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AI BASED ORACLES FOR THE REAL WORLD ASSETS

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Abstract

Artificial Intelligence can be used to enhance blockchain technology as a way to streamline the heterogeneous data representing Real World Assets and increase the trust level of off-chain data. The main objective is to effectively reduce the barrier of entry for minting digital assets by participants with valuable data and thus, contribute to the technology adoption by bringing more data providers with new business models within the Web3.0 realm.

Introduction

Blockchain technology extending beyond the realm of Decentralized Finance (DeFi) is a significant technological challenge. Decentralized ecosystems have to integrate an increasing amount of data from new economic actors seeking to benefit from the advantages of distributed ledgers.

Critically, the need to onboard data that is not blockchain native (off-chain data), has led to the creation of Oracles. These bridges which allow off-chain data to trigger smart contract logic have proven to be vital tools for integrating financial data (price feeds) or allowing the tokenization of financial instruments for native on-chain trading. Current Oracles are however expensive and complex to implement and do not fit with the heterogeneous nature of business data from real world assets. This restricts their use to financial institutions or large cap companies. This segregation of actors based on financial power is a limiting factor for Oracle technology and blockchain adoption in general. Conversely, it provides a cost-effective entry point for new Oracle users to tokenize real-world data and assets..

This whitepaper materializes this opportunity with NEYX: a new blockchain that aims to utilize the power of Machine Learning and Artificial Intelligence to create nextgen Oracles. This latest iteration on Oracle technology improves on existing ones by using AI to increase protocol efficiency, detect malicious behavior and match non standardized data.

1.State of Blockchain, Oracles and AI

Blockchain Rapid Evolution

Blockchain is a relatively new technology (2009) and has evolved into a multi billion dollar industry by providing unique, previously unavailable features to the digital world and economy. Namely secure, decentralized trustless systems allowing peer to peer exchanges with immediate finality. These features are only available "on-chain" i.e between assets that could be traced back to an on-chain creation event (minting) to guarantee their genuineness.

Oracles : The need for data originating outside of blockchain

The reach of blockchain technology has expanded beyond the on-chain world as consumption from outside data became rapidly necessary to allow smart contracts to implement logic based on "off-chain" events, i.e events or data originating outside of blockchain.
This data is provided by Oracles: They enable the activation or making of so-called decentralized decisions within the blockchain based on external data and therefore not decentralized.

At first price feeds allowed smart contracts to execute logic based on ETH/USD price like liquidation or automatic trades. Today, a major use of Oracles is for Proof of reserve purposes with the advent of stablecoins matched by off chain reserves to provide a stable medium of exchange that mitigates the volatility seen in cryptomarkets. Oracles offer here the necessary transparency for all actors to trust the reserves.

Historically, Oracles were created to address these needs of external data and they are now providing these services with various degrees of compromises *[12]* (Ezzat et al., 2022) to allow, in a practical way, and through various design patterns *[15] (Mühlberger et al., 2020)*, the flow of external-data to be fed on-chain at the expense of the natural trust, data quality and decentralization innate to pure on-chain assets.

AI transformative power

AI is a technology field seeing the results of almost 50 years of research. It started from a science focused on symbolic reasoning and rule-based systems that was fitting with the advances in computer science and programming languages in the 60 and 70. In the 80s, AI technology operated a radical shift towards Machine Learning. A new field of research with systems capable of learning from data, mimicking brain and neuronal designs to improve their performance over time through iterations.

With the advances of technology in computer science, hardware, the expansion of interconnectivity (Internet) and the massive amounts of information available in our society, these ML models are now capable of learning from bigger data sets with more performant algorithms, like deep learning, and more powerful hardware.
Today, the latest iterations of the most successful models use all this historical data to excel at tasks ranging from natural language processing and image recognition to complex game playing and predictive analytics.

The result is a new paradigm across multiple domains, fundamentally transforming how we interact with technology and each other.

2.Oracles Limitations in the Blockchain

Trust is not Truth

Oracles play the crucial role of onboarding new data providers that will feed information to smart contracts. Today's onboarding process relies on KYC / KYB / AML procedures derived from the financial services industry. The primary role of these procedures is to weed out bad actors. It's an efficient process to qualify large entities seeking to provide data about multi-million dollar markets.

For smaller markets, segregating bad actors from good actors is not sufficient. Data consumers will need to get services from smaller entities. KYB / AML procedures, designed for the compliance needs of the financial industry sector, may fall short to secure the quality of the data produced by and for smaller markets or entities.

Operating Oracles is complex and expensive

Price feeds are only economically viable for large, highly traded assets.
As for tokenization of real world assets, current solutions rely exclusively on expensive, hard to operate, trusted environments that are complex to interface with enterprise grade data management solutions. These limitations make Oracle solutions only dimensioned for multi-billion dollar markets and heavy market participants.

Oracles are needed even in pure on-chain market

With the advent of Decentralized exchanges (DEX) and their Automated Market Maker (AMM) pool based design [22], the need for pricing Oracles remains despite the availability of pure on-chain pricing. (i.e when all assets are native to a blockchain and shall not need external data to be exchanged) The reason lies in the vulnerability of smaller assets pools that have been

manipulated as demonstrated recently with the INV incident on Sushi swap *[1] (Rekt - Inverse Finance - REKT, n.d.)*

Oracles are ultra-specific

To some extent, the majority of Oracles that exist today are specialized in making highly precise queries in very specific contexts. Beyond pricing, another good example is for collateral valuation in lending and borrowing protocols to price proper interest rates.

The diversity of Real World Assets

However, when addressing broader markets involving real-world assets and data, this type of Oracle is inadequate. It's evident, for instance, that the price of a property isn't displayed like a market price at its entrance. Or how to tokenize high value company proprietary data ?

To obtain and utilize such real-world data, it's necessary to gather, cross-reference, analyze, and organize information in order to create predictive systems. The Oracles we currently know are unable to perform such tasks because their data collection model is limited to certain APIs and cannot reconstruct market data for real-world businesses.

Interoperability of digital assets is complex

Once brought on-chain by Oracles, web3 derived data is complex to interface, primarily due to compatibility issues between blockchains *[10] (Belchior et al., 2022) [19] (Pillai et al., 2020)*. This absence of standardization for transferring data from one chain to another impacts the Web3 ecosystem at multiple levels.
Not only is it a challenge to increase data value and usefulness, but it also creates a fragmented user experience hindering the accessibility of the technology. Furthermore, it is a source of vulnerability for digital assets as demonstrated by the many bridges targeted by malicious actors *[2] (Lee et al., 2022)*

3.Enhancing Oracles ecosystem with AI

Challenges and promises

At its core, blending AI and blockchain is both promising and challenging. AI requires multiple parallel fast re-synchronisation of states for applications requiring real-time processing as well as large amounts of data to be consumed for their machine learning algorithm to be performant.
Blockchain, on the other hand, faces scalability issues and doesn't excel at storing massive amounts of data due to its needs of distribution and has a high cost for decentralized processing power.

The promise of combining the creation of value through ML to help increase data quality, trust and decision making at the blockchain level combined with the immutability and data ownership provided by its decentralized structure solves many of the on-going challenges to access the untapped economy lying outside of blockchain or increase the efficiency of current Oracle solutions.

Optimizing AI Impact in blockchain: A Pareto Principle Approach

In the vast potential uses of a combined field of blockchain and AI *[7] (Bellagarda & Abu-Mahfouz, 2022)* we decide to focus on Oracle related problems i.e how to reach a better compromise between trust (encompassing actors and data), decentralization and cost. In other terms, the ambition of this AI powered blockchain is to enhance existing Oracles with additional security and trust and to broaden Oracle services by allowing smaller centralized data sources to be tokenized via new data standardization *[9] (Al-Breiki et al., 2020)* derived from AI analysis.

Security and Data trust

Security : Protocol Enhancement

Historical on-chain data analysis and predictive behavior will allow two main mechanisms to enhance the performance of the protocol : Elaboration of a Trust-Score (T-score) to promote good actors and facilitate / accelerate consensus and the elaboration of a Protocol AI Agent (P-AI agent) to detect malicious behavior to enhance security through AI derived implementation of detection systems *[13] (Haeberlen et al., n.d.)* and have these AI Sentinels

such as ADPP *[21] (Yao et al., 2022)* automatically audited and recalibrated *[19] (Preuveneers et al., 2018)*

Data trust and quality : Oracles Enhancement

At the Oracle level, An Off-chain AI agent combines data received from the Oracle with real world metrics comparable to the incoming feed to elaborate a Quality-Score. The Q-Score comes in addition to the traditional Oracle models relying on Trusted environments to ensure that the incoming data is genuine, of good quality or sufficiently distributed when the data source is more decentralized.

The AI enhancements proposed by NEYX build on multiple research studies and publications [see bibliography] and are dependent on the nature of the data that the Oracle derives its truth from. At the time of this writing, we segregate data types in two groups based on availability (number of sources and timing).
On one end of the scale we find high speed data price feed, high availability, multiple data sources with high frequency needs, and on the other end are Real World Assets minted from centralized sources with low frequency needs.

Multiple data sources / high frequency

To enhance the quality of Oracles providing data from multiple sources at high frequency we propose to implement an AI model based on online machine learning and conformal prediction.

Online learning, like the name suggests, is derived from running algorithms processing data in sequential ways as it becomes available. It has been proven particularly effective for financial markets.
Conformal prediction is a statistical model that produces a possible set of results called "prediction" attached with a degree of confidence that this set contains the true value.
Adaptive Conformal prediction extends the range of the algorithm practicality as it deals with distribution shifts as opposed to static distribution using an online learning component.
Data distribution defines the properties of each data point being fed to an Oracle, the challenge is to address shifts in this distribution, when the statistical properties of that data (trends, patterns, averages, variances, etc) change over time.

We propose to adapt ACon^2 *[3] (Park et al., n.d.)* - An Adaptive Conformal Prediction model that has been proven on Ethereum with limitations due to gas costs and computational efficiency - to a Proof of Stake consensus with low gas fees and high compute power such as Cosmos SDK to address ACon2 Ethereum based challenges.

Unique data source / low frequency

The idea is two fold. One is to derive additional data from the one received by the Oracle (especially when it comes from a single data point) to mimic a more decentralized data structure and gain the benefit of an increased trust based on more levels of comparison. Second is to combine it with other data sources to find common patterns in data structures and allow tokenization through a new set of standards previously undetected among incoming data points that can be extremely heterogeneous. IoT devices for example suffer from their uniqueness when it comes to tokenization *[8] (Abdelmaboud et al., 2022)* but can produce large quantities of data that could benefit from the blockchain unique features.

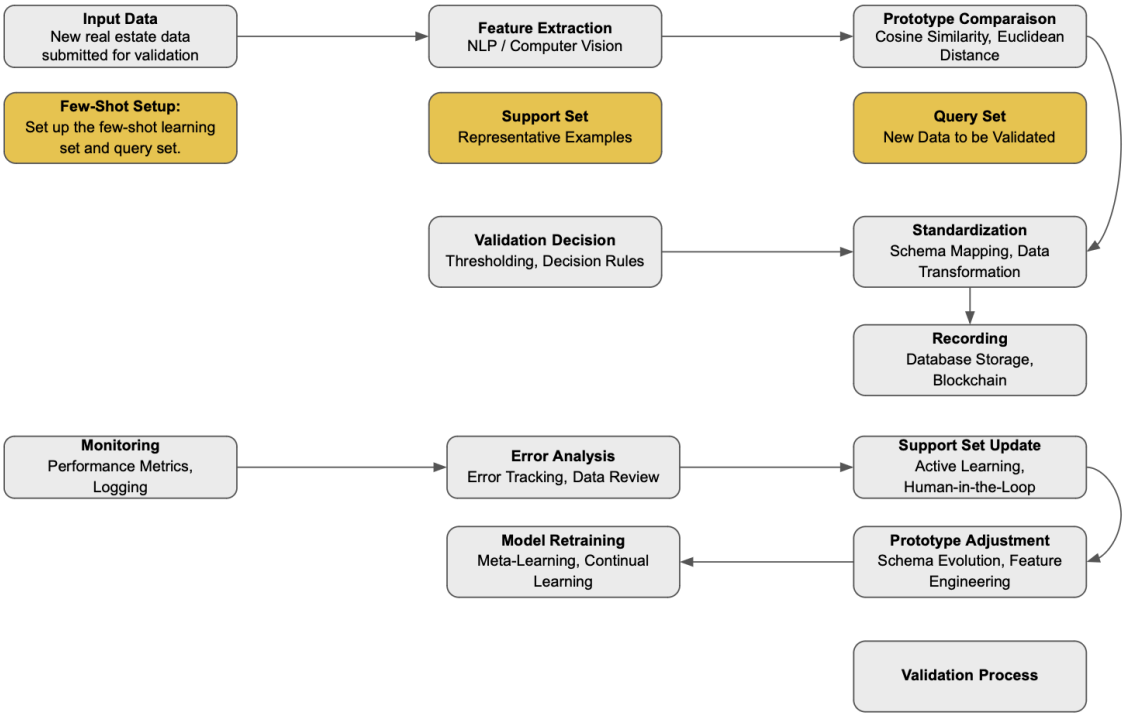
Few-shot learning is a subfield of machine learning and deep learning that aims to teach AI models how to learn from only a small number of labeled training data *[20] (Song et al., 2022)* The goal of few-shot learning is to enable models to generalize new, unseen data samples based on a small number of samples we give them during the training process.

This is particularly useful for an Oracle connecting to real world assets. The diversity and often uniqueness of RWA combined with privacy concerns from RWCompanies make these data sets small and difficult to verify. With Few-shot learning, it is possible to expand on similar business models with a limited number of datapoints.

This is an AI agent "outside" of the Oracle as it connects its knowledge to the incoming Oracle feed. Said feed always satisfies the current compromises of Oracles feeds but the trust level is augmented by the FS AI Agent.

- Helps identify trusted actors to accelerate consensus
- Accelerate trust analysis for new actors (new module with AI - analysis to create Initial trust score to accelerate Web2 established actors)
- Contributes to enhance DID *[11] (Decentralized Identifiers (DIDs) v1.0, n.d.)*
- Trust levels means adaptive consensus with trust enabled level of confidence x tx value
- Enables implementation of Sanction lists (users) *[21] (Yao et al., 2022)*
- Universalisation of RWData through ML to facilitate the creation of new markets matching previously unmatchable assets (only possible in blockchain because data must be owned)

Example of FS - Learning applied to tokenization of real estate goods



- Combining Agents from protocol and Oracles

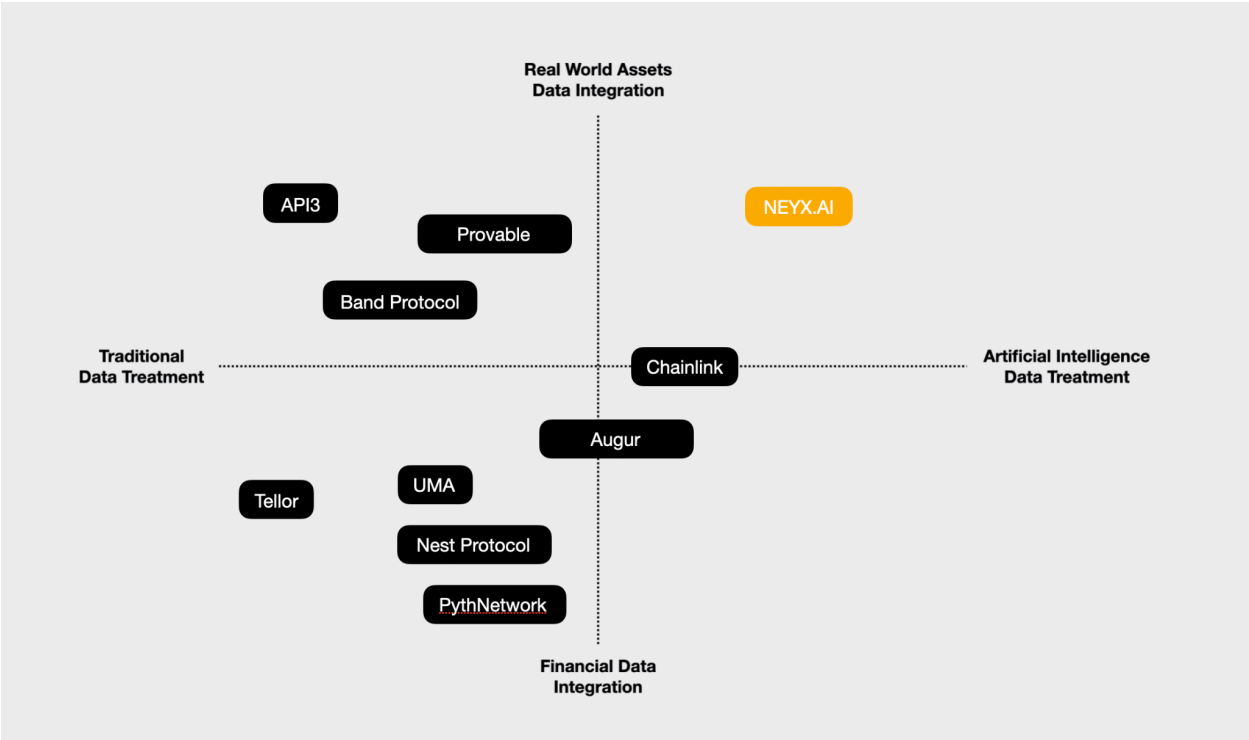
The P-AI agent from the protocol is naturally an Oracle and as such can receive data from the FS AI Agent traditional learning to enhance on-chain data with real world data to refine the T-Score of validators based on their off-chain behaviors / presence

Market Analysis and Unique Value proposition of Neyx.

The idea of transferring off-chain data to trigger events on a blockchain is not new. Chainlink is one of the pioneers and market leaders in this area. This project was among the first to leverage off-chain data, such as digital asset prices, to enable the execution of smart contracts and automation.
However, what is new is that players from traditional economies are looking to transfer their data and real-world assets onto a blockchain to benefit from the advantages of decentralization.
To address this, generic Oracles have not yet provided a convincing solution for:

- Ease of use and accessibility for everyone
- Processing heterogeneous data
- Scalability of the solution
- Integration of real-world assets.

Neyx offers a novel approach that, coupled with AI, brings these benefits to the market.



4. Economy of a Distributed AI Oracles Network

We have explained how Artificial Intelligence and Machine Learning can enhance the quality of the data provided by Oracles and enable the tokenization of new asset classes. We are now going to see how deploying these AI agents in a distributed network operating in coordination with Oracles can contribute to a new economically viable system dedicated to data normalization, verification and aggregation. The economic purpose is simple: viably bridge the two radically different paradigms of real world data and on-chain data.

Defining an architecture connecting AI Agents and Oracles

In our model, AI agents are continuously learning from the data that Oracles consume and produce, refining their predictions and enhancing their capacities. They can be deployed in many ways.

On one end of the spectrum they could be deployed "embedded" with Oracles in a pure "vertical" approach. The verticality is functional and economic because of the way AI would enhance the Oracle service. Although technically easily scalable, it creates a "siloed" intelligence, increases the cost of the Oracle operation and pushes this extra cost entirely on the data provider.

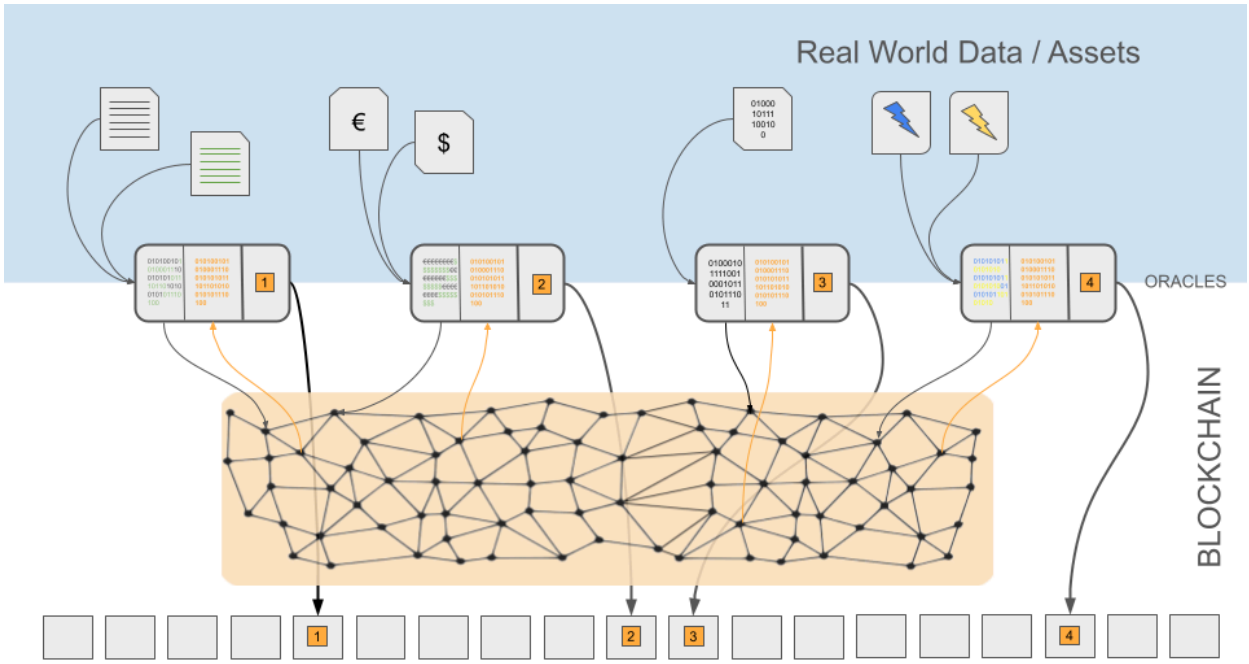
On the other end of the spectrum is a fully decentralized network of AI agents providing data intelligence as a service. The qualities of this approach are multiple. It offer an horizontal approach by leveraging the power of AI in a cross-sector, cross functional way, allowing all agents to learn from each other. The service provided is maximal for data providers: it's more intelligent than a siloed approach and less costly. In this approach, the challenge is technical as running ML Algorithms in a decentralized and permissionless fashion is still a topic under research *[4] (Kersic & Turkanovic, 2024)* showing promises, especially in the area of Federated learning *[5] (Bonawitz et al., 2019) [16] (Nguyen et al., 2021) [17] (Passerat-Palmbach et al., 2019)*. We choose to wait for further research as this would put the economic viability of the system at greater risk in the long term as the cold start period is not yet sufficiently defined.

A distributed approach presents a practical way of offering the benefits of an horizontal AI at a lower cost to data providers while maintaining a decentralized way of managing the network of AI agents.

A Distributed Network of AI Agents for Oracles

As we have previously discussed, we aim at facilitating the integration of a diverse universe of non blockchain-native assets, commonly referred to as Real World Assets.

In our distributed model, AI Agents act as quality analysts for the Oracles while participating in the aggregation and normalization of the incoming data provided by Oracles. This standardization of heterogeneous data ambitions to be the cornerstone of the model as it creates the most value by making a maximum range of off-data interoperable with on-chain data.



The provided diagram outlines the workflow in a distributed model for data validation, aggregation, and transmission in a blockchain context. AI agents validate and analyze data to ensure accuracy and reliability. The validated data is aggregated and standardized for uniformity before use. Oracles collect this standardized data and transmit it to the blockchain for use by smart contracts and other decentralized applications.

Evolving governance and economic incentives

At the core of the economic model are the AI Agents providing the service to the data providers and data consumers.

In the first phase, the agents will be distributed and the chain permissioned. This approach unlocks several advantages as it allows for a greater control on the actors participating in the network while it matures and scales out. In that regard, NEYX will be following the same principles of other Oracle services providers in this first stage. Strict onboarding process, quality control on processes and centralized then consortium based governance. Incentives are defined by the governing body and distributed to Agent providers through traditional financial mechanisms and/or/then enclosed use of the private chain token.

As the model scales we intend to move to the desired level of decentralization that will allow us to migrate to a permissionless chain. This transition will be aligned with the economic incentives

going from traditional incentives to token base and the evolution of the governance structure following the same path from consortium to token based.
At the end of this first phase preceding the opening of the chain, the private token will be reserved an allocation in the total public chain supply. This will act as a long term incentive for participants to develop the protocol service while proving its economic viability.

The NEYX Token (NEYXT)

The value creation derived from the network is captured by the NEYX token. The token will be used in a delegated proof of stake (DPoS) network to reward the participation of AI Agents and nodes to secure the network.
In the public permissionless version of the NEYX protocol we envision 4 types of AI Agents providing distinctive data enhancement services akin to the principle of separation of powers in traditional democracies but applied to the Data.

- AI Analysts will provide data quality measures, aggregation and standardization. They will produce most of the value derived from the protocol.

- AI Sentinels will enhance traditional DPoS protocol to detect unusual activity and raise alerts to the governing body. Blockchain transactions being naturally formulated as a transaction graph we base our alert mechanisms on the numerous graph-based algorithms to detect illicit behavior *[14] (Liu et al., 2020)* as well as statistical models *[6] (Yao et al., 2022)*. The network will prepare significant rewards in case of malicious behavior detection / prevention and distribute it to the whistleblower. The principles of the reward are simple: each participant provides a security deposit. Upon detection by a whistleblower and validation by the upper committee of an anomaly, the whistleblower collects all security deposits, resulting in a quadratic increase of cost of bribery.

- AI Decision makers are part of the governing body along with the chain participants. They are the final line of defense and rewarded through long term appreciation of the token as the economic value of the protocol grows.

- AI Calibrators or Concept Drift Detectors are designed to monitor and detect changes in the data distribution over time. Thanks to Calibrators, the AI model remains accurate and reliable even with significant changes in the underlying data patterns. By identifying and addressing concept drift, AI Calibrators help maintain the performance of machine learning models in dynamic environments.

The full tokenomics of the NEYX protocol will be described in a later publication but one can foresee the overall mechanisms at play as the economy of NEYX scales up. The addition of AI Agents will increase participation and lead to more data being processed, validated, and therefore enhancing the overall value of the network.
The protocol evolution, as well as its token is broken down into 3 distinct phases. In the background of those phases is the long term reward for the accumulation of value created by the network through its AI Oracle services and captured by the token.

In the first phase of initiation, A traditional Pay as you go financial model is preferred where AI Agent providers are compensated for their infrastructure costs through traditional financial mechanisms. They provide a service and they get compensated as it's being used through the distribution of a pool of reward accumulated by the network and managed by the governing body.
In the second phase of calibration, the private NEYX token is introduced as a primary stage implementation of the token based reward system as well as a governing tool to further decentralize the management of the protocol towards its participants. This phase is agile in its tokenomics while providing the premises of a decentralized governance.
Lastly, the public phase involves the conversion of private tokens into the public NEYX Token (NEYXt) with allocations, governing rules and fees defined during the calibration phase.

Quantifying Data Reliability in a distributed network

One of the key parameters of the economic model of the distributed AI Oracle network is its ability to properly qualify the data that is fed to the protocol. It requires a dynamic system rewarding the ecosystem participants that are ensuring the data reliability while penalizing incorrect or fraudulent inputs. We propose here a high view mathematical modelisation of AI Agents reliability scoring.

Objectives

- **Data Reliability**: Ensure that the data is accurate and verifiable.
- **Fraud Reduction**: Minimize the risks of falsified or erroneous data.
- **Transparency**: Guarantee clarity and accountability in the Oracle validation and reward process.

Definition of Variables

- $Q_i(t)$ Quality of data provided by Oracle `i` at time `t`
- $I_i(t)$ Integrity of data provided by Oracle `i` at time `t`
- $S_i(t)$ Score of Oracle `i` at time `t`

- $R_i(t)$ Reputation Oracle i at time t
- Δt Time interval for updating scores and rewards
- α Weight of data quality in score calculation
- β Weight of data integrity in score calculation
- T_{total} Total reward distributed at time t

Calculation of Score

The qualities $Q_i(t)$ and integrities $I_i(t)$ can be evaluated from 0 *worst* to 1 *best*

The Score $S_i(t)$ of Oracle i at time t is given by:

$$S_i(t) = \alpha \cdot Q_i(t) + \beta \cdot I_i(t)$$

We consider Quality, Integrity, and Reputation mutually exclusive as they measure[distinct aspects of an Oracle's performance and contributions. Reputation reflects historical performance, it provides context and stability to the Score, on the other hand Quality and Integrity reflect immediate performance.
Therefore, Reputation will be an aggregated function of Score of **length** ($n-1$) . We also introduce **decay** (λ) in the calculation so that older scores contribute less. Finally we normalize.

$$R_i(t) = \frac{\sum_{k=1}^{n-1} S_i(t - k\Delta t)e^{-\lambda k\Delta t}}{\sum_{k=1}^{n} e^{-\lambda k\Delta t}}$$

To simplify Score reading, we keep S_i bounded within $[0,1]$

$S_i(t) \in [0,1]$

$Q_i(t+\Delta t) \in [0,1]$

$I_i(t+\Delta t) \in [0,1]$

$\alpha + \beta = 1$

Reward Mechanism

This model provides a way to distribute rewards proportionally based on the scores of Oracles, accounting for the evolution of these scores over time and behavior of the Oracles. Adjusting the weights (α, β, γ) allows for flexibility in emphasizing different components in the score calculation thus adapting the model to specific needs of the system.

$$T_i(t) = T_{total} \cdot \frac{Si(t)}{\sum_{j=1}^{n} Sj(t)}$$

$T_i(t)$	The Reward collected by Oracle i at time t
$T_{total}(t)$	Total reward pool available for distribution at time t
$S_i(t)$	The score of Oracle i at time t. This score reflects the quality and integrity of the data provided by the Oracle
$\sum_{j=1}^{n} Sj(t)$	The total score of all Oracles at time t. This score is the base comparison for the evaluation of Oracle's performance.

In this model rewards are distributed based on the performance of each Oracle.
Proportional distribution of the reward and score for each Oracle
Normalization via the sum of all scores ensures that the total rewards distributed at any time t equal T_{total}
Incentivisation through binding of rewards and score to push the model towards higher data quality

CONCLUSION

In this paper, we have demonstrated how the intersection of blockchain technology and Artificial Intelligence has the potential to significantly expand the Web3 ecosystem.

Enhanced AI-Oracles allow new participants to transfer value on-chain whereas it was previously inaccessible due to the heterogeneous nature of the data representing real world assets.

This addition of new value is complemented by how a distributed network of AI agents also contributes to enhancing traditional Oracles technology, rendering them more accessible and providing another layer of trust through new verification processes.

While creating superior Oracles is a key advantage, the most transformative impact comes from the normalization and standardization of data as the onboarding of real existing value and financially active participants opens up even greater opportunities for business innovation while contributing to adoption of blockchain technology.

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Additional resources

A Security Risk Assessment Method for Distributed Ledger Technology (DLT) based Applications: Three Industry Case Studies. (n.d.). Retrieved June 4, 2024, from https://arxiv.org/html/2401.12358v1/#S5