of jobs could be displaced by AI by 2030. While AI also creates new job opportunities, workforce retraining and social policies are essential to mitigating economic disruption.

1.7 The AI Landscape: Industry, Academia, and Decentralization

AI development is driven by collaborations between industry leaders, research institutions, and emerging decentralized AI ecosystems.

1.7.1 Traditional AI Leaders

- Google DeepMind: Reinforcement learning and AI-powered healthcare.
- Amazon AWS: Cloud-based AI services.
- Microsoft & OpenAI: Generative AI models like GPT-4.
- Meta AI Research: AI applications in social media and the metaverse.

1.7.2 Decentralized AI Platforms

- SingularityNET: A decentralized AI marketplace.
- Ocean Protocol: Blockchain-based data-sharing for AI training.
- Fetch.AI: AI-driven automation in decentralized networks.

1.7.3 AI and Geopolitics

- China: Heavy investment in AI to achieve global leadership by 2030.
- United States: AI leadership driven by private-sector innovation.
- European Union: AI governance focusing on ethical regulations (e.g., AI Act).

Chapter 2 Decentralized Data Exchange Protocol

2.1 Introduction

The manufacturing industry generates vast amounts of data from sensors, machines, and other sources that have the potential to improve efficiency, reduce costs, and enhance supply chain management. However, challenges related to data security, privacy, and transparency hinder seamless data sharing. Traditional centralized data exchange methods expose stakeholders to risks such as unauthorized access, data manipulation, and cyberattacks, limiting collaboration and innovation.

To address these challenges, this chapter proposes a decentralized data exchange protocol that leverages blockchain technology, smart contracts, tokenization, and interoperability to facilitate secure and transparent data transactions. The proposed protocol allows manufacturers to share, monetize, and utilize data while preserving privacy and ensuring regulatory compliance. This chapter provides a technical overview of the protocol and its applications in industrial ecosystems, highlighting its potential to revolutionize data-driven manufacturing.

2.2 Background: The Need for Secure Data Sharing in Manufacturing

Data plays a critical role in modern manufacturing, enabling predictive maintenance, process optimization, and AI-driven decision-making. By analyzing historical and real-time data, manufacturers can identify inefficiencies, optimize resource allocation, and enhance productivity. However, the reluctance to share data across organizations due to security and competitive concerns has led to inefficiencies and missed opportunities.

2.2.1 Challenges in Traditional Data Exchange

- Security Risks – Centralized databases are prone to cyberattacks and unauthorized access.
- Lack of Transparency – Data manipulation or tampering risks increase when no immutable record-keeping system is in place.
- Privacy Concerns – Sensitive manufacturing data, such as proprietary designs and production processes, require controlled access.
- Regulatory Compliance – Manufacturers must adhere to data protection laws (e.g., GDPR), making data sharing more complex.

A decentralized data exchange protocol can mitigate these risks by ensuring secure and privacy-preserving data transactions without relying on a centralized authority.

2.3 Decentralized Data Exchanges: Principles and Benefits

Decentralized data marketplaces enable peer-to-peer data transactions through blockchain-based smart contracts, eliminating the need for intermediaries while ensuring security and transparency.

2.3.1 How Decentralized Data Exchanges Work

- Smart Contracts – Automated, self-executing agreements on the blockchain govern data transactions.
- Data Monetization – Stakeholders can tokenize and sell data securely.
- Interoperability – The protocol supports integration with different manufacturing systems.
- Access Control Mechanisms – Privacy-preserving techniques allow controlled data sharing.

2.3.2 Advantages of Decentralized Data Exchange

- Enhanced Security – Data is encrypted and stored on the blockchain, reducing risks of unauthorized access.
- Data Ownership – Participants retain control over their data and decide how it is shared.
- Improved Collaboration – Secure, permissioned access fosters cooperation between manufacturers, suppliers, and AI developers.
- Reduced Costs – Eliminates intermediaries and associated expenses.

2.4 Ocean Protocol: A Framework for Decentralized Data Exchange

Ocean Protocol is a blockchain-based solution designed to facilitate secure, privacy-preserving, and efficient data sharing. It enables the tokenization of data assets, allowing organizations to monetize and control access to their data.

2.4.1 Key Features of Ocean Protocol

- Smart Contracts for Data Transactions – Automates agreements between data providers and consumers.
- Data Tokenization (ERC-20 and ERC-721 NFTs) – Facilitates ownership rights and access permissions for datasets.
- Compute-to-Data Mechanism – Allows AI models to be trained on private datasets without exposing raw data.

- Decentralized Data Marketplaces – Enables stakeholders to publish, discover, and trade datasets securely.

2.4.2 Architecture of Ocean Protocol

The Ocean ecosystem consists of:

- Smart Contracts – Securely facilitate data transactions.
- Ocean Marketplaces – Platforms where datasets can be published, discovered, and monetized.
- Ocean.js & Ocean.py – Developer tools for integrating Ocean Protocol into applications.
- Compute-to-Data Services – Allow AI algorithms to process data while maintaining privacy.

2.4.3 2.4.3 Data NFTs and Datatokens

Ocean Protocol introduces two key blockchain-based assets:

- Data NFTs (ERC-721) – Represent intellectual property (IP) rights over a dataset.
- Datatokens (ERC-20) – Act as licenses for accessing data.

These assets allow manufacturers to retain ownership of data while permitting controlled access through smart contracts.

2.5 Secure Data Access and Permissions

A major challenge in data exchange is ensuring that only authorized parties can access specific datasets. Ocean Protocol provides fine-grained permission controls that allow publishers to set access conditions, pricing models, and security measures.

2.5.1 Role-Based Access Control (RBAC)

RBAC ensures that data is accessible only to authorized entities. Roles can include:

- Manufacturers (data providers)
- AI Developers (data consumers)
- Regulatory Authorities (compliance verification)

2.5.2 Privacy-Preserving Techniques

- Compute-to-Data – Allows AI models to analyze datasets without exposing raw data.

- Zero-Knowledge Proofs (ZKPs) – Enables verification of data transactions without revealing sensitive information.
- Homomorphic Encryption – Allows computations to be performed on encrypted data.

These techniques provide data utility while preserving privacy, enabling AI-driven insights without violating confidentiality.

2.6 Building a Decentralized Data Marketplace

Developing a decentralized data exchange using Ocean Protocol involves the following steps:

2.6.1 Steps to Implement a Data Marketplace

- Understand the Protocol – Familiarize with Ocean Protocol's architecture and smart contract framework.
- Define Data Sources – Identify datasets relevant to manufacturing (e.g., sensor data, supply chain analytics).
- Design the Marketplace – Determine access models (public, private, or permissioned).
- Deploy Smart Contracts – Implement pricing models, tokenized access, and governance mechanisms.
- Publish Data Assets – Upload datasets with metadata, pricing, and access conditions.
- Monitor Transactions – Use blockchain explorers to audit and track data transactions.

2.6.2 Benefits of Using Ocean Protocol for a Data Marketplace

- Decentralization – Eliminates reliance on intermediaries.
- Security – Blockchain-based encryption ensures tamper-proof data storage.
- Privacy – Compute-to-Data preserves confidentiality while allowing AI-driven analysis.
- Interoperability – Supports integration with existing manufacturing systems.

2.7 Compute-to-Data: Enabling AI without Data Exposure

One of the most significant innovations in decentralized data exchange is the Compute-to-Data mechanism, which allows AI models to process data without directly accessing or transferring it.

2.7.1 How Compute-to-Data Works

- Data remains at the source – AI models execute computations without moving raw data.
- Encrypted processing – AI algorithms operate within a secure, privacy-preserving environment.

- Results are shared, not raw data – The system provides only computed outputs, reducing exposure risks.

2.7.2 Applications in Manufacturing

- Predictive Maintenance – AI models analyze equipment performance without exposing proprietary data.
- Supply Chain Optimization – Secure analytics improve logistics and inventory management.
- Quality Control – AI detects defects while protecting sensitive production details.

By allowing AI to analyze data without direct access, Compute-to-Data significantly enhances privacy, compliance, and efficiency in decentralized data ecosystems.

Chapter 3 The Intersection of Cryptocurrency, Blockchain, and Sports

3.1 Introduction

The sports industry is undergoing a transformation driven by digital technologies, particularly blockchain and cryptocurrency. These two have emerged as disruptive tools in sports, offering new models for fan interaction, sponsorship, and financial transactions. Blockchain is a decentralized ledger that ensures transparency and security, while cryptocurrency introduces digital assets that redefine value, ownership, and participation. Together, these technologies enhance fan engagement, streamline transactions, and enable new financial models, such as fan tokens and NFTs (non-fungible tokens).

This chapter explores the growing synergy between blockchain, cryptocurrency, and sports, analyzing their demographic overlap, financial implications, and strategic impact on the industry.

3.2 Synergy Between Blockchain and Sports

The sports industry and blockchain technology share a demographic and technological alignment, particularly among younger generations such as Millennials and Generation Z. These demographics exhibit:

- High digital literacy

- Openness to emerging technologies
- Preference for interactive and immersive experiences

3.2.1 Demographic Overlap

The adoption of blockchain in sports is largely driven by the interests and behaviors of younger audiences:

- Cryptocurrency and sports fans overlap significantly, as both communities value digital innovation and decentralization.
- Tech-savvy fans prefer digital collectibles, such as NFTs and fan tokens, which offer a sense of ownership and participation in their favorite teams.
- Blockchain-based sports engagement aligns with eSports and fantasy sports trends, where digital assets play a crucial role.

This alignment has led to strategic partnerships between cryptocurrency companies and sports organizations, resulting in:

- Sponsorship deals between blockchain firms and major sports leagues.
- Fan tokenization, allowing supporters to engage in team decisions.
- Cryptocurrency integration in ticketing, merchandise sales, and loyalty programs.

3.2.2 Rise of Fan Tokens and Digital Collectibles

Fan tokens and NFTs have transformed fan engagement models by enabling:

- Voting Rights – Token holders influence minor team decisions, such as jersey designs or goal celebration songs.
- Exclusive Content – Fans gain access to behind-the-scenes footage, meet-and-greets, and VIP experiences.
- Tradable Digital Assets – Fans can buy, sell, and trade digital assets on blockchain-based marketplaces.

Examples:

- Paris Saint-Germain (PSG), Juventus, and FC Barcelona have launched fan tokens via Socios.com, allowing fans to participate in club decisions.
- The NBA’s Top Shot platform enables users to buy, trade, and own officially licensed digital highlights of NBA games as NFTs.

3.3 Blockchain and Cryptocurrency in Sports Operations

Blockchain and cryptocurrency impact the sports industry in three key areas:

- Payments and Transactions
- Tokenization of Assets
- Smart Contracts for Sponsorships and Player Agreements

3.3.1 Cryptocurrency as a Payment Method

Sports teams and organizations have begun accepting cryptocurrency payments for:

- Tickets and merchandise
- Sponsorship deals
- Player salaries and bonuses

Advantages:

- Faster cross-border transactions, reducing costs and delays in international payments.
- Decentralized finance (DeFi) applications, offering alternative funding models for sports teams.
- Crypto-based rewards and loyalty programs, incentivizing fan engagement.

Example:

- Dallas Mavericks and Sacramento Kings accept Bitcoin and Ethereum for ticket and merchandise purchases.

3.3.2 Tokenization in Sports

Blockchain enables tokenization, allowing sports organizations to digitize assets such as:

- Sponsorship rights
- Game tickets
- Player contracts
- Sports memorabilia and digital collectibles

Applications:

- Fan Tokens – Digital assets providing fans with access to exclusive team privileges.
- NFTs – Unique digital collectibles, such as signed jerseys or game-worn items.

Example:

- Formula 1's partnership with Crypto.com integrates crypto payments and NFT sponsorships in racing events.

3.3.3 Smart Contracts in Sponsorships and Player Agreements

Smart contracts are self-executing agreements that automate:

- Sponsorship payments (e.g., bonuses released when an athlete reaches a milestone).
- Player contract clauses (e.g., automatic salary increases for performance achievements).
- Revenue-sharing models, ensuring fair distribution among stakeholders.

Example:

- FC Barcelona's tokenized contracts with sponsors streamline revenue distribution through blockchain automation.

3.4 Blockchain's Impact on Sponsorships and Partnerships

3.4.1 Cryptocurrency Sponsorship in Sports

Cryptocurrency companies have become major sponsors in global sports, leveraging brand exposure and user adoption.

Notable Deals:

- Crypto.com's $700 million naming rights deal for the Los Angeles Lakers' stadium.
- FTX's $135 million partnership with the Miami Heat for arena naming rights.
- Tezos' collaboration with Red Bull Racing to create blockchain-powered digital collectibles.

3.4.2 Tokenized Sponsorship Models

Blockchain facilitates new sponsorship models by enabling:

- Tokenized sponsorship deals, allowing sponsors to buy blockchain-based ad slots.
- Decentralized funding, where fans contribute directly to team sponsorship through crypto donations.

3.5 Future Trends in Blockchain and Sports

3.5.1 Smart Ticketing and Anti-Fraud Measures

Blockchain enhances ticketing security through:

- Non-fungible digital tickets (NFTs) that prevent counterfeiting.
- Smart contracts that regulate ticket resale and pricing.
- Decentralized ticketing platforms, eliminating scalping and fraudulent resale.

Example:

- UEFA and FIFA are exploring blockchain-based ticketing to prevent fraud in major tournaments.

3.5.2 Decentralized Fantasy Leagues and eSports

Blockchain can decentralize fantasy sports and eSports, offering:

- Tokenized player assets, allowing gamers to trade virtual athletes.
- Smart contract-based payouts, ensuring fair competition.
- Play-to-earn gaming models, rewarding users with cryptocurrency for participation.

Example:

- Sorare, a blockchain-based fantasy football platform, allows users to own and trade NFT-based player cards.

3.5.3 Sports Media and Content Monetization

Blockchain can revolutionize sports media and broadcasting by:

- Enabling microtransactions for premium content.
- Empowering decentralized sports streaming platforms.
- Allowing athletes to tokenize content ownership, creating new revenue streams.

Example:

- NBA and NFL players are launching personal NFT collections, monetizing their digital brand presence.

Chapter 4 Evolution of LLMs in Academia

4.1 Introduction

The integration of Large Language Models (LLMs), such as GPT-4, into academia has transformed research and education, offering powerful capabilities in text generation, analysis, and synthesis. However, while LLMs enhance efficiency and accessibility, they also introduce ethical challenges, including:

- Bias in AI-generated content, affecting the objectivity of research.
- Academic integrity concerns, particularly in distinguishing student-authored vs. AI-generated work.

This chapter explores these two core challenges through a quantitative and analytical approach, incorporating:

- Statistical models to measure bias in LLM-generated research.
- Logistic regression analysis to distinguish between AI-assisted and student-authored texts.
- Hypothetical case studies that demonstrate the practical implications of LLMs in academia.

By presenting both the opportunities and risks associated with LLMs, this chapter highlights best practices and mitigation strategies to ensure the ethical integration of AI into academic institutions.

4.2 Evolution of LLMs in Academia

4.2.1 From Text Processing to Contextual Intelligence

LLMs have evolved from basic text processing tools to advanced AI-driven systems capable of understanding and generating contextually rich and coherent text. Key developments include:

- Early AI models focused on pattern recognition and text classification.
- Deep learning models introduced context-awareness in text generation.
- Transformer-based architectures (e.g., GPT-4, BERT) enabled language understanding at unprecedented levels.

These advancements have made LLMs indispensable in academic research and teaching methodologies.

4.2.2 Impact on Research and Education

Research Applications:

- Automated Literature Review: LLMs assist in summarizing and analyzing large bodies of academic literature.
- Hypothesis Generation: AI models suggest potential research questions and methodologies.
- Data Synthesis: LLMs integrate cross-disciplinary insights, making them valuable for social sciences, linguistics, and cognitive research.

Teaching Applications:

- AI-driven tutoring systems personalize learning experiences by adapting to individual student needs.
- Interactive educational tools powered by LLMs enhance language learning, scenario-based education, and academic simulations.

While these applications enhance productivity, they also raise concerns about bias, data privacy, and ethical considerations.

4.3 Ethical Concerns of Using LLMs in Academia

4.3.1 Bias in AI-Generated Research

One of the most critical challenges in academic AI usage is the bias embedded in LLMs' training data. These biases stem from historical, cultural, and societal influences within the datasets used to train the models. If not addressed, bias can:

- Distort research findings by favoring specific perspectives.
- Perpetuate stereotypes, particularly in social sciences, history, and policy-making research.
- Affect educational content, leading to biased curricula and misrepresented knowledge.

Example:

- If an LLM is used to study gender representation in media, pre-existing biases in training data could lead to skewed results that reinforce stereotypes.

4.3.2 Academic Integrity and Plagiarism

LLMs blur the line between human and AI-generated content, leading to concerns about:

- Authorship attribution – determining whether students have written their work independently.

- AI-generated plagiarism – students using LLMs to produce work without proper attribution.
- Over-reliance on AI tools, diminishing critical thinking and original research skills.

4.4 Addressing Bias in LLM-Assisted Research

To ensure fair and objective academic research, institutions must implement bias detection and mitigation strategies.

4.4.1 Case Study: Measuring Bias in LLM Outputs

A university research team employed an LLM to analyze social behaviors across various sources (social media, academic journals, historical texts). However, statistical analysis revealed gender and racial biases in AI-generated outputs. We conducted a quantitative bias analysis using:

- Standard Deviation (σ) Calculation
- Coefficient of Variation (CV)

4.4.2 Bias Mitigation Strategies

- AI Ethics Training: Implementing mandatory AI ethics courses for researchers.
- Bias Evaluation Frameworks: Instituting bias audits at various research phases.
- Diverse Training Data: Expanding datasets to include more representative knowledge sources.

By integrating quantitative analysis and institutional reforms, universities can mitigate AI biases and uphold research integrity.

4.5 Academic Integrity in the Age of AI-Assisted Writing

To address concerns about AI-generated plagiarism, institutions are developing machine learning models to detect AI-assisted content.

4.5.1 Logistic Regression Model for AI Detection

A logistic regression model is trained to classify texts as student-authored (0) or AI-generated (1) based on:

- Text Complexity (e.g., sentence length, word difficulty)
- Vocabulary Diversity (e.g., Type-Token Ratio)
- Syntax Variation (e.g., sentence structure complexity)

4.5.2 Performance Evaluation

- Confusion Matrix: Measures true/false positive and negative classifications.
- ROC Curve Analysis: Evaluates the effectiveness of AI detection (ideal model reaches an AUC score of 0.97).

4.5.3 Ethical Implications

- AI-assisted plagiarism detection must balance academic oversight with fair evaluation.
- Encouraging AI literacy helps students understand the ethical boundaries of AI usage in academia.

4.6 Future Considerations

4.6.1 Strengthening Ethical Guidelines

Universities must develop clear policies for LLM usage, outlining:

- Permissible AI assistance levels in assignments.
- Citation standards for AI-generated content.
- Disciplinary measures for unethical AI use.

4.6.2 Advancements in Bias-Free AI Models

Research is advancing toward bias-free AI models by:

- Training on diverse datasets to reduce cultural and societal bias.
- Implementing fairness algorithms that adjust AI outputs for greater neutrality.

4.6.3 Responsible AI Integration in Academia

To fully harness LLMs' potential, academia must:

- Encourage ethical AI usage in research and education.
- Develop AI literacy programs to educate students on responsible AI application.
- Continuously refine detection models to maintain academic integrity.

Chapter 5 Federated Learning in the Pharmaceutical Industry

5.1 Introduction

The pharmaceutical industry relies on large-scale data across research, clinical trials, and patient monitoring. However, challenges such as data privacy regulations (GDPR, HIPAA), cybersecurity risks, interoperability issues, and scalability constraints hinder efficient data use.

Federated learning offers a decentralized machine learning approach, enabling model training across multiple data sources without centralizing raw data. This ensures privacy and compliance while allowing for collaborative AI-driven research. This chapter explores pharmaceutical data management challenges, federated learning's role in secure AI model training, and practical implementation strategies along with future applications.

5.2 Data Management Challenges

5.2.1 Data Privacy and Compliance

Strict regulations such as GDPR and HIPAA impose strict controls on collecting, storing, and processing patient data. Companies must ensure:

- Encryption and anonymization to protect sensitive information.
- Audit trails and consent management for compliance.

5.2.2 Data Security and Cyber Threats

Pharmaceutical data is a prime target for cyberattacks, intellectual property theft, and clinical trial manipulation. Organizations must implement:

- End-to-end encryption.
- Intrusion detection and access control systems.

5.2.3 Data Integration and Interoperability

Pharmaceutical research relies on heterogeneous data sources (clinical trials, EHRs, genomics, real-world evidence), requiring:

- Standardized data exchange frameworks like CDISC and HL7.
- Advanced data harmonization techniques.

5.2.4 Data Quality and Reliability

Poor data quality (inconsistencies, missing values, biases) compromises research outcomes. Solutions include:

- Automated data validation and cleansing.
- Bias detection algorithms for fairer AI models.

5.2.5 Scalability and Big Data Analytics

AI-driven drug discovery and personalized medicine require processing massive datasets. Companies must leverage:

- Cloud computing and distributed AI models.
- Parallel processing for real-time insights.

5.3 Federated Learning for Data Management

Federated learning provides a privacy-preserving AI solution by keeping data decentralized while training models collaboratively.

5.3.1 How Federated Learning Works

Unlike traditional AI models that centralize data, federated learning enables local AI model training, sharing only:

- Model updates (not raw data) with a central aggregator.
- Secure multi-party computation (SMPC) to prevent data exposure.

5.3.2 Key Advantages

- Privacy & Compliance: Meets GDPR/HIPAA guidelines.
- Scalability: Handles distributed datasets efficiently.
- Collaborative AI: Improves predictive modeling across institutions.

5.4 Implementing Federated Learning

5.4.1 Infrastructure and Security

A successful federated learning system requires:

- Cloud-based infrastructure for distributed AI processing.

- Homomorphic encryption & differential privacy to protect model updates.

5.4.2 Regulatory Compliance and Ethical Considerations

- Transparent AI governance ensures adherence to laws.
- Collaboration with regulators ensures compliance with evolving privacy laws.

5.4.3 Future Research Directions

- Real-time pharmacovigilance (drug safety monitoring).
- AI-assisted precision medicine.
- Decentralized clinical trial management.

5.5 Compute-to-Data: A Privacy-Preserving Framework

To enhance federated learning, Ocean Protocol's Compute-to-Data model enables:

- Secure computation on decentralized data.
- Encrypted AI model updates instead of raw data sharing.
- Decentralized data marketplaces for privacy-conscious research

5.6 Addressing Risks and Challenges

5.6.1 Data Heterogeneity and Bias

Data from different sources may vary in quality, structure, and representativeness. Solutions:

- Normalization techniques to standardize inputs.
- Bias detection & correction algorithms.

5.6.2 Security and Privacy Risks

Protecting federated learning systems requires:

- Secure communication protocols to prevent cyber threats.
- Encrypted model aggregation to prevent unauthorized access.

5.6.3 Ethical AI and Governance

To ensure responsible AI adoption, companies should develop ethical AI training guidelines and implement continuous model validation processes.

Chapter 6 ENS Domains and NFTs for Integrated Business Entities

6.1 Introduction

Digital identities are crucial for businesses, and blockchain-based solutions such as Ethereum Name Service (ENS) domains and Non-Fungible Tokens (NFTs) provide a novel way to manage them. This chapter explores how ENS domains, NFTs, and Ocean Protocol's Compute-to-Data feature work together to enhance digital asset management.

ENS domains simplify asset management by linking human-readable names to Ethereum addresses, consolidating business identity, revenue, and intellectual property within a single wallet. NFTs provide proof of ownership and authenticity, enabling secure transactions and efficient asset tracking. Beyond these, algorithm tokenization introduces a new way to manage and monetize intellectual property by storing algorithm NFTs alongside business entity NFTs in a single wallet.

6.2 ENS Domains and NFTs

ENS domains replace complex Ethereum addresses with human-readable names, making interactions more user-friendly. By associating ENS domains with NFTs, businesses can establish unique digital identities while ensuring authenticity and security. This integration streamlines digital ownership and enhances accessibility, allowing businesses to manage assets and intellectual property within a decentralized ecosystem.

NFTs provide immutable proof of ownership and facilitate peer-to-peer transactions. As unique digital assets, they establish provenance and secure digital property rights. By linking NFTs to ENS domains, businesses can simplify identity verification and asset management, ensuring seamless transfers and greater market confidence.

6.3 Creating a Business Entity with ENS Domains and NFTs

6.3.1 Establishing a Business ENS Domain

A business ENS domain provides a decentralized identity, replacing lengthy hexadecimal addresses with a recognizable name. Registering a domain and linking it to a wallet creates a publicly verifiable identity, simplifying asset interactions within blockchain networks.

6.3.2 Linking the ENS Domain to a Wallet

Businesses can connect their ENS domain to a cryptocurrency wallet, allowing them to manage NFTs, revenue streams, and intellectual property from a single access point. This integration ensures efficient tracking and control of digital assets while reinforcing ownership security.

6.3.3 Representing the Business Entity as an NFT

Tokenizing a business entity as an NFT enables authentication and monetization of intellectual property, branding, and other digital assets. Businesses can embed metadata, licensing terms, and legal documentation within NFTs, creating a transparent and verifiable ownership record.

6.4 Ocean Protocol and Compute-to-Data

6.4.1 Introduction to Ocean Protocol

Ocean Protocol is a decentralized data exchange framework that facilitates secure data sharing and monetization. Built on blockchain technology, it provides a marketplace for discovering and accessing valuable datasets while preserving data privacy and ownership rights.

6.4.2 Compute-to-Data: A Privacy-Preserving Approach

Compute-to-Data enables computations on sensitive data without exposing raw information. By keeping data within its original environment, this method ensures security while allowing businesses to generate insights and monetize data assets. Businesses leveraging this feature can perform advanced analytics while maintaining strict privacy controls.

6.4.3 Utilizing Ocean Protocol for Data Asset Creation

Businesses can tokenize datasets as NFTs, enabling ownership verification and monetization through Ocean Protocol’s marketplace. Compute-to-Data allows businesses to execute algorithms on tokenized data without compromising security, fostering trust and expanding opportunities for collaboration.

6.5 Integration of Algorithms as NFTs

6.5.1 Algorithm NFTs: Introduction and Benefits

Algorithms can be tokenized as NFTs, allowing developers to assert ownership and monetize their intellectual property. Algorithm NFTs provide verifiable authenticity, facilitate licensing, and streamline algorithm distribution through blockchain-based marketplaces.

6.5.2 Algorithm Development and Representation

Algorithm developers can tokenize their creations by embedding relevant metadata, licensing details, and usage restrictions within NFTs. This representation ensures transparency and enables seamless transfer of ownership and access rights across blockchain networks.

6.5.3 Algorithm Execution Using Compute-to-Data

Compute-to-Data allows algorithm execution on private datasets without exposing proprietary data. This approach protects intellectual property while enabling collaborative research and analytics. Algorithm developers can monetize their solutions by offering secure, privacy-preserving computation services.

6.6 Centralizing Earnings and Intellectual Property

6.6.1 Monetization and Royalties Through NFTs

By tokenizing business assets and algorithms, businesses can generate revenue through direct sales, licensing agreements, and automated royalty distribution. Smart contracts embedded in NFTs facilitate transparent and secure payments, ensuring ongoing monetization.

6.6.2 Intellectual Property Management and Protection

NFTs provide an immutable record of intellectual property ownership, reducing the risk of disputes and unauthorized use. By incorporating licensing terms and usage rights, businesses can enforce compliance and maintain control over their digital assets.

6.6.3 Enhancing Collaboration and Value Creation

ENS domains, NFTs, and Ocean Protocol foster a collaborative ecosystem where businesses, developers, and data providers can exchange resources and expertise. By integrating algorithm and

data NFTs within a single framework, businesses can create data-driven solutions and unlock new revenue streams.

6.7 Case Studies and Applications

6.7.1 Industry-Specific Use Cases

Businesses are leveraging ENS domains and NFTs for diverse applications, from real estate analytics to energy efficiency optimization. Tokenizing data and algorithms allows for seamless monetization, while Compute-to-Data ensures privacy-preserving insights.

6.7.2 Real-World Implementations

Organizations such as Ocean Wave are utilizing blockchain-based digital identity and data monetization frameworks to enhance accessibility, security, and collaboration. These implementations demonstrate the potential of ENS domains, NFTs, and Compute-to-Data in transforming digital asset management.

6.8 Challenges and Future Directions

6.8.1 Legal and Regulatory Considerations

The integration of ENS domains and NFTs in business operations raises legal and regulatory challenges, including intellectual property rights, licensing enforcement, and taxation. Clear guidelines and frameworks are needed to ensure compliance and facilitate widespread adoption.

6.8.2 Scalability and Interoperability

Ensuring scalability and interoperability across blockchain networks is critical for the long-term success of ENS domains and NFTs. Standardized protocols and cross-chain compatibility will enhance usability and expand market opportunities.

6.8.3 Opportunities for Further Innovation

Advancements in decentralized governance, zero-knowledge proofs, and artificial intelligence integration will drive further innovation in blockchain-based digital asset management. Continued research and development will unlock new capabilities and refine existing solutions.

Chapter 7 Energy Performance of Residential Buildings: Web3 Use Case

7.1 Introduction

Residential buildings account for a significant portion of energy consumption and greenhouse gas emissions. Improving their energy efficiency can reduce emissions, combat energy poverty, and drive economic recovery. This chapter explores how machine learning and Web3 technologies, including blockchain, NFTs, and smart contracts, can be leveraged to enhance building energy performance analysis and recommendations.

Using Scotland's Energy Performance Certificate Register data, a machine learning model was developed to provide recommendations on building upgrades. The dataset and algorithm were published on Ocean Market, enabling decentralized, permissionless access through smart contracts. This use case demonstrates how blockchain-based AI applications can make government data actionable for the public, promoting energy efficiency and sustainability.

7.2 Web3 and Decentralized Data Sharing

Web3 enables decentralized data management through blockchain technology, eliminating the need for intermediaries. Key Web3 principles include:

- Decentralization: Data and applications are distributed across a peer-to-peer network rather than stored on centralized servers.
- Blockchain Transactions: Smart contracts facilitate interactions, ensuring transparency and immutability.
- Crypto Wallets and Tokens: Users access Web3 applications using wallets like MetaMask, which store tokens for payments and identity verification.
- Compute-to-Data: Allows machine learning models to run on private datasets without exposing raw data, ensuring privacy.

7.3 Legislative Context and Data Standardization

The European Union’s Energy Performance of Buildings Directive (EPBD) mandates improvements in building energy efficiency. The European Commission’s Renovation Wave Strategy aims to double renovation rates, enhancing energy efficiency and creating jobs. Standardization efforts, led by the EPB Center, include ISO standards such as:

- ISO 52000-1: General framework for assessing building energy performance.
- ISO 52016-1: Defines methods for calculating heating and cooling requirements.
- ISO 52018-1: Specifies performance indicators for energy-efficient building envelopes.

7.4 Data Processing and Transformation

The dataset used in this project comes from the Scottish Energy Performance Certificate Register. It includes detailed energy efficiency information on residential buildings.

7.5 Machine Learning Model Development

A decision tree model was chosen based on data characteristics and interpretability. Alternative models like logistic regression, random forests, and support vector machines were considered, but decision trees were selected due to their ability to handle categorical data efficiently.

Model selection criteria:

- Supervised learning approach: Since the dataset is labeled, a classification model was required.
- Decision tree advantages: Easy to interpret, handles non-linear data well, and provides clear decision rules.
- Training and validation: The model was trained on 900 records and tested on 101 records, achieving high accuracy in predicting energy efficiency improvements.

7.5.1 User Interaction and Model Deployment

To make the model accessible, a Web3-enabled input mechanism was developed. Users provide building characteristics via a dropdown interface, and the system generates upgrade recommendations based on the trained model.

Prediction process:

- Users select building attributes from a predefined menu.
- The system encodes the input and integrates it into the dataset.
- The model runs predictions, outputting recommended energy efficiency improvements.
- Users receive a list of suggested upgrades with confidence scores.

Example output:

- Upgrade to cavity wall insulation: 100% probability

- Install solar panels (2.5 kWp): 97.6% probability
- Replace single-glazed windows with double-glazing: 100% probability

7.6 Publishing on Web3 Platforms

The dataset and trained model were published on Ocean Market, allowing decentralized access through blockchain-based smart contracts.

Key Web3 integrations:

- Dataset publishing: The dataset remains encrypted, accessible only through Compute-to-Data.
- Algorithm publishing: Users can run the prediction model on the dataset without downloading raw data.
- Smart contract transactions: MetaMask transactions govern dataset and model access, ensuring transparency.
- NFT-based ownership: When published, an NFT is minted as proof of ownership, enabling monetization.

7.7 Business Case and Future Potential

This Web3 use case demonstrates a viable model for leveraging blockchain and AI in public data analytics. The decentralized nature of the project eliminates reliance on centralized institutions while enabling monetization.

Key takeaways:

- Democratized access: Anyone can analyze building energy performance without specialized expertise.
- Automated monetization: Dataset and algorithm publishers can charge fees via smart contracts.
- Scalability: The framework can be extended to other datasets and industries.

Future directions:

- Development of a user-friendly Web3 interface.
- Expansion to additional building datasets.
- Integration with real-time energy consumption data for dynamic recommendations.

Chapter 8 NFL Fantasy Football Predictions – Use Case

NFL Fantasy Football has evolved into a competitive, strategy-driven game where accurate player performance predictions are crucial. This chapter presents a model integrating blockchain technology and machine learning to forecast NFL player points for the 2023 season. Using data from Pharaoh Analytics, the study includes data analysis, feature engineering, model training, and evaluation.

8.1 Data Analysis

Exploratory Data Analysis (EDA) was conducted to understand the dataset, identify missing values, outliers, and derive insights for feature selection.

- Dataset Overview: The dataset includes historical performance statistics for NFL players over multiple seasons.
- Statistical Summaries: Mean, median, and standard deviation were computed for key metrics like yards gained, touchdowns, and fantasy points.
- Missing Values & Outliers: Data cleaning techniques, including imputation and anomaly detection, ensured quality.
- Correlation Analysis: Heatmaps and scatter plots helped identify relationships between features and fantasy points.

8.2 Feature Engineering

Feature selection, transformation, and creation were performed to enhance model accuracy.

- Feature Selection: Key performance indicators, such as touchdowns and receptions, were prioritized based on correlation and domain knowledge.
- Feature Transformation: Normalization and encoding techniques ensured features were in suitable formats for modeling.
- Feature Creation: Rolling averages, efficiency metrics, and injury history indicators were introduced to improve predictions.

8.3 Model Build

Several machine learning models were evaluated to determine the best approach.

- Model Selection: Candidates included Linear Regression, Random Forest, Gradient Boosting, and Neural Networks.

- Model Training: Hyperparameter tuning and cross-validation were applied to optimize performance.
- Evaluation Metrics: RMSE, MAE, and R-squared were used to assess accuracy.

8.4 Leveraging the Data Challenge for Model Development

A data challenge using Pharaoh Analytics data was conducted via Ocean Protocol's Desights platform, engaging 350 data scientists. Nine participants submitted models, with a prize pool of $5,000 awarded to the top three solutions.

- Data Preprocessing: Cleaning and transformation of 4,600 records from 2016-2023.
- Player & Team Filtering: Focused on active players in key offensive positions (QB, WR, TE, RB).
- Clustering: Team and player clusters were created to normalize performance metrics.

8.5 Best-Performing Model Selection

Multiple models were tested:

- Neural Network: MAE of 42.2.
- XGBoost: MAE of 41.8.
- K-Nearest Neighbors: MAE of 42.0.
- ElasticNet Regression: Chosen for its balance of accuracy and interpretability (MAE of 42.0).

8.6 Final Predictions & Implementation

The final ElasticNet model was trained on the entire dataset and used to predict player points for the 2023-2024 season. Results were compiled into a CSV file for easy interpretation.

Chapter 9 Ocean Foam: Empowering Data Scientists

9.1 Overview of Ocean Foam

Ocean Foam extends Ocean Protocol's Data Challenge program by fostering collaboration between data scientists and entrepreneurs. The platform enables continuous monetization, intellectual property protection, and Web3 integration, ensuring that insights, models, and decentralized applications (dApps) generate long-term value.

9.2 The Role of Ocean Foam in Innovation

Data remains underutilized due to access, monetization, and collaboration challenges. Ocean Foam addresses these issues by providing a decentralized space for data scientists to develop, refine, and monetize machine learning models. Unlike traditional competitions with one-time rewards, Ocean Foam offers ongoing revenue streams through dApp integration and licensing.

9.3 Objectives and Goals

For Data Scientists:

- IP Ownership: Maintain rights over algorithms and models.
- Continuous Monetization: Earn recurring revenue from model integration and licensing.
- Creative Freedom: Develop solutions independently of institutional constraints.

For Entrepreneurs:

- Business Insights: Transform raw data into actionable intelligence.
- Expert Access: Connect with top-tier data scientists.
- Scalability: Utilize ready-to-deploy dApps and predictive models.

9.4 The Need for Ocean Foam

Industries require platforms that unlock data's full potential. Ocean Foam enables:

- Data Accessibility: A repository of high-value datasets.
- Monetization Pathways: Recurring revenue for algorithm creators.
- Secure Data Exchange: Trust-driven collaboration through blockchain technology.

9.5 Vision and Mission

Ocean Foam aims to create an open, decentralized ecosystem that supports innovation and entrepreneurship by offering secure, collaborative, and profitable data utilization tools.

9.6 Brand Values

- Innovation: Supports new data-driven solutions and decentralized monetization models.
- Transparency: Ensures verifiable transactions and decentralized governance.
- Privacy: Implements Compute-to-Data for secure analytics.
- Collaboration: Encourages community-driven problem-solving.

- IP Protection: Guarantees model ownership and fair compensation.

9.7 Target Audience

- Primary: Data scientists and Web3 entrepreneurs looking to monetize models or integrate data-driven applications.
- Secondary: Academic institutions and SMEs seeking scalable analytics solutions.

9.8 Problem-Opportunity Statement

For Data Scientists:

- Access to diverse datasets.
- Monetization beyond competition winnings.
- Business alignment for real-world impact.

For Entrepreneurs:

- Affordable data science resources.
- Streamlined model deployment.
- Scalable predictive analytics.

9.9 Market Entry: Web3 Real Estate

Market Overview:

- Dubai's real estate sector is rapidly digitizing, with blockchain-backed transactions expected by 2025.
- Predictive analytics is in demand, with 72% of investors seeking advanced forecasting tools.

Competitive Landscape:

- Existing platforms lack blockchain-integrated predictive analytics.
- Ocean Foam fills this gap by combining data science, transparency, and automation.

9.10 Growth Strategy and Financial Projections

Entry Strategy:

- Partnerships: Collaborate with real estate firms and regulatory bodies.
- Education: Demonstrate blockchain's role in property valuation.

- Regulatory Compliance: Align with government digital transformation initiatives.

Revenue Streams:

- Subscription Models: Tiered plans from $50–$500 per month.
- Pay-Per-Report: One-time market reports priced at $10–$100.
- Premium Features: Advanced predictive models and AI-driven insights.

Growth Projections:

- Year 1: 1,500–2,500 transactions, generating $500K–$1.2M.
- Year 2: 2,500–5,000 transactions, reaching $1.2M–$2.4M.
- Year 3: 5,000–7,500 transactions, scaling revenue to $2.4M–$3.6M.

9.11 Final Thoughts

Ocean Foam combines data science, blockchain, and decentralized applications to create a sustainable ecosystem. Its real estate market entry showcases its potential for disrupting industries by offering predictive analytics, transparency, and automation. By leveraging Web3 principles, Ocean Foam empowers data scientists and entrepreneurs to build scalable, monetizable solutions.

Chapter 10 Conclusions

10.1 General Conclusions

This thesis explored the integration of artificial intelligence (AI) with decentralized technologies, blockchain, large language models, and federated learning. AI is reshaping industries by enhancing decision-making, ensuring data privacy, and optimizing business processes. The study established a foundational understanding of AI's capabilities and examined its application in decentralized ecosystems like Ocean Protocol. By integrating AI with blockchain, industries can address data privacy concerns and foster trust in data exchange.

Key findings include AI's role in predictive modeling, its impact on the sports industry, and its application in decentralized finance. Case studies demonstrated AI's effectiveness in optimizing energy efficiency for buildings and improving NFL fantasy football predictions. Additionally, the introduction of Ocean Foam highlighted how decentralized platforms empower data scientists to

collaborate and monetize their work. The research also examined the ethical implications of AI, emphasizing the need for transparency, governance, and responsible deployment.

In conclusion, AI's transformative impact on business is evident across various sectors. However, ensuring ethical deployment and establishing governance frameworks will be crucial for sustainable innovation. As AI continues to evolve, businesses must address data security, bias, and accountability to maximize its benefits while minimizing risks.

10.2 Original Contributions

- Integrated AI and blockchain in the sports industry, focusing on revenue diversification and fan engagement.
- Conducted a statistical analysis of NFL player performances over eight years, identifying the Linear (ElasticNet) model as the best predictor for fantasy football points.
- Proposed a decentralized data exchange protocol for the manufacturing sector using blockchain and smart contracts.
- Developed a federated learning framework for secure AI model training across distributed data sources.
- Introduced a logistic regression model to differentiate between AI-generated and human-authored content, advocating for responsible AI use in research.
- Explored ENS domains and NFTs as tools for digital asset management, enhancing business identity and monetization.
- Created an AI-powered algorithm for improving building energy efficiency, leveraging open government data.
- Launched Ocean Foam, a Web3 platform for data scientists to collaborate, monetize models, and retain intellectual property ownership.

10.3 Future Research Directions

10.3.1 Scaling Ocean Foam

Expanding Ocean Foam requires enhancing infrastructure, refining the user interface, and integrating cloud-based storage for scalability. Increased computational capacity will support more complex AI models and real-time analysis. Improving user experience with AI-driven support tools and onboarding resources will facilitate broader adoption.

10.3.2 Industry Expansion

Ocean Foam will target energy, agriculture, and smart cities, where decentralized data solutions can drive efficiency. Predictive analytics can optimize energy grids, enhance agricultural productivity, and improve urban planning. Geographic expansion will focus on emerging markets, offering decentralized solutions for economic development and public services.

10.3.3 Community Engagement

Building a collaborative ecosystem through hackathons, open-source contributions, and educational initiatives will strengthen user engagement. Encouraging knowledge sharing and real-world problem-solving will accelerate innovation and platform growth.

10.3.4 Emerging Technologies

AI advancements, quantum computing, and DeFi integration will shape the future of decentralized data platforms. Quantum computing will enable faster computations, while token-based incentives will create new monetization opportunities. Ocean Foam will remain at the forefront of these technological shifts, ensuring continuous innovation in decentralized AI applications.

References

[1] I. H. Sarker, "AI-Based Modeling: Techniques, Applications and Research Issues Towards Automation, Intelligent and Smart Systems," *SN COMPUT. SCI.*, vol. 3, no. 2, p. 158, Feb. 2022, doi: 10.1007/s42979-022-01043-x.

[2] "The National Artificial Intelligence Initiative (NAII)," National Artificial Intelligence Initiative. Accessed: May 30, 2022. [Online]. Available: https://www.ai.gov/

[3] "4 types of AI (artificial intelligence) explained," Enterprise AI. Accessed: Sep. 10, 2024. [Online]. Available: https://www.techtarget.com/searchenterpriseai/tip/4-main-types-of-AI-explained

[4] "What is Artificial General Intelligence? - TechTarget," SearchEnterpriseAI. Accessed: May 31, 2022. [Online]. Available: https://www.techtarget.com/searchenterpriseai/definition/artificial-general-intelligence-AGI

[5] B. Nancholas, "What are the different types of artificial intelligence?," University of Wolverhampton. Accessed: Sep. 25, 2024. [Online]. Available: https://online.wlv.ac.uk/what-are-the-different-types-of-artificial-intelligence/

[6] "What Is Self-Aware AI? - Blue Goat Cyber." Accessed: Sep. 25, 2024. [Online]. Available: https://bluegoatcyber.com/blog/what-is-self-aware-ai/

[7] SingularityNET, "A Deep Dive on the Differences Between Narrow AI and AGI," SingularityNET. Accessed: Sep. 25, 2024. [Online]. Available: https://medium.com/singularitynet/a-deep-dive-on-the-differences-between-narrow-ai-and-agi-19016011c966

[8] L. Bunyaviroch and N. Thanyawet, *Review on AI Using Image Processing in The Medical Field*. 2021.

[9] "Discover the Differences Between AI vs. Machine Learning vs. Deep Learning [2022 Edition]," Simplilearn.com. Accessed: May 31, 2022. [Online]. Available: https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/ai-vs-machine-learning-vs-deep-learning

[10] S. Al-Janabi, M. Mohammad, and A. Al-Sultan, "A new method for prediction of air pollution based on intelligent computation," *Soft Computing*, vol. 24, Jan. 2020, doi: 10.1007/s00500-019-04495-1.

[11] R. van Loon, "Machine learning explained: Understanding supervised, unsupervised, and reinforcement learning," Big Data Made Simple. Accessed: May 31, 2022. [Online]. Available: https://bigdata-madesimple.com/machine-learning-explained-understanding-supervised-unsupervised-and-reinforcement-learning/

[12] P. Deepan and L. R. Sudha, "Deep Learning Algorithm and Its Applications to IoT and Computer Vision," in *Artificial Intelligence and IoT: Smart Convergence for Eco-friendly Topography*, K. G. Manoharan, J. A. Nehru, and S. Balasubramanian, Eds., Singapore: Springer, 2021, pp. 223–244. doi: 10.1007/978-981-33-6400-4_11.

[13] "AI vs. Machine Learning vs. Deep Learning: What's the Difference? | Built In." Accessed: May 31, 2022. [Online]. Available: https://builtin.com/artificial-intelligence/ai-vs-machine-learning

[14] info@lawtomated.com, "A.I. technical - Machine Learning vs. Deep Learning," lawtomated. Accessed: Sep. 11, 2024. [Online]. Available: https://lawtomated.com/a-i-technical-machine-vs-deep-learning/

[15] "What is Web3 and why is it important?," ethereum.org. Accessed: Dec. 12, 2022. [Online]. Available: https://ethereum.org

[16] "What are AI agents?," MIT Technology Review. Accessed: Sep. 25, 2024. [Online]. Available: https://www.technologyreview.com/2024/07/05/1094711/what-are-ai-agents/

[17] A. Ghavi, A. Qureshi, G. Weinstein, J. Schwartz, and S. Lofchie, "A Primer on DAOs," The Harvard Law School Forum on Corporate Governance. Accessed: Sep. 25, 2024. [Online]. Available: https://corpgov.law.harvard.edu/2022/09/17/a-primer-on-daos/

[18] P. Li, "Web3 Meets AI Marketplace: Exploring Opportunities, Analyzing Challenges, and Suggesting Solutions," Oct. 29, 2023, *arXiv*: arXiv:2310.19099. doi: 10.48550/arXiv.2310.19099.

[19] "Ipsos Global AI 2023 Report-WEB_0.pdf." Accessed: Sep. 25, 2024. [Online]. Available: https://www.ipsos.com/sites/default/files/ct/news/documents/2023-07/Ipsos%20Global%20AI%202023%20Report-WEB_0.pdf

[20] K. Nader, P. Toprac, S. Scott, and S. Baker, "Public understanding of artificial intelligence through entertainment media," *AI Soc*, pp. 1–14, Apr. 2022, doi: 10.1007/s00146-022-01427-w.

[21] "HAI_AI-Index-Report-2024_Chapter9.pdf." Accessed: Sep. 25, 2024. [Online]. Available: https://aiindex.stanford.edu/wp-content/uploads/2024/04/HAI_AI-Index-Report-2024_Chapter9.pdf

[22] B. Z. and A. Dafoe and C. for the G. of A. Oxford Future of Humanity Institute, University of, *6 High-level machine intelligence | Artificial Intelligence: American Attitudes and Trends*. Accessed: May 31, 2022. [Online]. Available: https://governanceai.github.io/US-Public-Opinion-Report-Jan-2019/high-level-machine-intelligence.html#subsecharmgood

[23] "What the future of work will mean for jobs, skills, and wages: Jobs lost, jobs gained | McKinsey." Accessed: May 31, 2022. [Online]. Available: https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages#part%203

[24] "AI, automation, and the future of work: Ten things to solve for (Tech4Good) | McKinsey." Accessed: Sep. 10, 2024. [Online]. Available: https://www.mckinsey.com/featured-insights/future-of-work/ai-automation-and-the-future-of-work-ten-things-to-solve-for

[25] "Unlocking Value in Manufacturing through Data Sharing," World Economic Forum. Accessed: Mar. 17, 2023. [Online]. Available: https://www.weforum.org/projects/data-sharing-for-manufacturing/

[26] "Top 10 Trends 2023." Accessed: Mar. 15, 2023. [Online]. Available: https://view.ceros.com/applied-intelligence/top-10-trends-2023

[27] "How big data can improve manufacturing | McKinsey." Accessed: Mar. 17, 2023. [Online]. Available: https://www.mckinsey.com/capabilities/operations/our-insights/how-big-data-can-improve-manufacturing

[28] "Big Data in manufacturing: Trends, tips, success stories," Software Development Company - N-iX. Accessed: Mar. 17, 2023. [Online]. Available: https://www.n-ix.com/big-data-in-manufacturing/

[29] R. A. R, "The scope of Decentralizing Data Marketplaces using blockchain," Accubits Blog. Accessed: Mar. 18, 2023. [Online]. Available: https://blog.accubits.com/the-scope-of-decentralizing-data-marketplaces-using-blockchain/

[30] "ERC-721." Accessed: Mar. 18, 2023. [Online]. Available: http://erc721.org/

[31] "ERC-20 Token Standard," ethereum.org. Accessed: Mar. 18, 2023. [Online]. Available: https://ethereum.org

[32] "Data NFTs and Datatokens." Accessed: Mar. 18, 2023. [Online]. Available: https://docs.oceanprotocol.com/core-concepts/datanft-and-datatoken

[33] "Decentralized Identifiers (DIDs) v1.0." Accessed: Mar. 18, 2023. [Online]. Available: https://w3c.github.io/did-core/

[34] "tech-whitepaper.pdf." Accessed: Aug. 20, 2024. [Online]. Available: https://oceanprotocol.com/tech-whitepaper.pdf

[35] "Architecture." Accessed: Mar. 18, 2023. [Online]. Available: https://docs.oceanprotocol.com/building-with-ocean/Compute-to-Data/Compute-to-Data-architecture

[36] "General Data Protection Regulation," *Wikipedia*. Mar. 13, 2023. Accessed: Mar. 18, 2023. [Online]. Available: https://en.wikipedia.org/w/index.php?title=General_Data_Protection_Regulation&oldid=1144398012

[37] "Role-based access control," *Wikipedia*. Feb. 13, 2023. Accessed: Mar. 18, 2023. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Role-based_access_control&oldid=1139093053

[38] Jamie, "Fine-Grained Permissions now supported in Ocean Protocol," Medium. Accessed: Mar. 18, 2023. [Online]. Available: https://blog.oceanprotocol.com/fine-grained-permissions-now-supported-in-ocean-protocol-4fe434af24b9

[39] "us-tmt-2022-sports-outlook.pdf." Accessed: Aug. 16, 2024. [Online]. Available: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-2022-sports-outlook.pdf

[40] PricewaterhouseCoopers, "Making sense of bitcoin, cryptocurrency and blockchain," PwC. Accessed: Aug. 16, 2024. [Online]. Available: https://www.pwc.com/us/en/industries/financial-services/fintech/bitcoin-blockchain-cryptocurrency.html

[41] "What is Blockchain and Artificial Intelligence (AI)? | IBM." Accessed: Aug. 16, 2024. [Online]. Available: https://www.ibm.com/topics/blockchain-ai

[42] "Sports Fans Are Into Cryptocurrency, and Brands Are Capitalizing." Accessed: Aug. 19, 2024. [Online]. Available: https://pro.morningconsult.com/articles/sports-fans-cryptocurrency-poll

[43] M. Takaoğlu and T. Dursun, "Decentralized Ledger Technologies in the Sports Industry: Applying NFT and Ordinal Theory for Athlete Data Management, Event Management, and Sports Collectibles," *Journal of Sports Industry & Blockchain Technology*, vol. 1, no. 1, Art. no. 1, Jul. 2024, doi: 10.5281/zenodo.12599668.

[44] "Crypto Adoption in Sports: Examining the Benefits and Challenges," Financial and Business News | Finance Magnates. Accessed: Aug. 16, 2024. [Online]. Available: https://www.financemagnates.com/cryptocurrency/innovation/crypto-adoption-in-sports-examining-the-benefits-and-challenges/

[45] A. Mendonça, "Blockchain Technology and Sports: The Impact of NFTs in the Sports Industry".

[46] A.-S. Berkani, H. Moumen, S. Benharzallah, S. Yahiaoui, and A. Bounceur, "Blockchain Use Cases in the Sports Industry: A Systematic Review," *Int J Netw Distrib Comput*, vol. 12, no. 1, pp. 17–40, Jun. 2024, doi: 10.1007/s44227-024-00022-3.

[47] T. Bason, P. Petratos, R. Porreca, and M. Mohiuddin Babu, "Sport and Blockchain," Jan. 2023.

[48] Crypto.com, "Crypto.com announced as official title partner of the Formula 1 Crypto.com Miami Grand Prix." Accessed: Aug. 16, 2024. [Online]. Available: https://crypto.com/company-news/crypto-com-announced-as-official-title-partner-of-the-formula-1-crypto-com-miami-grand-prix

[49] "FTX Fallout: How Sponsorship Partners are Moving Forward: Stinson LLP Law Firm." Accessed: Aug. 16, 2024. [Online]. Available: https://www.stinson.com/newsroom-publications-ftx-fallout-how-sponsorship-partners-are-moving-forward

[50] "Smart sports," MIT Technology Review. Accessed: Aug. 19, 2024. [Online]. Available: https://www.technologyreview.com/2021/01/29/1017028/smart-sports/

[51] J. Rankin and J. Emmett, "How Technology Is Redefining the Fan Experience at Sports and Music Venues," Gensler. Accessed: Aug. 19, 2024. [Online]. Available: https://www.gensler.com/blog/immersive-technology-is-redefining-the-sports-fan-experience

[52] J. C. Institute, "Embrace the Change: Benefits and Strategy of Web3 for Football Clubs," Johan Cruyff Institute. Accessed: Aug. 19, 2024. [Online]. Available: https://johancruyffinstitute.com/en/blog-en/embrace-the-change-benefits-and-strategy-of-web3-for-football-clubs/

[53] E. Glebova and P. Mihalova, "New currencies and new values in professional sports: blockchain, NFT, and fintech through the stakeholder approach," *JPES*, vol. 23, no. 5, pp. 1244–1252, Nay 2023.

[54] J. G. Meyer *et al.*, "ChatGPT and large language models in academia: opportunities and challenges," *BioData Mining*, vol. 16, no. 1, p. 20, Jul. 2023, doi: 10.1186/s13040-023-00339-9.

[55] M. Perkins, "Academic Integrity considerations of AI Large Language Models in the post-pandemic era: ChatGPT and beyond," *Journal of University Teaching & Learning Practice*, vol. 20, no. 2, Feb. 2023, doi: 10.53761/1.20.02.07.

[56] L. De Angelis *et al.*, "ChatGPT and the rise of large language models: the new AI-driven infodemic threat in public health," *Frontiers in Public Health*, vol. 11, 2023, Accessed: Nov. 13, 2023. [Online]. Available: https://www.frontiersin.org/articles/10.3389/fpubh.2023.1166120

[57] S. Porsdam Mann, B. D. Earp, N. Møller, S. Vynn, and J. Savulescu, "AUTOGEN: A Personalized Large Language Model for Academic Enhancement—Ethics and Proof of Principle," *The American Journal of Bioethics*, vol. 23, no. 10, pp. 28–41, Oct. 2023, doi: 10.1080/15265161.2023.2233356.

[58] H. Li, J. T. Moon, S. Purkayastha, L. A. Celi, H. Trivedi, and J. W. Gichoya, "Ethics of large language models in medicine and medical research," *The Lancet Digital Health*, vol. 5, no. 6, pp. e333–e335, Jun. 2023, doi: 10.1016/S2589-7500(23)00083-3.

[59] M. Hosseini and S. P. J. M. Horbach, "Fighting reviewer fatigue or amplifying bias? Considerations and recommendations for use of ChatGPT and other large language models in scholarly peer review," *Res Integr Peer Rev*, vol. 8, no. 1, p. 4, May 2023, doi: 10.1186/s41073-023-00133-5.

[60] M. S. Orenstrakh, O. Karnalim, C. A. Suarez, and M. Liut, "Detecting LLM-Generated Text in Computing Education: A Comparative Study for ChatGPT Cases," Jul. 10, 2023, *arXiv*: arXiv:2307.07411. doi: 10.48550/arXiv.2307.07411.

[61] Z. Liu, Z. Yao, F. Li, and B. Luo, "Check Me If You Can: Detecting ChatGPT-Generated Academic Writing using CheckGPT," Jun. 07, 2023, *arXiv*: arXiv:2306.05524. doi: 10.48550/arXiv.2306.05524.

[62] "Getting started with logistic regression | Hex." Accessed: Nov. 28, 2023. [Online]. Available: https://hex.techlogistic-regression

[63] "1.1. Linear Models," scikit-learn. Accessed: Nov. 28, 2023. [Online]. Available: https://scikit-learn/stable/modules/linear_model.html

[64] "What is GDPR, the EU's new data protection law?," GDPR.eu. Accessed: May 22, 2023. [Online]. Available: https://gdpr.eu/what-is-gdpr/

[65] "Health Insurance Portability and Accountability Act of 1996 (HIPAA) | CDC." Accessed: May 22, 2023. [Online]. Available: https://www.cdc.gov/phlp/publications/topic/hipaa.html

[66] N. Rieke, "What Is Federated Learning?," NVIDIA Blog. Accessed: May 22, 2023. [Online]. Available: https://blogs.nvidia.com/blog/2019/10/13/what-is-federated-learning/

[67] "Top 7 Challenges Faced by Pharma AI," Spiceworks. Accessed: Apr. 18, 2023. [Online]. Available: https://www.spiceworks.com/tech/artificial-intelligence/guest-article/top-challenges-faced-by-pharma-ai/

[68] "Standards." Accessed: May 22, 2023. [Online]. Available: https://www.cdisc.org/standards

[69] "Introduction to HL7 Standards | HL7 International." Accessed: May 22, 2023. [Online]. Available: https://www.hl7.org/implement/standards/index.cfm?ref=nav

[70] S. Dupré, "AI TRENDS & USE CASES IN THE PHARMACEUTICAL INDUSTRY," Swiss Data Science Center. Accessed: Aug. 21, 2023. [Online]. Available: https://datascience.ch/ai-trends-use-cases-in-the-pharmaceutical-industry/

[71] "What is federated learning?," IBM Research Blog. Accessed: May 22, 2023. [Online]. Available: https://research.ibm.com/blog/what-is-federated-learning

[72] K. Dasaradharami Reddy and T. R. Gadekallu, "A Comprehensive Survey on Federated Learning Techniques for Healthcare Informatics," *Comput Intell Neurosci*, vol. 2023, p. 8393990, Mar. 2023, doi: 10.1155/2023/8393990.

[73] Y. Chen, F. Luo, T. Li, T. Xiang, Z. Liu, and J. Li, "A training-integrity privacy-preserving federated learning scheme with trusted execution environment," *Information Sciences*, vol. 522, pp. 69–79, Jun. 2020, doi: 10.1016/j.ins.2020.02.037.

[74] S. Banabilah, M. Aloqaily, E. Alsayed, N. Malik, and Y. Jararweh, "Federated learning review: Fundamentals, enabling technologies, and future applications," *Information Processing & Management*, vol. 59, no. 6, p. 103061, Nov. 2022, doi: 10.1016/j.ipm.2022.103061.

[75] **R. Maiorescu and A. Semenescu, "DECENTRALIZED DATA EXCHANGE PROTOCOL FOR THE MANUFACTURING INDUSTRY," *Nonconventional Technologies Review*, vol. 27, no. 1, Art. no. 1, Mar. 2023, Accessed: May 22, 2023. [Online]. Available: http://www.revtn.ro/index.php/revtn/article/view/411**

[76] "tech-whitepaper.pdf." Accessed: Aug. 21, 2023. [Online]. Available: https://oceanprotocol.com/tech-whitepaper.pdf

[77] "FELT Architecture." Accessed: May 22, 2023. [Online]. Available: https://docs.feltlabs.ai/fundamentals/felt-architecture

[78] G. Georgiev, "What is ENS? Ethereum Name Service Explained (Updated 2022)," CryptoPotato. Accessed: May 31, 2023. [Online]. Available: https://cryptopotato.com/what-is-ens-ethereum-name-service/

[79] S. Kaczynski and S. D. Kominers, "How NFTs Create Value," *Harvard Business Review*, Nov. 10, 2021. Accessed: Sep. 21, 2023. [Online]. Available: https://hbr.org/2021/11/how-nfts-create-value

[80] Maruf, "What is ENS? Ethereum Name Service in a Nutshell," NFT Plazas. Accessed: May 30, 2023. [Online]. Available: https://nftplazas.com/what-is-ens-ethereum-name-service/

[81] "Chain Research – The Significance of ENS Domain Names and Their," Chain. Accessed: May 31, 2023. [Online]. Available: https://www.chain.com/blog/ens-domain-names-and-their-use-cases

[82] brantly.eth, "Step-by-Step Guide to Importing a DNS Domain Name to ENS," Medium. Accessed: May 31, 2023. [Online]. Available: https://medium.com/@brantly.eth/step-by-step-guide-to-importing-a-dns-domain-name-to-ens-d2d15feb03e8

[83] x, "The Role of ENS in Web3," Web3 Domains^{SM}. Accessed: May 31, 2023. [Online]. Available: https://web3domains.com/the-role-of-ens-in-web3/

[84] "What is Ocean Protocol? (OCEAN) | Ocean Coin | Kraken." Accessed: May 31, 2023. [Online]. Available: https://www.kraken.com/learn/what-is-ocean-protocol

[85] F. Benincasa, "The Rise of NFTs: Why Minting AI Algorithms is an Excellent Idea," Smarter.ai. Accessed: May 31, 2023. [Online]. Available: https://medium.com/smarter-ai/the-rise-of-nfts-why-minting-ai-algorithms-is-an-excellent-idea-d401e07bacb0

[86] "Five legal considerations for businesses taking a lead on NFTs." Accessed: May 31, 2023. [Online]. Available: https://www.ey.com/en_lu/tax/five-legal-considerations-for-businesses-taking-a-lead-on-nfts

[87] M. Madine, K. Salah, R. Jayaraman, Y. Al-Hammadi, J. Arshad, and I. Yaqoob, "appXchain: Application-Level Interoperability for Blockchain Networks," *IEEE Access*, vol. 9, pp. 87777–87791, 2021, doi: 10.1109/ACCESS.2021.3089603.

[88] "Energy performance of buildings directive." Accessed: Nov. 03, 2022. [Online]. Available: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

[89] "EPC Data - March 2022 Extract - EPD Publication Note - Domestic Buildings - 2022Q1.pdf."

[90] "statistics.gov.scot : Domestic Energy Performance Certificates - Dataset to Q3 2022." Accessed: Dec. 12, 2022. [Online]. Available: https://statistics.gov.scot/data/domestic-energy-performance-certificates

[91] G. Edelman, "The Father of Web3 Wants You to Trust Less," *Wired*. Accessed: Dec. 12, 2022. [Online]. Available: https://www.wired.com/story/web3-gavin-wood-interview/

[92] "What is Web 3 ? - And what you need to know to get started." Accessed: Dec. 12, 2022. [Online]. Available: https://myraah.io/web3/whatisweb3

[93] "Web3," *Wikipedia*. Dec. 12, 2022. Accessed: Dec. 12, 2022. [Online]. Available: https://en.wikipedia.org/w/index.php?title=Web3&oldid=1126936341#cite_note-4

[94] P. Kim, "Understanding web3: The new version of the web that works on blockchain," Business Insider. Accessed: Dec. 12, 2022. [Online]. Available: https://www.businessinsider.com/personal-finance/what-is-web3

[95] "An overview of Web3 wallet - Kyros Ventures." Accessed: Dec. 12, 2022. [Online]. Available: https://blog.kyros.ventures/2022/08/18/an-overview-of-web3-wallet/

[96] "EUR-Lex - 52021PC0802 - EN - EUR-Lex." Accessed: Dec. 13, 2022. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A52021PC0802

[97] "Implementing-the-EPBD_BPIE_2019.pdf." Accessed: Sep. 17, 2024. [Online]. Available: https://bpie.eu/wp-content/uploads/2019/04/Implementing-the-EPBD_BPIE_2019.pdf

[98] "Renovation Wave," European Commission - European Commission. Accessed: Dec. 12, 2022. [Online]. Available: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1835

[99] "BPIE is a leading independent centre of expertise on energy performance of buildings. > BPIE - Buildings Performance Institute Europe," BPIE - Buildings Performance Institute Europe. Accessed: Sep. 17, 2024. [Online]. Available: https://www.bpie.eu/

[100] "The Energy Performance of Buildings Directive (EPBD) — EPB Standards — EPB Center | EPB Standards." Accessed: Nov. 03, 2022. [Online]. Available: https://epb.center/epb-standards/energy-performance-buildings-directive-epbd/

[101] "— Documents — Support — EPB Center | EPB Standards." Accessed: Dec. 13, 2022. [Online]. Available: https://epb.center/support/documents/iso-52018-1/

[102] "Nearly zero-energy buildings | sosesg.com." Accessed: Sep. 12, 2024. [Online]. Available: https://www.sosesg.com/en/articolo/nearly-zero-energy-buildings

[103] Zach, "How to Perform One-Hot Encoding in Python," Statology. Accessed: Dec. 13, 2022. [Online]. Available: https://www.statology.org/one-hot-encoding-in-python/

[104] Z. Bobbitt, "How to Perform One-Hot Encoding in Python," Statology. Accessed: Sep. 17, 2024. [Online]. Available: https://www.statology.org/one-hot-encoding-in-python/

[105] "Machine Learning Algorithms Technical test | Test & Quiz." Accessed: Dec. 13, 2022. [Online]. Available: https://welovedevs.com/app/tests/machine-learning-algorithms

[106] D. Gong, "Top 6 Machine Learning Algorithms for Classification," Medium. Accessed: Dec. 13, 2022. [Online]. Available: https://towardsdatascience.com/top-machine-learning-algorithms-for-classification-2197870ff501

[107] M. Komorowski, D. Marshall, J. Salciccioli, and Y. Crutain, "Exploratory Data Analysis," in *Secondary Analysis of Electronic Health Records*, 2016, pp. 185–203. doi: 10.1007/978-3-319-43742-2_15.

[108] T. Rawat and V. Khemchandani, "Feature Engineering (FE) Tools and Techniques for Better Classification Performance," May 2019, doi: 10.21172/ijiet.82.024.

[109] I. H. Sarker, “Deep Learning: A Comprehensive Overview on Techniques, Taxonomy, Applications and Research Directions,” *SN COMPUT. SCI.*, vol. 2, no. 6, p. 420, Aug. 2021, doi: 10.1007/s42979-021-00815-1.

[110] “Ocean_NFL/2_statistics.ipynb at master · abessalov/Ocean_NFL · GitHub.” Accessed: Aug. 19, 2024. [Online]. Available: https://github.com/abessalov/Ocean_NFL/blob/master/2_statistics.ipynb

[111] “Football Position Abbreviations.” Accessed: Aug. 19, 2024. [Online]. Available: https://www.rookieroad.com/football-position-abbreviations-5454289/

[112] “dubai-residential-market-review-summer-2024-11505.pdf.” Accessed: Sep. 27, 2024. [Online]. Available: https://content.knightfrank.com/research/2364/documents/en/dubai-residential-market-review-summer-2024-11505.pdf

[113] R. Maiorescu and A. Semenescu, "ETHICAL USE OF LARGE LEARNING MODELS IN ACADEMIA," *ACTA TECHNICA NAPOCENSIS*, Series: Applied Mathematics, Mechanics, and Engineering, Vol. 67, Issue III, September, 2024, pag.503- 508. [Online]. Available: https://atna-mam.utcluj.ro/index.php/Acta/article/view/2526

[114] R. Maiorescu and A. Semenescu, “LEVERAGING FEDERATED LEARNING FOR ENHANCED DATA MANAGEMENT PHARMACEUTICAL INDUSTRY,” In: Moldovan, L., Gligor, A. (eds) The 17th International Conference Interdisciplinarity in Engineering. Inter-ENG 2023. Lecture Notes in Networks and Systems, vol 929. Springer, Cham. [Online]. Available: https://doi.org/10.1007/978-3-031-54674-7_30