NEBULA AI (NBAI) —

DECENTRALIZED AI BLOCKCHAIN

WHITEPAPER

Nebula AI Team

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Abstract

The blockchain technology provides a digital trust mechanism for human beings which enhances the efficiency of exchange of an asset that is of value to someone including but not limited to votes, IP etc. and reduces costs - the genuinely credible and efficient Internet of Value is approaching. In recent years, many breakthroughs have been made in the field of artificial intelligence (AI), and AI is now penetrating every corner of society and will become an essential cornerstone of change in society.

Nebula AI Inc., (Nebula AI) is committed to building a decentralized artificial intelligence computing blockchain (NBAI) that reduces the energy costs of traditional Proof of Work by converting GPU mining machines into AI computing services. The AI transactions recorded on NBAI will be irreversible. The distributed computing network also ensures high concurrency and low latency computing power. The conversion of GPU mining machines makes it possible to provide more cost-effective artificial intelligence services.

Nebula AI will cooperate with large-scale third-party Internet data centers to provide adequate computing power for AI computing. Nebula AI has established an artificial intelligence training centre in Canada. System-based quantitative finance, image identification and other blockchain applications are also in development.

The well-developed NBAI ecosystem integrates the top-level applications such as DAI App, scientific research and application, university education, and the bottom-level of NBAI blockchain, Artificial Intelligence Mining Machine and Artificial Intelligence Data Center. The innovative economic model of the NBAI ecosystem is the realization of a complete set of value-added economic systems.

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- **Uncertain laws relating to digital token offerings**: The regulatory position of NBAI tokens and distributed ledger technology is unclear and/or unsettled in certain jurisdictions, and there may be risks that the NBAI token may be considered to be a security, or that it might be considered to be a security in the future, in these jurisdictions. Nebula AI may cease operations in a jurisdiction in the event that regulatory actions, or changes to law or regulation, make it illegal to operate in such jurisdiction, or commercially undesirable to obtain the necessary regulatory approval(s) to operate in such jurisdiction.

- **Security issues**: Hackers or other malicious groups or organizations may attempt to interfere with the NBAI tokens and/or the Platform in a variety of ways, including, but not limited to, malware attacks, denial of service attacks, consensus-based attacks, Sybil attacks, guerilla-style attacks, smurf attack and spoofing. Furthermore, there is a risk that a third party or Nebula AI may unintentionally introduce weaknesses into the core infrastructure of the Platform and/or the NBAI tokens, which could negatively affect the Platform and/or the NBAI tokens.

- **Ethereum-based protocols**: As the NBAI token and the Platform are based on Ethereum-based protocol and architecture, any malfunction, breakdown or abandonment of the relevant Ethereum-based protocol or architecture may have a material adverse effect on the NBAI tokens and/or the Platform. Moreover, advances in cryptography, or technical advances (including, but not limited to, the development of quantum computing), could present unknown risks to the NBAI tokens and/or the Platform by rendering ineffective the cryptographic consensus mechanism that underpins the Ethereum-based protocol.

- **Imperfect information disclosures**: The Platform is at the stage of development as of the date of these Terms and its algorithm, code, consensus mechanism and/or various other technical specifications and parameters could be updated and changed frequently and constantly. While the White Paper and other marketing materials (as the case may be) released relating to the development of the Platform has been prepared with the then up-to-date key information of the Platform, it is subject to adjustments and updates from time to time following the growth and development of the Platform and/or the ecosystem on the Platform. Due to the decentralized nature of the Platform, Nebula AI may not be able to, and is not obliged to, update you on all details relating to the development of the Platform (including, but not limited to, its progress and expected milestones). By purchasing, holding and using the NBAI tokens, you accept that there may be an insufficiency of the information disclosed.

- **Early development risks**: You understand and accept that the Platform is currently in a development phase and requires substantial development. Due to unforeseeable material conceptual, technical and commercial changes before the final release, you understand and accept the risk that the development of the Platform may not be executed or implemented as planned, for reasons including but not limited to, the event of a decline in the prices of any digital asset, virtual currency or NBAI token, unforeseen technical difficulties, and the shortage of funds for developing Nebula AI's cryptocurrency project.

- **Illiquidity**: There is no prior market for NBAI tokens and the NBAI token sale may not result in an active or liquid market for NBAI tokens. The NBAI token is intended to be used solely within the network of the Platform, hence there may be an illiquidity risk with respect to any NBAI token held.

- **Uninsured losses**: The NBAI token is uninsured unless you specifically obtain private insurance to insure them. In the event of loss or loss of utility value of the NBAI token, there is no public insurer or private insurance arranged by Nebula AI to offer any recourse to you.

- **Tax treatment**: The tax characterization of the NBAI token is uncertain. You must seek your own tax advice in connection with the purchase, holding and/or usage of the NBAI tokens, which may result in adverse tax consequences to you, including withholding, taxes, income taxes and tax reporting requirements.

- **Competitors**: It is possible that alternative networks could be established that utilize the same or similar code and protocol underlying the NBAI token and/or the Platform and attempt to re-create similar facilities. The Platform may be required to compete with these alternative networks, which could negatively impact the NBAI token and/or the Platform.

- **Risks arising from insufficient interest**: It is possible that the Platform may not be used by a large number of individuals, companies and other entities or that there may be limited public interest in the creation and development of distributed ecosystems (such as the Platform). Such a lack of use or interest could negatively impact the development of the Platform and therefore the potential utility of the NBAI token.

- **Risks of dissolution**: It is possible that, due to any number of reasons, including, but not limited to, an unfavourable fluctuation in the value of cryptographic and fiat currencies, decrease in the utility of the NBAI token due to negative adoption of the Platform, the failure of commercial relationships, or intellectual property ownership challenges, the Platform may no longer be viable to operate and Nebula AI may be dissolved.

- **Risks arising from lack of governance rights**: As the NBAI token confers no governance rights of any kind with respect to the Platform or Nebula AI, all decisions involving the Platform or Nebula AI will be made by Nebula AI at its sole and absolute discretion, including, but not limited to, decisions to discontinue the services and/or the ecosystem on the Platform, to create and sell more NBAI tokens for use in the ecosystem on the Platform, or to sell or liquidate Nebula AI. These corporate decisions could adversely affect the Platform and the NBAI token that you hold.

- **Loss of talent**: The development of the Platform depends on the continued co-operation of the existing technical team and expert consultants, who may have specialized knowledge and expertise in their respective sectors. The loss of any member may adversely affect the Platform or its future development.

- **Risks relating to "forking"**: The Platform is based on certain open-source elements and Nebula AI does not monopolize the development, marketing, operation or otherwise of the Platform. Any entity may independently develop a patch or upgrade to the Platform and the acceptance of these patches or upgrades by a sufficient percentage of NBAI token

holders could result in two or more divergent networks. The community on the Platform may split in support of the divergent networks respectively. The temporary or permanent existence of forked networks could adversely affect the operation of the Platform and the NBAI token that you hold.

- **No ownership and control rights**: Ownership of the NBAI tokens does not grant you the right of ownership or right to share in Nebula AI. The NBAI tokens do not give NBAI token holders the right to participate in the decision making about the direction and development of the Nebula AI business. However, the opinions of NBAI token holders and the Platform users are very important to Nebula AI and may be taken into account by Nebula AI when such decisions are being made.

- **Risk on the number and value of the NBAI tokens**: The quantum and value of the NBAI tokens may be affected by factors, within or outside Nebula AI's control, including but not limited to the supply and demand for NBAI tokens in the market. These factors could adversely affect the quantum and value of the NBAI tokens.

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1. Technology and Industry Overview

1.1 The Internet of Value

The traditional Internet is based on historical content (instead of creating new value) and is known by the industry as the Internet of Information. The blockchain technology, on the other hand, has evolved the Internet into a network infrastructure for building social trust systems through the establishment of an efficient and reliable value exchange system, which will enable the Internet to generate new value and realize the efficient exchange of value, otherwise known by the industry as the Internet of Value.

1.1.1. Blockchain Technology Development

Blockchain technology is a comprehensive technology system based on distributed systems, computer networks, cryptography, data structures and other research results in various fields. The technology in blockchain records and maintains data in multiple ways, ensures data transmission and access security by applying cryptography, and the data is stored in a chain structure and can only be read or written so as to ensure its consistency, prevents tampering and cannot be denied. Blockchain technology represented by Bitcoin and Ethereum implements peer-to-peer credit transactions between distributed nodes by adding technologies such as data encryption, consensus mechanisms, timestamps, and economic incentives. It has solved the problems of cumbersome and inefficient transaction cycles, high costs and unsafe data storage, which have become commonplace in traditional centralized systems, and became the nuclear technology of the modern digital cryptocurrency system. This technology system enables information consensus, sharing, and co-responsibility among all participants that can be entirely ported to the underlying applications of most trust-based business models and organizations.

Satoshi Nakamoto published the Bitcoin Design Paper *Bitcoins: A Peer-to-Peer Electronic*

Cash System in 2008, where he indicated to create a new decentralized electronic payment system, which "based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party [12]". From then on, the blockchain technology represented by Bitcoin began to be known to the world.

Blockchain technology is typically divided into two generations by industry and academia:

- Bitcoin — solves the problem of encrypting ledger and decentralized payments.
- Ethereum — enriches the application value of blockchain technology. The smart contracts used by Ethereum can use virtual machines and contract programming to provide new ideas for the development of cryptocurrencies. At the same time, a large number of DApps and ICO financial innovations came into being, opening up new territory for financial markets.

As the first application of the blockchain, Bitcoin realized the mode of the decentralized cryptocurrency ledger system. Bitcoin relies on the completion of computational tasks based on a particular algorithm and does not depend on any individual or organization, thereby ensuring consistency with the distributed ledger system. Vitalik Buterin applied the concept of smart contracts in his design of Ethereum [4], giving us a common framework for blockchain with Turing completeness.

The application of blockchain technology establishes credible peer-to-peer transmission, which provides us with a new social trust mechanism, supporting common decision-making whilst protecting individual rights and interests, and both opening transaction information whilst protecting node privacy. This mechanism enhances the efficiency of the value exchange and reduces the cost, laying a new foundation for the development of the digital economy. It marks the beginning that society evolves from the Internet of Information to building a genuinely credible and efficient Internet of Value. At the same time, the application of blockchain innovation is thriving, reflecting the new direction of public service development and industrial innovation revolution.

1.1.2. DApp and Artificial Intelligence

DApp (Decentralized Application) is a kind of application that runs on the node of the decentralized P2P network server. It mainly consists of front end presentation layer, background server and smart contract. With the rapid development of Ethereum, a few millions DApps have emerged in all walks of life, and the Internet of Value ecosystem is increasingly complete.

In recent years, many breakthroughs have been made in the field of artificial intelligence, and there is a wave of research on artificial intelligence on a global scale. The research and application of artificial intelligence have now penetrated every gap in human society, which has also been integrated with the application of DApps. However, the research on artificial intelligence requires strong computational power, which has been promoted from the early stage of CPU computation to GPU computing. The large-scale application deployment has higher requirements on hardware performance and system concurrent processing.

Nebula AI blockchain, as a new generation of AI blockchain, is dedicated to solving the computing power needs of human beings in the process of artificial intelligence, expediting the inter-regional transfer of resources and writing integrated and decentralized AI applications more conveniently, so as to realize a seamless integration of blockchain micropayments, hyperledger, decentralized features, and AI applications and achieve the transformation from DApp + AI to DAI App.

Nebula AI is committed to building a decentralized artificial intelligence computing blockchain (NBAI) that reduces the energy costs of traditional Proof of Work (PoW) by converting GPU mining machines into AI computing services. On the Nebula AI blockchain, developers can design their own DAI Apps based on Nebula AI's generic programming interface, and gain rewards as NBAI Tokens by publishing Apps. The AI transactions recorded on NBAI will be irreversible. The distributed computing network also ensures high concurrency and low latency computing power. The conversion of GPU mining machines makes it possible to provide more cost-effective artificial intelligence services. Nebula AI has established an artificial intelligence training centre in Canada and is dedicated to disseminating the latest applications and knowledge in the AI industry

and delivering talents to society. Also, Nebula AI will cooperate with large-scale third-party Internet data centres to provide computing power for AI computing. System-based quantitative finance, image identification and other related blockchain applications are also in development.

The NBAI blockchain will inject fresh blood into the Internet of Value and provide cost-effective basic services for global artificial intelligence development.

1.2 Market Prospects

Blockchain technology has achieved global application deployment. All countries are closely watching the development of the blockchain, and planning the application of the blockchain. According to market research firm Gartner, the value of blockchain-based businesses will reach 100 billion U.S. dollars by 2020. In addition to the large-scale application of blockchain technology to the financial sector, blockchain technology will create over one trillion US dollars in value in the manufacturing and supply chain industries. Klaus Schwab pointed out that the blockchain is the fourth industrial revolution after mechanization, electrification and digitization. It is estimated that by 2025, 10% of the global GDP will use blockchain technology for data storage [17]. Marketsand Markets forecasts that the average annual growth of global blockchain applications and solution providers to improve business operations will reach its peak between 2016 and 2021 [9]. The market prospects of blockchain technology mainly lies in social public services and economic models optimization.

At the level of social public service, blockchain technology is penetrating into areas of social security, intellectual property and public administration, and mainly focuses on four areas: identity verification, forensic authentication, information sharing, and transparent governance. The British government released, for the first time, the report *Distributed ledger technology: Beyond Blockchain* in 2016, which explores the critical application of distributed ledger in government affairs [19]. Subsequently, the United States set up a “Congressional Blockchain Caucus” and the governments of Russia, Singapore, Dubai, Japan and China all accelerated the social application of blockchain technology [14]. Under the influence of the underlying philosophy of distributed consensus, transparent open source and social collaboration of blockchain technology, the public

service realizes an overall change from data management process optimization to management thinking, that helps to increase public participation, reduce social operating costs and improve the quality and efficiency of social management, which plays an important role in promoting the level of social management and governance.

At the level of economic optimization, the core philosophy of the blockchain economy lies in the reconstruction of business logic, creating a new pattern of finance and economy in the future, not just a technological revolution [6]. As early as 2015, the blockchain has become the highest-paid sector in U.S. venture capital. The current global blockchain has more than 2,000 projects, and the global value of cryptocurrency assets amounts to 90 billion US dollars. Blockchain has high application value regarding finance, shared economy and Internet of Things, which has attracted the wide layout of business groups such as Goldman Sachs, Citigroup, Nasdaq, Deloitte and Airbnb. User groups in the fields of blockchain/cryptocurrency assets are also growing rapidly: from 2 million users worldwide in early 2013 to 20 million users in early 2017 [18]. In the blockchain system, participants can trade without having to know each other's basic information so as to achieve "trustless trust" and change the third-party-based trust model in the traditional mode, and the economic system can be out of the current system's constraints or endorsement by third parties, resulting in the situation whereby two sides realize the delivery of value. An economy based on blockchain solutions can improve existing business rules, build a new industrial collaboration model and improve the efficiency of collaborative logistics. Blockchain can provide systematic support for economic and social transformation and upgrading [16]. The significant advantages are the optimization of business processes, lower operating costs and synergy, and these advantages have emerged in all areas of society, including financial services, supply chain management, smart manufacturing, education and employment.

After 60 years of ups and downs, the artificial intelligence industry is finally recovering with the rise of machine learning. As it has now formed a new round of development in the world, countries have sounded the horn to explore the mysteries of human wisdom. The scale of the global artificial intelligence market reached 168.39 billion US dollars in 2015. In 2016, the research and development of artificial intelligence in all fields in the world have been

strengthened and emphasized, with the market scale of the industry increasing to more than 190 billion US dollars [11]. According to the market demand, the global market size of artificial intelligence is expected to reach 270 billion US dollars by 2018.

DApp will form the backbone of the internet of value in the future. Artificial intelligence will cover all application areas. Blockchain, as the infrastructure of the former two, will undoubtedly become popular and will inevitably bring significant changes to the traditional Internet, society and the natural environment.

1.3 Existing Challenges

1. Highly Centralized

Google and Amazon have started to provide cloud services of artificial intelligence computing. However, as single-commerce companies, they could stop providing the service at any time, given special circumstances, which are based on their own interests and the pressure of, for instance, governments and other organizations. For example, Google was banned by the Chinese government, leaving Chinese users unable to utilize their services.

The blockchain is a new decentralized protocol that securely stores data information through a distributed ledger (a type of database distributed across multiple addresses, multiple regions, or multiple participants) [3]. The blockchain is based on the architecture of “decentralization”. The rights and obligations of any nodes are equal; the data blocks in the system are jointly maintained by all nodes, and each node shares rights and obligations, is verified by node distribution in the world, to ensure that the information cannot be forged and tampered with; and technically guaranteeing the transaction, without the need for a third-party structure to provide a trust mechanism. Corporations use decentralized distributed ledger technology to process, verify transactions, or other types of data exchange, and the records are stored in the ledger. Once most participants agree, each record is given a time stamp and a unique encrypted signature. The distributed ledger provides verifiable and auditable information history, and all participants can

view suspicious records [10]. This technique guarantees that it is impossible to shut down the entire network as long as more than one node is in operation. This makes it possible to design a decentralized AI cloud service which cannot be blocked.

2. Data Privacy Security

Although centralized companies have various security agreements, it is still difficult for companies to ensure data privacy when faced with internal leaks. Also, when the government requests for data, the centralized company is limited to geographical restrictions of the host country, leaving the only option to cooperate with the government and transfer ownership of the data. As a result, users' data security cannot be 100% guaranteed.

Based on the cryptography technology, blockchain is a kind of low cost, high security, customizable and encapsulated decentralized trust solution tool based on encryption technology, which relies on the encryption algorithm, peer-to-peer transaction and information stored in each node without trusting a single centre [20]. Each node is involved in maintaining the security and accuracy of the information by keeping a copy of a complete set of historical databases. The peer-to-peer blockchain encryption technology can be used to ensure that only the owner of the private key can access specific information, while other users cannot decrypt data. This is of great significance for a variety of high-value training data and models. The advantages of blockchain in terms of data security are as follows:

- Use highly redundant databases to ensure the integrity of the information.
- Verify data using cryptography-related principles to ensure that the data cannot be tampered with.
- Use multiple private keys for access control.

3. Maintenance Costs

The maintenance of a centralized computing center will cost heavily on the workforce. Thus, the use of blockchain micropayments makes it easier to pay for maintenance and allows anyone to lend their computing power. The shared economy model dramatically reduces maintenance

workforce costs as well as computing costs.

4. Hash Calculation Efficiency

Currently Ethereum, Zcash and other GPU PoW consume a lot of power and hash computing. The computing power of these GPUs can be used for AI calculations, rather than simply being used as PoW. A recent study shows that Bitcoin mining has consumed more electricity than the average annual electricity consumption of 159 countries this year. Such a high level of power consumption has become an urgent problem to be solved. Digiconomist estimates that Bitcoin mining consumes about 30.14TWh annually, which is much higher than the average annual electricity consumption of 25TWh in Ireland [8]. In fact, a recent ING study by ABN AMRO shows that a Bitcoin transaction consumes enough power for a full week of average American household use [21]. Digiconomist also found that mining the second most expensive cryptocurrency, Ethereum, consumes more power than that of most countries [1].

5. Blockchain Application Development Environment

With the rapid growth of various applications (DApps) on the blockchain, a good state of the ecosystem is at the heart of the user experience. This includes how users can retrieve their expected DApps in massive blockchain applications, how to motivate developers to provide more DApps to users, and how to help developers develop better DApps in a faster manner. Take Ethereum as an example, there are tens of thousands of DApps based on Ethereum. Imagine if the scale of DApps in the blockchain world is close to that of the Apple App Store, it would be a serious problem to discover and find a user's expected DApps. With the popularity of blockchain technology, more and more application scenarios of blockchain technology have been discovered. Blockchain technology scenarios have been gradually expanded from the original cryptocurrency to more scenarios and user groups. For example, the community represented by Ethereum introduced the concept of smart contracts in blockchain technology, and Ripple used the blockchain technology to implement the real-time gross settlement system. With the increasing diversity of application scenarios, user demands for blockchain is also increasing, and we will

expect to face more challenges.

1.4 Project Objectives

In order to improve the status quo of the current centralized cloud computing ecosystem, we intend to utilize the decentralization of blockchain technology to rent and distribute the computing power of artificial intelligence machines globally. Blockchain encryption technology efficiently avoids the problem of internal leakage and the maintenance of distributed AI calculation units is handed over to the owners of various AI calculation units, which considerably reduces the workload of maintenance. We split this overall goal into the following sub-goals:

1. Shared AI Computing Platform

The shared AI computing device platform will address the unbalanced demand between consumers and suppliers of AI devices. Suppliers of AI computing devices are unable to use 100% of their computing power, which leads to some computing resources being idle. On the other hand, a large number of users who require the computing power of AI cannot obtain economical and efficient AI computing resources. Peer-to-peer payment in blockchain technology, as well as blockchain ledger technology, enable shared AI computing to be paid and shared in the most convenient way.

2. AI Physical Computing Units

A large number of GPU computing mining machines can be converted into AI computing units, from simple hash calculations into more meaningful AI task calculations. Due to the particularity of AI calculations, it is necessary to pre-install the specified system and regularly update the client, including the ledger system, in order to play hardware performance better and share AI computing power.

3. Decentralized AI Applications

Decentralized AI Applications system requires a corresponding interface for DAI App

programmers to invoke conveniently and use the platform's computing power. It includes the payment API, computing capacity estimation API and work estimation API, etc., in order to speed up the development of AI applications.

4. Integrated IPFS Distributed Storage

Decentralized applications require distributed file storage systems to store data. An option is the IPFS (Inter-Planetary File System) storage system to replace the traditional centralized cloud storage or local file storage, in order to achieve better distributed storage.

IPFS is a protocol and eponymous network designed to create a content-addressable, peer-to-peer method of storing and sharing hypermedia in a distributed file system. The nodes in the IPFS network will form a distributed file system [2]. Most of the future IPFS will use cross-chain service. Please read the section of Cross-chain Service Usage to learn more about cross-chain technology.

5. AI Engineer Training Center

Nebula AI will establish a systematic artificial intelligence training center to provide practical knowledge in the field of artificial intelligence. Engineers gradually create and train artificial intelligence models in product design through system learning and project operations. We are dedicated to disseminating the latest applications and knowledge in the AI industry and developing and delivering outstanding AI talents. Our mission is to fill the talent gap, and to give full play to the power of artificial intelligence in business.

2. NBAI Ecosystem

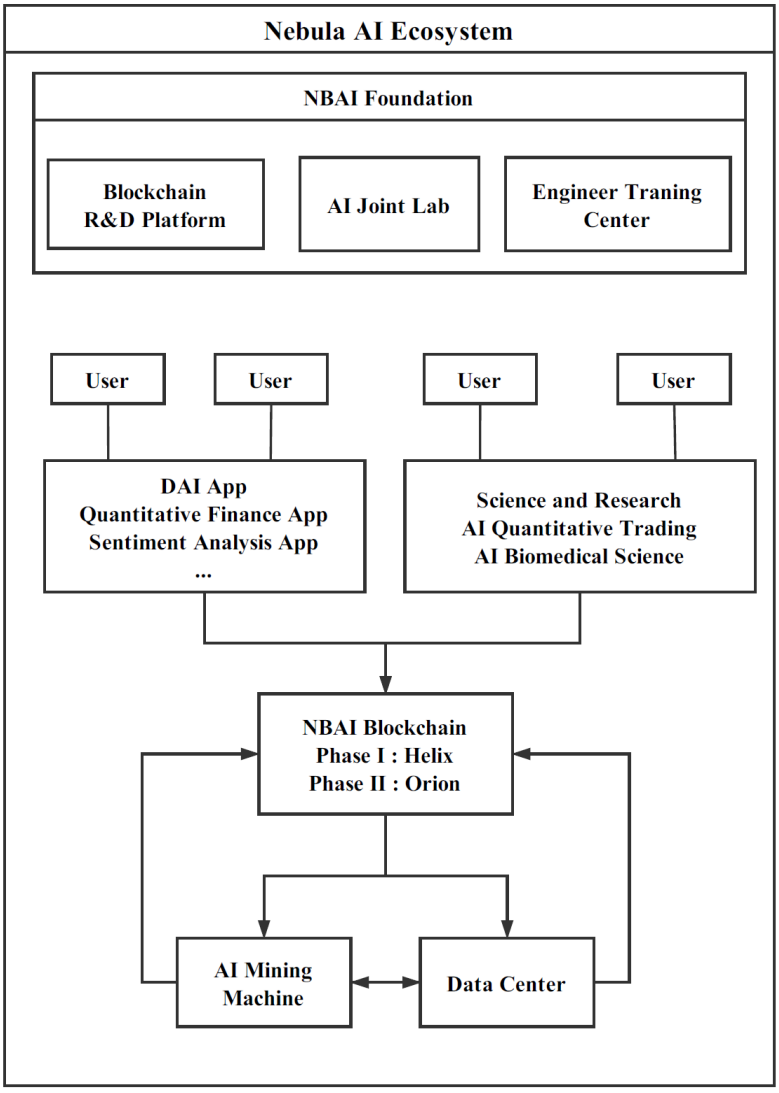

Figure 1: NBAI Ecosystem

The NBAI ecosystem consists of two major components, the NBAI foundation and the NBAI system. The NBAI foundation supports the development, operation, and management of blockchain development platforms, AI joint labs, and engineer training centers. The NBAI system integrates the top-level applications such as DAI App, scientific research and application, university education, and the bottom-level of NBAI blockchain, Artificial Intelligence Mining

Machine and Artificial Intelligence Data Center.

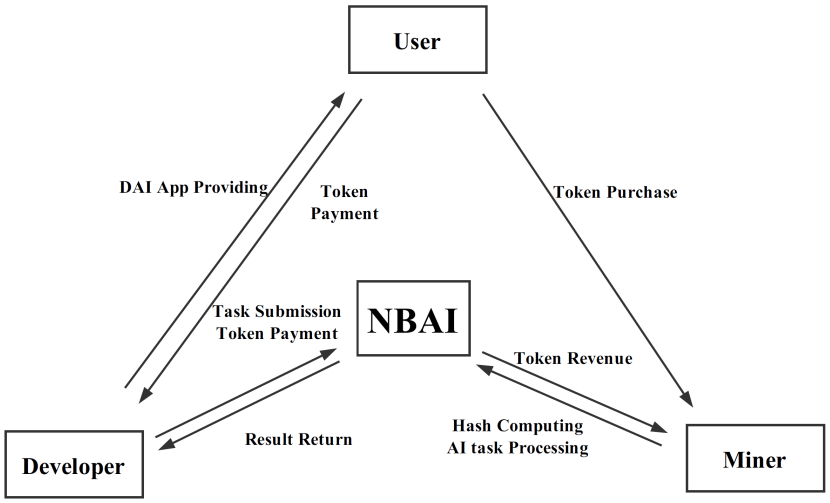

Figure 2: NBAI Economic Model

Figure 2 indicates the economic model of the NBAI ecosystem. Developers provide users with DAI Apps, users pay for NBAI tokens or use Apps for free based on the rules set by the developers. Developers submit artificial intelligence tasks to NBAI and pay for NBAI tokens based on NBAI's estimated costs. Thereafter, NBAI will open the tasks, and miners are free to receive and handle the tasks from NBAI. NBAI will obtain the corresponding NBAI token as a reward after completing the tasks. Clients and miners can trade NBAI tokens through the cross-chain token exchange platforms, so as to achieve a complete set of value-added economic systems.

2.1 NBAI

In the NBAI ecosystem, there are many deep training models (such as RNN, CNN and LSTM) to be trained, which requires large number of GPU computing to complete. In order to solve this problem, we have to change the manner of mining blockchain. Instead of simply using PoW as the solution, we intend to issue the NBAI tokens by PoW in early stages of roadmap (until 2018 Q3, Helix chain) and Proof of Group (PoG) in later stages(2019 Q1 onwards, Orion chain). Existing

miners can perform artificial intelligence algorithms calculation to obtain token rewards. In the early days, Ethereum protocol(Ethash) will still be used as PoW to ensure the stability of the block of NBAI blockchain. However, after the release of main-net PoG will be enabled.

2.1.1. Helix (PoW)

At the same time that the White Paper is released, an artificial intelligence public blockchain loaded with smart contracts will also be released. Therefore, the first phase of the project will be implemented using an independent ether chain. The independent ether chain has the following advantages:

- Less Traffic Delay.
- Customized Gas, which can help to motivate miners to get profits through smart contracts instead of relying on gas profits from smart contracts.
- Customized Difficulty, which can increase the speed of generating the block, as well as adjust the speed of NBAI token production.

According to varying computing abilities, each artificial intelligence node can obtain the tasks in the task pool through smart contracts. Then, they calculate the task, and obtain the token rewards after submitting the results. The hash of a smart contract is recorded in the block to identify the address of the task. The contract will set out the task address, workload and work costs.

However, as bitcoin has attracted most of the world's computing power nowadays, other blockchain applications using the PoW consensus mechanism have found it hard to obtain enough hash power to protect their own safety. Mining causes a waste of a lot of resources, which will inevitably lead to environmental destruction and energy shortage. It is difficult to shorten the confirmation time of the block, and the cycle of reaching a consensus is longer, which is no longer suitable for popular business applications. Also, the PoW consensus mechanism has no solution to

the 51% attack yet [7]. Therefore, we intend for the NBAI ecosystem to apply a new set of consensus mechanisms to address the potential loopholes in PoW and the consensus mechanism to optimize NBAI.

2.1.2. Orion(POG)

Due to the large training data of artificial intelligence, the time taken to acquire data in the system becomes very crucial. The characteristic of cloud computing is the closer the distance between nodes, the lower the cost of communication, and the higher the corresponding computational efficiency. Based on this feature and the existing issues of the PoW consensus mechanism, we will use a new consensus mechanism — Proof of Group (PoG). In PoG we will use consensus systems and NBAI credit mechanisms to ensure efficiency and security. The definitions are as follows:

1. Work Node and Ledger

A work node is a main artificial intelligence computing task execution node; whose main role is to perform artificial intelligence computing tasks.

In addition to the normal calculation, the ledger can also be responsible for man- aging other nodes and performing ledger functions. When an AI task needs to be executed, the ledger is responsible for allocating subtasks to all work nodes in the area. The task results are then written into the IPFS. The completed contract will finally be submitted through the Byzantine consensus to the ledger for verification.

When a new work node joins the system, it will first broadcast the information and search for nearby nodes.

- If it finds existing nodes within the response time (t), then it chooses to join the network of designated nodes to become one of the worker.
- If no nodes respond within the response time (t), then it elects itself as a ledger.

2. How to Become a Ledger

Within a network, there are two ways for a work node to become a ledger:

- After the disappearance of the original ledger in the network, the node with the highest credit automatically becomes the ledger.
- Assume that there are n work nodes in the network, denoted as P. The survival time of each node is denoted as t. If $\exists p_i$, the product of the sum of its response time to all the other nodes in the network $\sum_{i=1}^{n-1} T$ its survival time is the smallest, then this node becomes the ledger.

3. Virtual Working Group

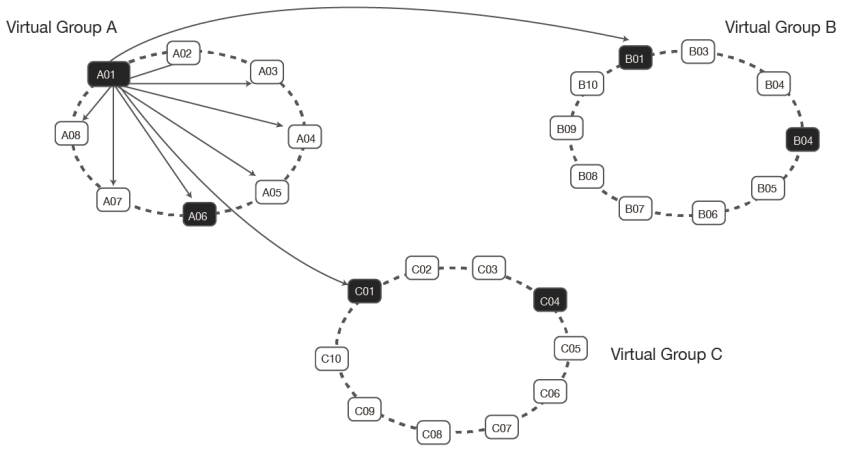

Figure 3: Virtual Working Group

Several work nodes will be combined into a working group. The backup factor in a working group is defined as the number of nodes that can simultaneously process the ledger. Assuming a total sum of n nodes, the backup factor can be 1 <k <n + 1; when k = n, it will convert into a Helix system. A backup system is a way of keeping ledger within a group. However, miners may try to

increase the backup factor k artificially in order to obtain the NBAI tokens from mining. For this reason, the system is mainly based on AI calculations and the mining output should be lower.

4. Communication Among Groups

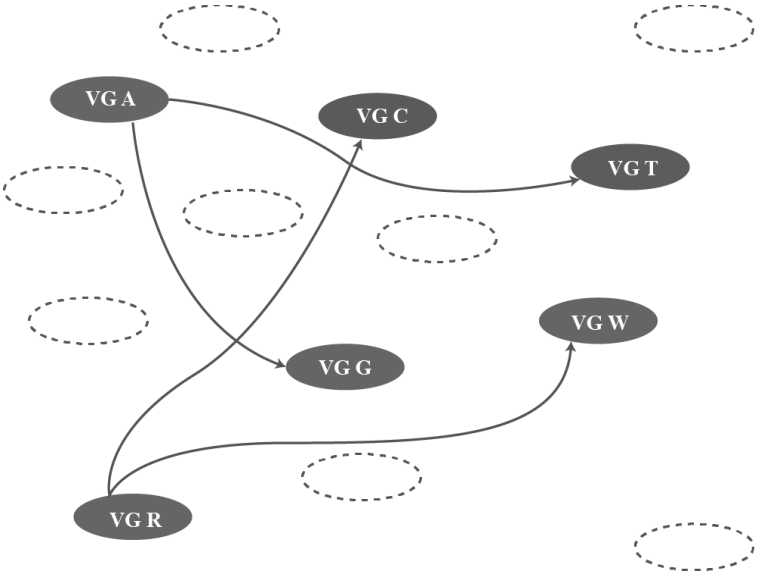

Figure 4: Communication Among Groups

The working groups composes a ledger network. The network uses the Byzantine consensus system for joint ledger, which fully guarantees the balance between preventing 51% attacks and ledger efficiency.

In Nebula AI's Proof of Group (PoG), each participant is denoted as P_i, needs to know other people they think are important in the blockchain network, denoted as Pk_j. A transaction settlement, denoted as *TS*, requires waiting for the vast majority of other people in the group to agree on any previous trade.

Assume P_i, $Pk_j \in$ group G, consensus algorithm *Consensus*(*A, B*), consensus verify algorithm *Verify*(*V, NL*), then consensus for each node is calculated as

$$\forall\, TS(P_i) = \prod_{j=1}^{n} Consensus(Pk_j, P_i) \qquad (1)$$

Furthermore, those who are considered important are confirmed only if they are confirmed by their important participants. Thus, in the working group, the final consensus is calculated as:

$$TSA = Verify(\frac{\prod_{i=1} TS(P_i)}{Consensus(G)}, [P_i, Pk_j]), P_i \in G \cap Pk_j \in G \quad (2)$$

Eventually, when there are enough network nodes, the system will accept the transaction, and this series of hierarchical group consensus will make it impossible for an attacker to have complete consensus information and thus be unable to attack. The PoG Consensus ensures the completeness of AI tasks and transactional information.

2.1.3 Task Implementation

The task pool contains two kinds of tasks:

- Generating tasks, such as Ethash and protein sequencing.
- User tasks, where users submit tasks to solve certain problems, and the users will set the number of NBAI tokens required for tasks. Either task comes with a small smart contract system for submitting contracts and calculations. Mining will receive NBAI tokens as rewards for tasks and ledgers at the same time.

A standard training task includes the following:

- Training data used by tasks, where the dataset can come from the foundation or be customized.
- Training script used by tasks, where training methods come from standard RNN, CNN, LSTM and other customized deep learning methods.
- NBAI tokens utilized for training tasks, where training tasks will be completed by the

AI mining Machine, and the user must specify the amount of NBAI tokens that will be utilized. The higher the number of NBAI tokens utilized, the higher the training priority.

The task system is stored on the integrated IPFS, which is stores the arithmetic encryption algorithm and task code. When the miner receives the computational task, it returns its own hardware parameters, downloads the computational task unit remotely, and trains the dataset. After packaging the standard distributed TensorFlow, the appropriate redundancy calculation is added to ensure the reliability of the calculation results.

2.1.4. Cross-Chain Service Usage

As a decentralized artificial intelligence system, many components will be decentralized. However, designing all these components on their own is very inefficient and the system should be interoperable with other decentralized services and be used cross-chain. There are two types of cross-chain: Value Cross-Chain and Technology Cross-Chain.

Value cross-chain is a cross-chain transaction regarding decentralized exchanges such as the exchange in the EtherDelta through smart contracts to obtain the required service tokens. The token is then used to drive the appropriate services. This technology is simple, yet it has a low performance. If tokens can be redeemed in advance in the system, latency will be reduced. Under the current conditions, USDT and Bitcoin will all be typical value cross-chain media.

Examples of technology cross-chain include cross-chain transactions between Bitcoin and Litecoin, which uses Segwit isolation in order to realize the cross-chain transactions between different currencies, as well as ongoing zero-knowledge verification transactions between Zcash and Ethereum. Zero-knowledge proofs make Zcash tokens untraceable by creating private transactions on the public Zcash blockchain. A bottom chain needs to be designed for cross-chain transactions. Currently, a large number of ICO projects have attempted cross-chain.

For example, the Polkadot project of Ethcore in the field of cross-chain communications has been designed with the core philosophy of addressing two main problems of blockchain

technology diffusion and acceptance: immediate scalability and extensibility. The project is currently based on Ethereum to achieve its interconnection with the private chain, and treat other public chain network as the upgrade target. After its technology matures, the integration will dramatically enhance the scope and performance of the project [5].

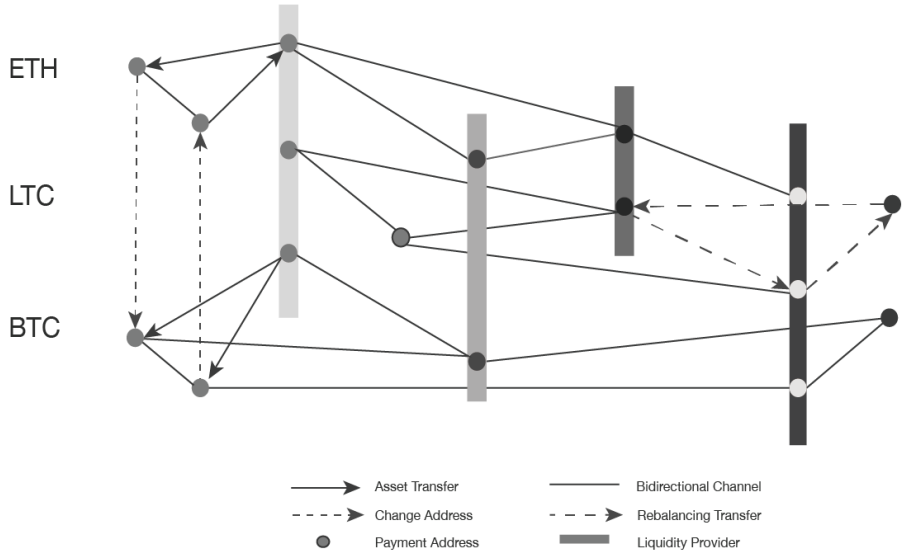

Figure 5: Cross-Chain Service Usage

2.2. AI Data Center and Mining Machine

2.2.1. AI Data Center

To guarantee adequate AI power supply before large-scale users join, we will cooperate with large-scale third-party Internet data centers in Quebec. Quebec has a very competitive global electricity bill, a cold climate, abundant resources and 34 data centers. In addition, the world's leading companies, including IBM, Nokia, Amazon and Microsoft have built data centres in Quebec.

The advantages of choosing Quebec as an artificial intelligence data center are as follows:

- Adequate Water and Low Electricity Rates

Table 1: *Quebec electricity rates*

Province	375 kWh	750 kWh	1,000 kWh	2,000 kWh	5,000 kWh
Quebec	32.48	52.77	68.66	146.46	379.86
Manitoba	34.03	60.96	78.92	150.75	366.24
British Columbia	32.05	61.92	89.07	197.63	523.34
New Brunswick	52.88	88.32	111.94	206.44	489.94
Alberta	57.775	96.175	121.78	224.195	531.44
Saskatchewan	61.955	103.685	131.505	242.79	576.65
Ontario	64.7	110.64	141.69	267.34	674.38
Nova Scotia	64.69	118.55	154.46	298.09	728.98

According to Ontario Hydro and Hydro Québec's statistics in 2013, Canada has the world's lowest electricity rates. Among all provinces in Canada, Quebec has the lowest electricity rates [15], and more than 90% of the electricity use hydropower energy.

- Lower Temperature

Quebec has a winter of up to nine months and its average temperature in winter is below minus 10 degrees Celsius, even below 20 degrees Celsius in summer. Low temperature optimizes the heat dissipation of the equipment room.

- Adequate AI Talents Pool

Google, Facebook and Microsoft have set up artificial intelligence centers in Montreal,

which brought together a large number of talents in the field of artificial intelligence. For example, Yoshua Bengio, professor of computer science and operations research at the University of Montreal, is the world's top researcher of artificial intelligence. He is the head of the Montreal Institute of Learning Algorithms and one of the three founders of advanced machine learning in the field of artificial intelligence. In addition, the Canadian government also fully supports the research and development of artificial intelligence. The federal government has given funds of 213 million Canadian Dollars to the University of Montreal, while the provincial government plans to add 100 million Canadian dollars in the next five years as investment.

- University Research

Nebula AI has partnered with McGill University School of Medicine, to collaborate in joint research and development for the innovative use of artificial intelligence in surgery.

2.2.2. AI Mining Machine

A 1080Ti graphics card computing power is 7514 GFLOP/s. Using the Caffe framework to train the GoogLeNet model of 1.3 million image data on the GTX 1080Ti, the computation time of epoch 30 times is 19 hours and 43 minutes. The calculation time of six cards can be shortened to 3.5 hours.

Any mining machine that supports CUDA operations (mainly Nvidia series graphics cards) can be installed in the AI mining system. AI mining machines pre-installed common AI algorithms, such as CNN, RNN, reinforced learning, etc., as well as a large number of other commonly used libraries, such as TensorFlow, etc. The upgraded client included with the system, can automatically update the AI pre-installed support library. The first batch of computing miners will be preloaded with python 3.6 support libraries. The ledger client that supports Ethash is also integrated into the system.

There are three types of methods to obtain rewards as NBAI tokens that are available on AI mining machines:

1. Rewards from Ledger.

The Equahash-based algorithm supports NBAI tokens from Ledger. However, the amount of NBAI tokens obtained here would generally be less than that obtained from AI calculation.

2. Rewards from AI Calculation.

The NBAI tokens obtained from AI Calculation is the most important source of obtaining NBAI tokens for miners.

3. Rewards from IPFS.

Mining machines can be turned duo-mining mode, support Sia and storj mining. IPFS can also be used to pay for the data storage in AI calculations.

2.3. DAI App Development

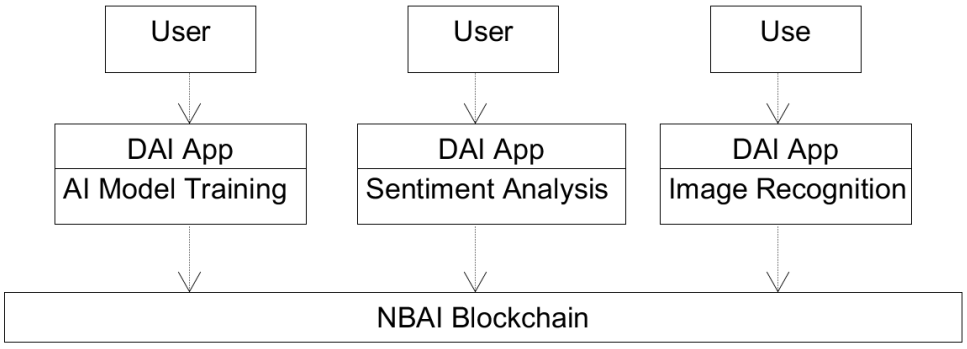

Figure 6: AI DAI App

The Ethereum community calls smart-contract based applications as Decentralised Applications. The goal of DApp is to create a friendlier interface for the smart contract, and to add

additional features such as IPFS. DApp can run on a centralized server that interacts with Ethereum nodes. Examples include the famous EtherDelta, Ethercat, etc.

However, the current smart contracts are not enough for decentralised AI applications. The reasons are as follows:

- Ethereum smart contracts do not come with AI calculations.
  EVM is a Turing complete contract virtual machine, but its consensus computing system can only perform simple tasks, and it is unable to perform complex artificial intelligence calculations.
- Ethereum mining clients do not support the computational libraries required for AI calculations.

  The operation of artificial intelligence depends largely on the support of various development kits, and distributed computing is its main task. The supporting libraries required for the relevant computing tasks can be implemented with separate computing clients.

However, as a commercial AI application, the blockchain hyperledger and payment function remains at the core of the system. Due to the scarcity of artificial intelligence computing resources, shared computing power will become a very useful function. Each user can link to the chain, and use blockchain to rent or lend computing power to complete the calculation tasks. DAI App users can also write standard, compliant smart contracts, according to their own needs.

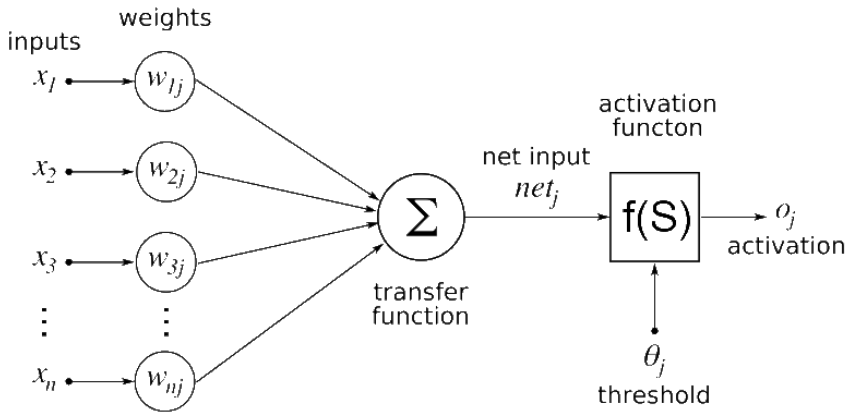

Figure 7: Deep Learning

When training a deep learning model, two major operations are performed: forward propagation and backward propagation. In forward propagation, the input is passed through the neural network, and after processing the input, an output is generated. Whereas in backward propagation, the weights of neural network are updated based on errors in forward propagation. One of the most critical problems in neural network training is the training speed, especially for deep learning, which will consume a lot of time. The computationally intensive part of a neural network consists of multiple matrix algorithms, and the GPU has unique advantages regarding matrix operations and numerical calculations. In particular, floating point and parallel computations can outperform the CPU by tens to hundreds of times. While using GPU to train deep learning models, it is also easier to classify and predict on the cloud, enabling far more data and throughput with less power consumption and less infrastructure occupation. Therefore, getting enough computing power through smart contracts for artificial intelligence calculations is an effective method.

Let's take a typical style transfer learning model (Gatys et al.) As an example to compare the time that a GTX 1080 Ti GPU, K80 GPU (AWS P2), i5 7500 CPU, and CPU (AWS P2) use the TensorFlow framework to calculate.

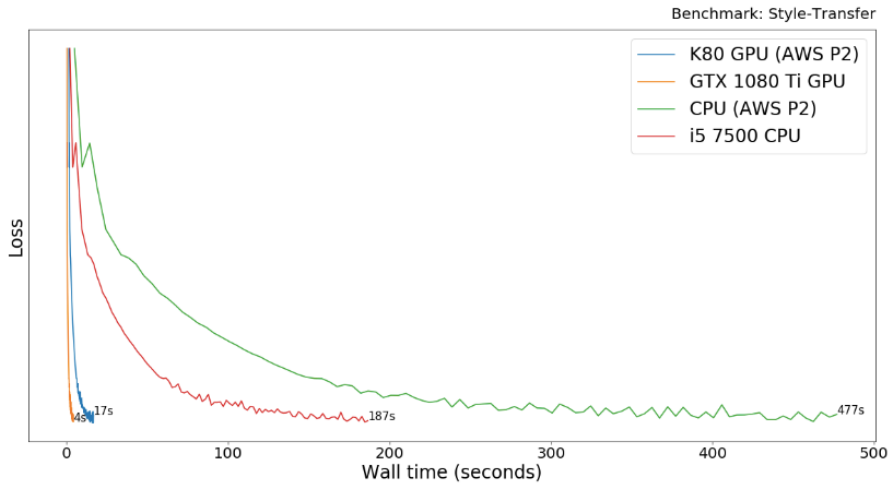

Figure 8: GPU vs CPU

The GTX 1080 Ti GPU performs nearly 50 times better than the i5 7500 CPU.

Nebula AI provides very elegant, cost-competitive computing power. Nebula AI artificial intelligence mining machine uses Nvidia 1080 Ti GPU. Let's take Amazon P2.xlarge (Nvidia Tesla K80) as an example: In reference to market price in spring 2018, Nvidia 1080 Ti costs 803.85 US dollars each, other supporting hardware costs 2,000USD, the electricity costs 0.12 US dollars per hour, and assuming a 1080 Ti has a life span of two years, thus, equipment cost per minute is (803.85+2000)/ (365 × 24 × 60 × 2) = 0.00267USD, its unit computing cost per hour is 0.00267 × 60+ 0.12 = 0.28 USD/hour.

The above calculations give Nebula AI remarkable price advantages in comparison with Amazon. The official test data shows that the Nvidia 1080 Ti's Tensorflow GPU performance is four times that of Amazon P2.xlarge instance [13]. According to published report by Amazon web services [22], the price of P2.xlarge is 0.9 US dollars/hour, this means that even in depreciated model, the cost/hour comparison between Nebula AI and Amazon is 0.28/0.9 = 31.1%. If we consider electricity only, the cost difference is estimated to be 13.3%. Other than cost difference, users who use Amazon or Google cloud platform need to upload their data to those servers for calculation, in which condition data privacy is not guaranteed, but the decentralized NBAI ecosystem can solve this problem.

2.4. Higher Education

NBAI provides rich interfaces for scientific research in major universities around the world, which can significantly improve the work efficiency of researchers, reduce R&D costs, and break the barriers between high-level programming needs and low-level configurations. The Platform as a Service (PaaS) provided by the NBAI ecosystem enables university students to focus on research

instead of bottom configuration.

2.5. Nebula AI Foundation

The Nebula AI ecosystem is expected to become a partner community using NBAI cryptocurrency. The Nebula Foundation aims to be an independent, non-profit, and democratic governing body for this ecosystem.

A blockchain AI Foundation will be established for the promotion and education of foundational artificial intelligence and fund venture activities. We encourage the participation of everyone in the community, and the involvement in R&D interactive activities for DAI Apps to be integrated onto Nebula AI platform.

Based on the principle of independence, the Foundation's wallet address will be a secured multi-signature wallet. Only 3 out of 4 signatures authorize a transaction. Increasing the signature should be reviewed by the Finance and Management Committee. A large amount of tokens uses cold storage, while a small amount of tokens use multiple signatures.

2.5.1. AI Joint Laboratory

Nebula AI Foundation will extend broad cooperation in the field of AI, Blockchain, Distributed Computing with Universities of Montreal, University of Toronto and McGill University. Canada is going to create new center of super-artificial intelligence in Toronto, Waterloo, Montreal, and Edmonton, in order to establish a sound financial, business and human resources-ecological chain. In 2017, the federal government's annual budget also indicated that the government intends to place the development of the artificial intelligence industry as one of the top priorities at national level.

The research conducted by Professor Yoshua Bengio and his team at the University of Montreal over the past 10 years has laid the groundwork and places Montreal at the forefront of artificial

intelligence. Bengio also conducts academic research at the Institute of Algorithms (MILA) at the University of Montreal. MILA is supported by The Institute for Data Valorisation (IVADO). Nebula AI is actively communicating with MILA to promote collaborative research.

The Surgical Innovation program, Department of Surgery, McGill University School of Medicine (North America s top medical school) and Nebula AI embarked on a research project about AI medical imaging supported by Mitacs. The Mitacs Project is a collaborative project initiated by the Canadian Information Technology and Integrated Systems Mathematics Organization and has been in operation for more than ten years. Jake Barralet is the leader of the program.

In February 2018, R & D laboratories are set up in Silicon Valley, and we cooperate extensively with local universities and the industry on the application of artificial intelligence and the research on blockchain.

2.5.2. AI Engineer Training Center

Every successful project is inseparable from a large number of engineers. The current market is in a shortage of AI talents. Nebula AI collaborates with educational institutions such as the local ECV learning on funding and project platforms. AI scientists at Nebula AI will also serve as project trainers and recruit a large number of AI intern trainees, continuing to provide high-calibre talents for the AI industry. On January 27, 2018, the first group of students attended an AI Engineer training class led by Dr. Tengke Xiong. These students will become a solid R&D team reserve force for Nebula AI in the future. Blockchain training has also been scheduled in the program, which will take place in mid-May 2018.

3. NBAI Architecture Design

3.1. NBAI Logical architecture

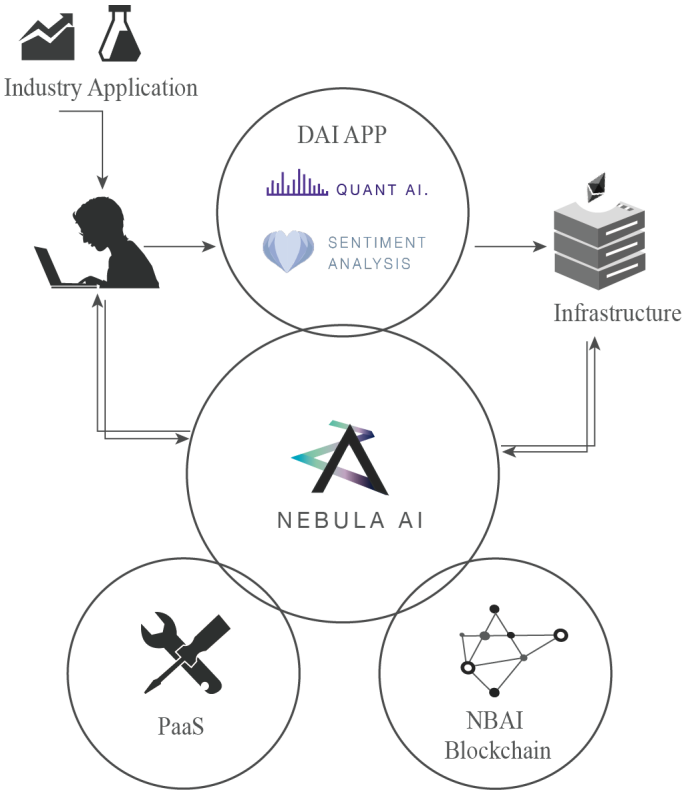

Figure 9: System Logic Diagram

The logical structure of NBAI is mainly composed of industry application requirements, developers, DAI App, infrastructure and Nebula AI. Nebula AI provides PaaS (Platform as a Service) and NBAI blockchain. A large number of artificial intelligence development needs in industries such as finance, healthcare and biology have prompted developers to develop DAI Apps for different industry applications, and provide solutions by deploying applications. Nebula AI will provide a wealth of interfaces and applications for developers. The decentralized blockchain provided by NBAI, in conjunction with the Nebula AI credit mechanism, will address the issue of P2P trust and big data processing for sensitive data and models.

3.2. NBAI System Architecture

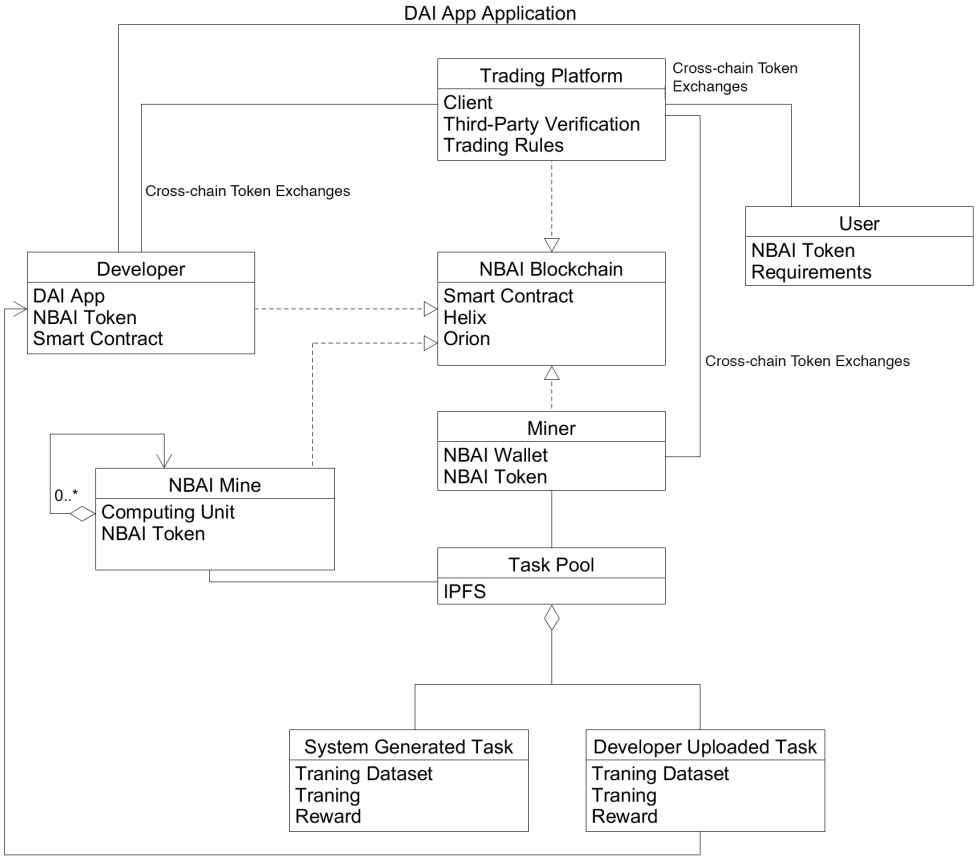

Figure 10: System Architecture

The system architecture of NBAI is mainly composed of NBAI, developers, users, trading centers, miners and task pools. Nebula AI not only provides a decentralized NBAI blockchain, it also offers cross-chain token exchanges to improve the value exchange in the NBAI ecosystem.

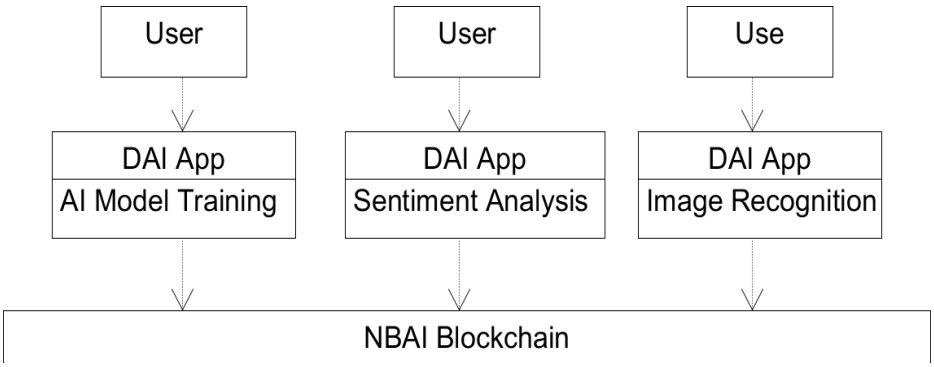

Figure 11: Shared AI Cloud Computing Platform

Nebula AI provides a shared AI cloud computing platform, and PaaS (Platform as a Service) enables non-IT sector practitioners to achieve rapid development and deployment, and reduce the dependence on the system environment and computing power.

3.3. API/SDK Support

Some common prepaid, retainage smart contracts can be generated programmatically using the SDK, and the APIs provide interfaces in a centralized service. The first batch of supported SDKs uses python as the main programming language, followed by java and .NET. With the support of the SDK, users can programmatically drive AI calculations more conveniently and become an interface point with the centralized system.

4. NBAI Optimized Design

4.1 Data Security Encryption

Data will be saved using homomorphic encryption. The idea of homomorphic encryption refers to the operation of encrypting several data and then deciphering the result, which is consistent with the result of performing an operation when these data are not encrypted. The current homomorphic encryption schemes can be divided into three types: partial homomorphism, somewhat homomorphism and fully homomorphism. Partial homomorphism can only realize a certain kind of algebra (or, multiply, add). The somewhat homomorphism can realize a finite number of additions and multiplications simultaneously. Full homomorphism realizes any number of additions and multiplications. Homomorphic encryption scheme can only realizes the encryption function, but can also be used for cipher text data calculation.

Let $< G, * > < H, o >$ be two algebraic systems, $f : G \rightarrow H$ is a mapping. If $\forall a, b \in G, f(a * b) = f(a) of(b)$, then f is a homomorphic mapping from G to H. Encryption is a mapping from plaintext to cipher text space. If the crypto map is a homomorphic map, we say that it is a homomorphic encryption scheme. We give the following definitions:

Let $E(K, x)$ denote the encryption of x using the encryption algorithm E and the encryption key K. F represents an operation. For E and F, there exists an efficient algorithm G:

$$E = (K, F(x_1, ..., x_n)) = G(K, F, (E(x_1, ..., x_n))) \tag{3}$$

Then the encryption algorithm E is said to be homomorphic for F.

If the definition of the equation only holds for

$$F(x_1, \ldots, x_n) = \sum_{i=1}^{n} x_i$$

Then the encryption scheme is an additive homomorphic encryption scheme.

If the definition of the equation only holds for

$$F(x_1, \ldots, x_n) = \prod_{i=1}^{n} x_i$$

Then the encryption scheme is an multiplication homomorphic encryption scheme.

An encryption scheme is a fully homomorphic encryption scheme if the equality in the definition holds for $F(x_1, ..., x_n)$, which contains a mixture of addition and multiplication operations.

The homomorphic encryption scheme that only holds for one kind of operation is called the partially homomorphic encryption scheme.

The homomorphic encryption scheme ε of the public key system consists of 3 random algorithms $KeyGen_\varepsilon$, $Encrypt_\varepsilon$ and $Decrypt_\varepsilon$.

- $KeyGen_\varepsilon$: Receive the safety factor λ as input, output the private key sk and the public key pk, pk defines the plaintext space P and ciphertext space X.
  - $Encrypt_\varepsilon$: Receive input pk and plaintext $\pi \in P$, and output cipher text $\psi \in X$, encrypted with plaintext π with public key pk, denoted as $\psi = Encrypt_\varepsilon(pk, \pi)$.
  - $Decrypt_\varepsilon$: Receive the input sk and ψ, output the plaintext π.

The computational complexity of the above three random algorithms is determined by the polynomial of λ, and the encryption system should satisfy the correctness condition:

if $(sk, pk) \xleftarrow{R} KeyGen\varepsilon(\lambda)$, and $\pi \in P$, $\varphi \xleftarrow{R} Encrypt\varepsilon(pk,\pi)$, then $Decrypt\varepsilon(sk, \varphi) = \pi$.

In addition, the $Evaluate_\varepsilon$ algorithm is interpreted as: Entering a public key pk, a circuit C from the circuit set C_ε and a set of ciphertext $Y =< \psi_1, ..., \psi_t >$, output the ciphertext $\psi \in C$. If

$$\psi_i = Evaluate_\varepsilon(pk, \pi_i),\ i = 1, ..., t,$$

Then:

$$Evaluate_\varepsilon(pk, Y, C) = Evaluate_\varepsilon(pk, C(\pi_1, ..., \pi_t) \quad (4)$$

Once the algorithm is preserved, the data structure is preserved. Therefore, in the process of machine learning, we only need the data structure, we can decrypt the encrypted information and machine learning.

4.2 Distributed System Optimization

Data transmission can be sped up by the equal segmentation of big data processing. The worker node on NBAI receives the task for concurrent processing, after which each node returns the result to the selected aggregation node for the task's consolidation, and finally returns the task owner. In these transmissions and processing, we optimize NBAI by node election, data access, load balancing, network security and the research of redundancy mechanisms.

When NBAI receives AI tasks with large datasets from developers, single miners cannot handle the tasks on their own. We will need to split the tasks and deliver them to multiple miners for calculation, and eventually return the aggregated task results to the developer. This series of operations needs to rely on a complete and optimized distributed system. NBAI will also be optimized to meet the performance demands of high throughput, low latency and high concurrency.

Although the traditional distributed system structure has only three layers, according to business demands, it will often be designed to more levels. A multi-tier structure often has a wide range of proxy processing and routing. Most of these proxy processes are connected via TCP to both ends. However, in order to avoid the high failure rate and high maintenance cost of TCP, NBAI will apply message queuing mechanisms to realize inter-process communications.

NBAI uses NoSQL to provide a solution to the distribution of data storage tiers, In addition to the advantages of high-volume and high-speed access, NoSQL can only retrieve and write using an index. This constraint brings the advantages of distributed implementation, the system can press this main index to define the data stored in the process. Such a big data-level task, can be safely sent to different nodes.

```
future<int> get();
futre<> put(int);

void function(){
        get().then(then[] (int i)){
                put(i + 1).then([] {
                        std::cout ”an integer has been put”;
                        });
                });
}
```

Figure 12: Future/Promise Model

Because distributed systems involve a great deal of network communications and the system relies on asynchronous, non-blocking programming models, developers generate a large number of callback functions in the programming of distributed systems. Task instructions will be distributed to multiple processes, and completed through a combination of network communications. However, this asynchronous programming model callback is very detrimental to code maintenance. In order to solve this problem, NBAI uses the Future/Promise model to optimize the callback function.

5. NBAI Token

5.1 Token Plan

5.1.1 Use Value of Tokens

The NBAI token is used to purchase computing power. When the training data is relatively small, the number of tokens consumed is less, and when the training data is large, the token consumed increases accordingly. The number of NBAI tokens used depends on the training costs(time and computing power consumed for specific task) and the value of the current token . The current value of token is the hash power of each 1080Ti graphics card within one minute, that is, 7514 GFLOP/s × 60.

5.1.2 Token application

Tokens will be used in the following three cases:

- Developers Test

Developers in the test will utilize some tokens for model training. Depending on how many tokens are utilized, the training time required to train the model will be reduced by 50% to 90%.

- Use of DAI APPs

  DAI APPs may be set as paid apps by developers; users must utilize the NBAI tokens in exchange for these AI services, such as the trend prediction of cryptocurrencies app in this White Paper.

- Purchase of DAI training services

  When users utilize training services to obtain finer models, they are required to pay for retraining the models.

5.1.3 User scenarios

1. Quantitative Trading

Quantitative trading has been using computers for assistance from many years ago. Analysts use a variety of quantitative models to design metrics and observe data distribution, using the computer as an operator. Until the rise of machine learning in recent years, the data can be rapidly and quantitatively analyzed, fitted, and predicted, so that analysts can predict the market trend of future financial products more accurately. However, the calculations of these models still require a lot of artificial intelligence computing power. With the traditional approach, each trading section needs to set up a data center on its own. However, sharing computing power can eliminate the need for expensive maintenance, and allow financial trading firms to focus more on predicting itself.

2. AI Learners Program

Colleges and universities have increasingly set up artificial intelligence courses, which will become more popular in the next few years. Students usually choose small tasks to run on their computers, and run time-consuming tasks in the school computer labs. However, these fragmented tasks can be solved with blockchain computing cloud. Low-cost AI computing services are ideal for students to complete a variety of computing tasks, and to quickly modify their models.

3. Biomedical Artificial Intelligence

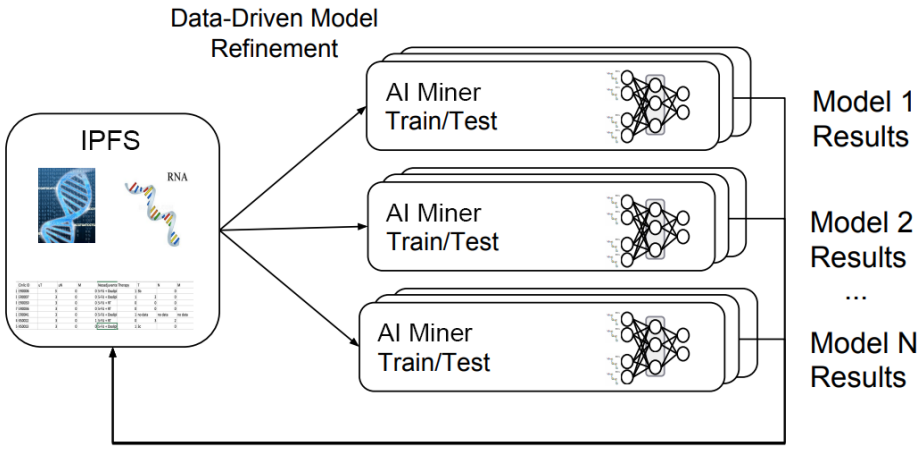

Figure 13: AI for Cancer Research

Early detection of tumours is of great significance. However, because of the small area of early cancer lesions, the traditional method is difficult to judge whether the tumour is benign or malignant, which makes it difficult for clinical diagnosis. Doctors often need to conduct tests using the biopsy method, which not only increases the medical cost but also brings patients great pain. The application of artificial intelligence in medical image recognition and multidisciplinary collaborative diagnosis can effectively overcome this difficult point, enhance the ability of doctors to diagnose, help to make quick decisions and promote the transformation of medical services to one of individualization and precision.

5.2 DAI App Developer profit model

1. DAI App Task Types

- Class I — Require training model.

  App users have to utilize tokens to drive calculations that consume a lot of resources. The training time may take hours or even hundreds of hours.

- Class II — No need to train models or use existing models.

The Apps do not need to consume computing power, users only need to pay a certain NBAI tokens for smart contract costs. It is also possible to invoke the computing results of Class I DAI Apps to generate the application. This type of DAI Apps is less expensive.

2. Task Calculation

A standard computing contract contains the following basic elements:

- AI task data address
- AI task program script
- AI task execution result output address
- The number of NBAI tokens required for AI task

3. Task Release

When the task is posted on the chain, all AI miners can accept tasks from the system. The task is identified as “in progress” when it is executed by the mining machine. The user can set several different levels of redundancy calculations to ensure a more accurate result. Nounce can be set to different levels such as 1, 2, 3 to correspond to different redundancy calculations. Larger numbers mean more calculations are needed to ensure the accuracy of the results. The corresponding cost will be higher.

4. Cost Calculation

AI calculation is generally divided into the training phase and the using phase. The training phase will consume a lot of training resources, and most of the computational power will be used here. In the using phase, due to the end of the training, less power will be consumed. At the start of the task, the smart contracts will pre-charge a portion of the NBAI tokens as pre-payment and, at the end of the calculation, will re-calculate the total NBAI tokens utilized and require the customer to pay the balance of NBAI tokens to obtain the data. The users need a certain amount of NBAI tokens to start booking service, multi-signature automatic contracts will lock the NBAI tokens to ensure the transaction being operated

normally.

5. Task Execution

The mining machine clients read the task plans from the chain and parse them into executable AI code. Artificial intelligence and training data can be stored in external links when tasks start being executed. The code will be executed in the following steps:

- Parse the encryption task.
- Download data remotely.
- Set the task to execute state.
- Write the progress and result of the operation.
- Mining machine binds address for rewards.

6. Calculation Ends

DApp users download the results of the implementation, which can be used directly for the web demo or offline use. Execution results can be obtained by API method, and be used after decrypting.

5.3. NBAI AI Application Case

Hedge funds, banks and large international companies like Goldman Sachs are benefiting from smart-technology-based foreign exchange and stock trading. These companies predict the short-term and long-term effects of various financial markets through “deep learning” — mathematically-based predictive and probabilistic models which evolve continuously. Cryptocurrency players such as Pantera Capital, and financial institutions including Santander and Citibank, are also looking at making money from cryptocurrencies. Designing an artificial intelligence model requires a large amount of computing power. Each user must compute the model each time when the parameters are adjusted. At this point, getting enough computing power through smart contracts for artificial intelligence computing is an effective method. The standard

system goes through the following steps:

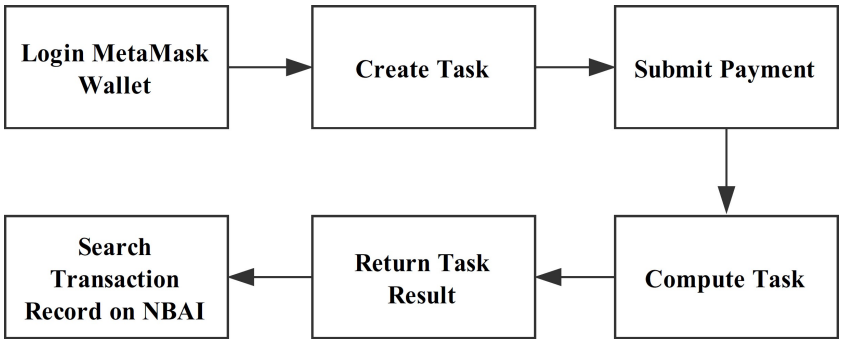

Figure 14: NBAI AI Application Case

6. Roadmap

Q1 2017 Began to design concept, research, and explore the hyperledger.

Q3 2017 Developed the Quant-AI DAI APP and conceptual prototype.

Q1 2018 Started to sell tokens; Helix test chain went live.

Q3 2018 Helix public chain will go live, integrate the first DAI APP; start to develop the Orion and Orion prototype chain.

Q1 2019 Orion test chain will go live.

Q3 2019 Orion public chain will go live and integrate 10 DAI APPs.

Q1 2020 Orion will integrate 50 DAI APPs.

Q3 2020 Orion will integrate 500 DAI APPs.

Note: Nebula AI reserves the right for earlier release for the phases of roadmap.

7. Collaboration Plan

1. **Collaboration Projects**

- Distributed System Optimization and Cloud Computing Project
  — Concordia University
- Surgical Innovation Program
  — Department of Surgery - McGill University & Mitacs
- Canada Summer Jobs
  — Government of Canada

2. **Collaboration Partners**

- YES Montreal
- McGill University
- Concordia University
- Services ECVictor Inc
- Timechain
- Beepay
- Express Mining
- ECV Learning
- The IT Professionals Association of Greater Montreal(APIGM)

8. ICO Plan

The initial release is 6.7 NBAI billion tokens. Each year, it is intended for a certain amount of tokens to be produced, with the amount decreasing in six years from 2% to 0.2% of the total initial number of NBAI tokens released(6.7 billions). Tokens are consumed when users use customized predictive features of artificial intelligence, and the amount of tokens consumed depends on the amount of computation. The demand of tokens will increase along with the increasing complexity

or better performance for AI tasks, in which condition higher computation power will be consumed.

Miners obtain tokens through mining, and AI mining machines are the main sources of mining returns. Any application based on the NBAI's blockchain (such as quantitative trading, Biomedical AI) can only be paid by NBAI tokens.

Tokens are ERC 20 tokens, and will be replaced by Nebula AI main chain tokens in the ratio of 1:1 in the future.

Public offering is 1 Ethereum = 100,000 NBAI.

ICO softcap: 5,000 Ethereum.

Private placement starts from January 22, 2018, and ends on March 30, 2018.

The private placement hardcap: 18,000 Ethereum.

Public offering starts within one month after the end of private placement. The

public offering hardcap: 12,000 Ethereum.

45%	Sold by the private placement and public offering
25%	Held by the foundation & community
15%	Held by the core team
10%	Held by the early-stage investors
5%	Held by marketing & Partner supporters

Unsold tokens from private placement will be merged into public offering. Unsold tokens of public offering will be completely destroyed.

For token investors that participate in the private placement and public offering, there will be no token lockup period.

The tokens held by the foundation will be frozen after crowdfunding ends and are released in 18 stages (across a time period of approximately 3 years), every 60 days for a cycle, and 1/18 of the foundation holdings will be released each time.

After the public offering, NBAI tokens will gradually be listed on global cryptocurrency

exchange platforms.

Token sale contact email: tokensale@nebula-ai.com.

9. Core Team

The NBAI project has been receiving validation since early 2017. After several technical modifications and evolutions, the initial use of Hyperledger Fabric evolved into Bitcoin, and finally Ethereum technology as the main chain, which lasted one year. During this period, we have received assistance from the United States, China, Singapore and Canada.

9.1. R&D Team

Charles CAO CEO & Co- Founder

Charles graduated from Fudan University in 2007 where he majored in Electronic Engineering. He afterwards worked at Shanghai Academy of Spaceflight Technology and IBM Shanghai. He obtained his master's degree in Electronic and Computer

Engineering at Concordia University in 2010. During the course of his studies, he received funding from The Natural Sciences and Engineering Research Council of Canada for engaging in Video Transcoding Studies.

After graduating, Charles worked at SAP, Autodesk, Expedia and Paysafe (acquired by Blackstone Group for $ 3.9 billion) as the core team lead.

In 2013, Charles set up Service ECVictor where he focused on building the electronic platform for software technology and he has successively invested in multiple online to offline start-ups involved in the following industries: medicine, education, e-commerce, and logistics. He has been actively following the progress of the Bitcoin blockchain since 2013 and has been widely recognized in the community.

In 2014, Charles founded the Montreal IT Association with more than 700 members. The Montreal IT Association held more than 100 events, as well as many popularization and research

seminars on cutting-edge technologies such as blockchain, artificial intelligence and big data.

Charles founded Express Computing Inc. (an Ethereum mining company) in July 2017 in Quebec, Canada.The hash power sales website went live and operated over the same period and completed thousands of dollars in hash power sales three hours after the website went live. The company's integrated operations includes mining machine design, mining and sales.

Charles is active within the North American blockchain community and analyses multiple ICO products. He is devoted to the education, popularization and deep research of blockchain in North America.

Qinhui LIN Project Manager

Qinhui has over 13 years of consulting and developing experience in the startup and banking industry. He was a former CTO in a residential social platform startup and led a team to build solid, high-concurrency and scalable social portal who has 3 million registered users. In particular, he has over 7years experience providing consulting and development services for banking institutions such as Wellsfargo, GE Capital and Laurentian Bank in Montreal and working closely with stakeholders to provide technical solutions upon request. At NBAI, he is dedicated to blockchain programming, mining and integrating with AI to build an efficient win-win AI and blockchain ecosystem.

Tengke XIONG AI Architect

Dr. Xiong has acquired a Ph.D. and postdoctoral degree in Computer Science at Sherbrooke University. In addition to this, he has more than 10 years of experience in AI development. He was a visiting scholar at Shenzhen Institute of Advanced Technology, the Chinese Academy of Sciences and has published 6 papers in top international journals, regarding the topic of data mining. Before joining Nebula AI, he worked as chief scientist at multiple AI companies and has also founded his own AI research company. Dr Xiong and is now responsible for AI project architecture in Nebula AI.

YanYan LI CFO

Yanyan holds a master's degree in Finance and a bachelor's degree in Management Information Systems from Fudan University. She had three years of work experience in a leading securities company in China and over two years' experience in the investment industry in the Canadian market. She is also a Canadian Chartered Financial Analyst candidate and a Chartered Professional Accountants of Canada candidate.

Yanping LU AI Architect

Yanping Lu obtained her Ph.D. degree in Computer Science at Sherbrooke University. She has many years of experience in intelligence model optimization, high dimensional data feature selection/classification and application in medical image processing. She was an assistant professor in Xiamen University and has publications in top AI journals such as Machine Learning, IEEE Transactions on Biomedical Engineering etc. Dr Lu joined Nebula AI as its AI Solution Architect and is responsible for development of the environment for deep learning, big data analytics etc.

Lu YAO AI Engineer

Lu worked at HK Financial Invest. PLC as a Quantitative Trading Specialist, and as a Statistical Modelling Analyst at AXA (HK). She was the leader of Risk Warning and Machine Learning Research funded by SCUT. She is a master of economics and is proficient in Python and R. She focuses on the application of deep learning and Neural network algorithms in finance.

Tong PANG Blockchain Developer

Tong majored in Computer Science in Concordia University. As a full stack developer, he is proficient in blockchain algorithm such as Ethash and DPOS. He is responsible for the design and implementation of blockchain products.

Kaichen ZHANG AI Engineer

Kaichen holds a master's degree of Computer Science from Concordia University. Proficient in Java, Python and JavaScript, he has been engaged in work and research in the direction of combining artificial intelligence, blockchain and business intelligence. He is a contributor of an

“Internet Marketing” textbook, and was formerly the regional manager of a financial education company. He focuses on the field of semantic analysis and deep learning.

Ming YUE AI Developer

Ming graduated from the Civil Aviation University of China. He has 10 years of experience in machine learning and software development. As an expert in computer vision and machine learning algorithms, he had developed many video inspection software systems for iron/steel and the railway industry in China. Currently Ming focuses on Image Recognition and Computer Vision in Nebula AI.

Richard YAN Senior Full Stack Developer

Richard graduated from Fuzhou University and has more than 10 years of experience in software development in South America, Europe and North America. He participated in developing a number of large software platforms and he is proficient in python, Node.js, and performance optimization.

Alberto Lacerda Front End Developer

Alberto majored in Computer Science at Laureate International Universities. With over 10 years of experience in the IT field. He has worked for Accenture as its Software Developer, and had collaborated with FIFA for its World Cup projects. Currently, Alberto is working as the Front End Developer for Nebula AI.

Chi ZHANG Blockchain Developer

Chi obtained a master’s degree in Computer Science at Concordia University. He is familiar with technologies and frameworks related to Python, Js and Java. He takes responsibility for developing and maintaining backend services, and currently, Chi focuses on developing blockchain related applications.

Yue LI Blockchain Developer

Yue graduated from the Beijing University of Posts and Telecommunications and has experience in software development in both China and North America. He participated in

developing multiple software platforms. Yue is proficient in Java, Spring and code performance optimization. He works as a blockchain developer in Nebula AI.

Hong PANG Python Developer

Hong graduated from Tianjin University and obtained a master's degree in Applied Science at Concordia University. He is familiar with python, PHP, Javascript as well as related frameworks. He has been working as a backend software developer and currently he is taking part in R&D of blockchain technology at Nebula AI.

Pin ZHOU Software Developer

Pin obtained a master's degree in computer science at Harbin University of Science and Technology. She has over 8 years of experience in IT development. Currently, she works as a software developer at Nebula AI.

Yi Cao AI Developer

Yi obtained a master's degree from McGill University. With 3 years' experience in project management, she is passionate in feature engineering, data mining and application of deep learning in medical diagnostics. Yi works as a machine learning engineer at Nebula AI.

Xiaojun WEN Front End Developer

Xiaojun graduated from the Software Applications Specialist program in Vanier college. He has two years' experience in front-end development and created over 20 websites for different clients. Familiar with front-end developing techniques like HTML/CSS, JavaScript, Xiaojun currently works as the front end developer for Nebula AI.

Sidi SHEN UI Designer

Sidi majored in Graphic Design at Lehigh University in the USA, and worked as a Freelancer for 3M Company in Shanghai. She is an experienced UI/VI designer, being a recipient of many awards in the design industry. She is responsible for the design of all the company's products, website promotional materials, and marketing activities.

Alecsa Tabisaura UI Designer

Alecsa majored in graphic design at Cégep Marie-Victorin, in Montreal, Canada. She has worked as a freelance graphic designer for various projects and companies. She is experienced in branding design and UX design. Currently, she is a part of the design team, working as a graphic designer for Nebula AI.

Mable XU Marketing Coordinator

Mable majored in Acting and Broadcasting at the Communication University of China. With over five years of experience in sales and marketing field, she is currently working as the executive assistant and marketing coordinator for Nebula AI.

Coco MA Marketing Specialist

Coco graduated from Zhejiang University of Media and Communications, she has more than 10 years of senior media, social advising experience and marketing coordination. She is expertise in developing and executing marketing strategies. Currently Coco is working as marketing specialist for Nebula AI.

Ivan NONVEILLER Marketing Analyst

Ivan is Google-certified marketing and content analyst, with a strong focus on SEO, business intelligence, optimization and growth. Ivan majored in Psychology at UQAM and has over 5 years of experience in the design of data-driven solutions and information architecture. He is proficient in Ahrefs, Google Analytics, Majestic, Marketo, Hubspot, Moz Pro, and SEMrush.

Jessica Boxerman Marketing Coordinator

Jessica has years of marketing experience, and is active in many European North American communities. She is responsible for European and American community building, brand building and marketing public relations.

Yan XU Front End Developer

Yan obtained his bachelor’s degree at Peking University, followed by a master’s degree at Ecolé Polytechnique de Montreal. He has worked as a Web Developer in SAP, and currently is the leader of the Web Developer team at Nebula AI.

Carlos Gonzalez Oliver Blockchain Developer

Carlos is a Computer Science Ph.D. student at McGill University, and co-founder of Delphi Crypto blockchain consulting. He has expertise in machine learning, algorithmic solutions to biological problems, and a passion for scientific applications to blockchain technology.

9.2. Advisory Team

Yan LIU Cloud Computing and Distributed Professor

As Concordia University's cloud computing and distributed system expert, Dr. Liu published hundreds of articles, and she has more than nine years experience in defense system development. She worked in America at the Department of Energy Pacific Northwest National Laboratory and at the National ICT Australia as a senior engineer.

Thomas Fevens Medical Imaging and Computer Vision Advisor

Associate Chair in Department of Computer Science and Software Engineering at Concordia University, Dr. Fevens leads the computational mathematics and visualization lab, and he is also the director of the Surgical Innovation Centre. Dr. Fevens has a vast number of top publications in computer-aided medical diagnosis and 3D graphics. In 2018, Nebula AI has established and promoted artificial intelligence collaboration with Dr Fevens' laboratory, in the field of medical imaging.

Zhenhua LIN AI Advisor

Dr. Lin is a post doctorate student at the University of California, Davis, engaging in mathematical statistics. He graduated from Fudan's Computer and Information Technology Department in 2008 with a major in Information Security. In 2011 and 2013, he received a master's degree in computational science and a master's degree in statistics from Simon Fraser University in Canada, and graduated with a Ph.D. in Statistics from the University of Toronto in 2017, focusing on functional data analysis and differential geometry statistics. His research interests include non-Euclidean statistics, statistical machine learning, and the implantation of distributed machine learning in blockchain.

Xun SHI Blockchain Advisor

Dr. Shi works for the video processing technology company Harmonic Inc., located at Silicon Valley. He completed his Ph.D. studies at York University in Toronto, Canada, in 2012 and focuses on computer vision and artificial intelligence. He received a bachelor's degree in computer graphic from Beijing University of Computer Science in 2006. He is currently a video compression algorithm design engineer. He focuses on the theory and industrialization of computer hardware and software algorithms, especially on blockchain, cryptography, encrypted networks, and decentralized video broadcasts.

Louis Cleroux Blockchain Expert

Louis works with early-stage entrepreneurs looking to improve/disrupt blockchain technologies such as Ethereum and Bitcoin. His latest tech investment is around Smart Wallets & Smart Apps.

Yu GUAN Blockchain Advisor

Yu is a . NET / C# / Azure Cloud/DevOps/Microsoft technology expert. He started his career at Microsoft and have been focusing on software architect/design/development for almost 20 years. He is conferred the Microsoft Most Valuable Professional (MVP) award by Microsoft CEO Satya Nadella. Currently, he is CTO of a hi-tech real estate management platform company in Canada.

Bin ZHU Cloud Computing Advisor

Bin is a Data Science Expert who has worked in Huawei and MindGeek, where he built and led a 30-person Big Data R&D team. He has more than 15 years of experience in database and big data, as well as having dealt with PB level data. He is also an expert in team communication, coordination and management.

Douglas Leahey Business Development Consultant

Dr. Leahey graduated with a Ph.D. in Environment, and currently he is a Montreal Youth Employment Adviser. He provides legal, financial, and government- related innovative support project advisory services. He also assists in the development of strategic directions and marketing

strategies of companies.

Jake Barralet Advisor of Internship Mitacs

Dr. Barralet is a Materials Science graduate who specialized in Biomaterials during his Ph.D. at the Interdisciplinary Research Centre in Biomedical Materials, QMW, and the University of London. After a postdoctoral position at Tokyo Medical and Dental University, he worked at Smith and Nephew Group Research Centre, York, UK, developing bone graft and casting materials. At the University of Birmingham in the UK, he progressed research themes regarding tissue engineering and bone grafts in collaboration with biologist and clinical co-workers. Currently, he co-operates with Nebula AI in the AI biomedical field.

10. Conclusion

As the world's first AI blockchain system, Nebula AI is dedicated to driving the advancement of artificial intelligence technologies, building a credible trust-based blockchain, creating social value and serving all of humanity. NBAI builds the next generation of AI blockchain infrastructure platform that enables developers in many industries to truly develop, compute and deploy artificial intelligence with high efficiency, low cost, safely and reliably, without worrying about the underlying development, system configuration and environment setup.

NBAI can be considered as a consensus system for decentralized data. As the value carrier, NBAI tokens realize the value flow of artificial intelligence in the NBAI ecosystem. Whilst the traditional Internet connection can solve the problem of data communication, NBAI further solves the problem of data consensus on the basis of traditional Internet. Compared to a large, centralized platform, NBAI can avoid data being stored or stolen by service providers and realize the public processing tasks while ensuring data privacy.

The rapid development of blockchain technology has made it possible to realize the digital credit society. NBAI will inject more fresh and vibrant blood into the development of global blockchain technology and look forward to pushing artificial intelligence, an important area where society can change, to new heights.

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Appendix A Revision History

Version	Date	Update
V2.3	27/02/2018	Change the private placement hardcap from 25,000 ETH to 18,000 ETH.
		Change the public placement hardcap from 24,000 ETH to 12,000 ETH.
		Cancel the plan to build 10MW AI computing center.
		Change to cooperate with large-scale third-party Internet data centers.
		Adjust Collaboration Plan.
		Adjust the proportion of tokens.
		Add Advisory Team members.
V2.4	07/03/2018	Add R&D Team members.
V2.5	16/03/2018	Change the private sale date.
V2.6	19/03/2018	Adjust the softcap.
V2.7	09/04/2018	Add R&D Team members.
		Merge unsold tokens from private sale into public offering.
V2.8	24/05/2018	Revise according to token offering requirements under Singapore Securities and Futures Act