

Effect Network

Decentralized Network for Artificial Intelligence

DRAFT

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Abstract

The Artificial Intelligence market is growing at a remarkable rate but has become more inaccessible than ever. The requirement for large annotated datasets and a complex technical infrastructure has driven AI development behind the closed doors of corporations. This paper introduces an open, decentralized network called *Effect*, that provides services in the Artificial Intelligence market. The network replaces several existing services and requires no fees, has a low barrier of entry and provides fast growth of the industry. This is accomplished by three platforms that run on the NEO [1] blockchain and are fueled by a network token called AIX. The first platform is a marketplace for tasks that require human intelligence. It allows anyone in the world to perform tasks for a fair payment and gives businesses access to a large workforce of human intelligence. The second platform is a decentralized registry of AI services described by a rich ontology. On this platform any algorithm can be accessed as a service in a unified manner and has a convenient way to receive payment. The last platform provides a decentralized, distributed computational platform that can run popular deep learning frameworks. The effect of this network will define the future relationship between humans and AI.

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*Whether we are based on carbon
or on silicon makes no
fundamental difference; we should
each be treated with appropriate
respect.*

Arthur C. Clarke

1 Introduction

In the past five years there has been a rapid growth in the number of practical Artificial Intelligence (AI) applications around us. Smart services, like self-driving cars, face and voice recognition in mobile phones and image translation are getting a central place in everyday life. This rise can be explained by the advances in machine learning research and the ready availability of cloud computing. This has resulted in large adoption by the industry and the birth of a billion-dollar-economy around smart applications. While academic achievements are available to the public, most intelligent algorithms are developed behind the closed doors of large corporations. We propose a private, decentralized ecosystem called the *Effect Network*. The network is designed to provide a feature complete alternative to the services shown in Table 1, and operates fully on smart contracts deployed on a Turing-complete blockchain.

Market	Suppliers	Market Cap.
Micro tasking	Amazone Mechanical Turk, Fiverr	...
AI as a service	IBM Watson, Amazon Rekognition	...
ML Computation	Google Cloud ML, Amazone AI	...

Table 1: Overview of markets (WIP)

1.1 Blockchain

A blockchain is a decentralized data store that can contain arbitrary logic and processes, without the need for a trusted central party. Blockchain was first proposed in the Bitcoin whitepaper by Satoshi Nakamoto, 2009 [2]. Since then the technology has been applied in many areas, and has had a disruptive influence in the markets of banking, insurance, real-estate and many more. Decentralized applications have some unique properties like transparency and a fixed history. We propose a protocol that decentralizes the global market in Artificial Intelligence; which lowers the barrier for entry, stimulates market growth and greatly reduces usage cost.

1.2 Artificial Intelligence Market

The AI market will benefit from decentralization because of the high degree of interaction between agents. An open and decentralized ledger can facilitate

the interactions and will boost collaboration between parties. The main reasons that currently make AI development inaccessible for individuals are listed below:

Data processing Intelligent applications perform tasks that traditionally require human feedback. Such tasks involve processing unstructured data and finding patterns that can provide useful output. These applications are trained on large data sets with annotations. Obtaining an annotated data set is non-trivial and requires a lot of time and money.

Diverging tasks An obstacle when developing a complex algorithm is the need to interact with parts of the world outside the current domain. For example: a self-driving car learning to steer will also need to identify road signs around the world. This situation can best be treated as a knowledge system where the classification of the sign is done by an external application. This quickly increases the amount of work needed.

Computational cost Developing and training a large AI is a computational intensive task. This requires a technical infrastructure capable of processing terabytes of data, doing batched processing on multiple GPUs and coordinating the results.

These three points are solved by the *Effect Network*. Like other decentralized applications, *Effect* directly connects supply and demand without the need for an intermediary party. This brings many advantages:

- **Accessibility.** By directly linking supply and demand through our micro-tasking platform (see section 2) *Effect Mechanical Turk* will make training AI algorithms easier, faster and cheaper. This will enable users who do not have access to a large dataset or a big network to train their AI algorithm.
- **Accuracy.** The *Effect Exchange* is an exchange with a rich ontology of specialist AI applications. Individual applications are able to find each other to buy or sell information, as specified in section 3. Through this exchange, users can use data sets with significantly higher complexities to train their AI algorithms.
- **Performance.** Users can directly buy existing data sets on the *Effect Exchange* (section 3) or quickly create their own data set by creating micro-tasks on the *Effect Mechanical Turk* platform (section 2). By enabling users to retrieve accurate data sets quickly, they can immediately use these datasets to train AI Algorithms.
- **Interoperability.** By putting the AI algorithms on the blockchain and creating a standard to which these AI algorithms have to comply to, we can truly decentralize AI and achieve interoperability between individual AIs. The combination of multiple AI algorithms will result in powerful capabilities and emergent intelligence that no single AI algorithm can achieve on his own.

The network will be deployed in consecutive phases, allowing adaption and development of the network to grow together. The phases cover independent market sections but are interconnected in our network model and are all fueled by the same token, called *AIX*.

2 Phase 1: Decentralized Mechanical Turk

The *Effect Mechanical Turk* platform is a decentralized, peer to peer marketplace for tasks that require human intelligence. It provides similar features as centralized services like Amazon Mechanical Turk¹, Fiverr², Crowdsourcse³ and Guru.com⁴. It is a crowd sourcing technology that enables requesters to submit tasks that can be completed by human agents in exchange for compensation. Users can work on tasks from requesters at any time, anywhere and from any device. The tasks are called Human Intelligence Tasks (HIT). The providers of the HITs are called *requesters* (see section 2.1). When a worker completes a task they are paid with the cryptographic token *AIX*.

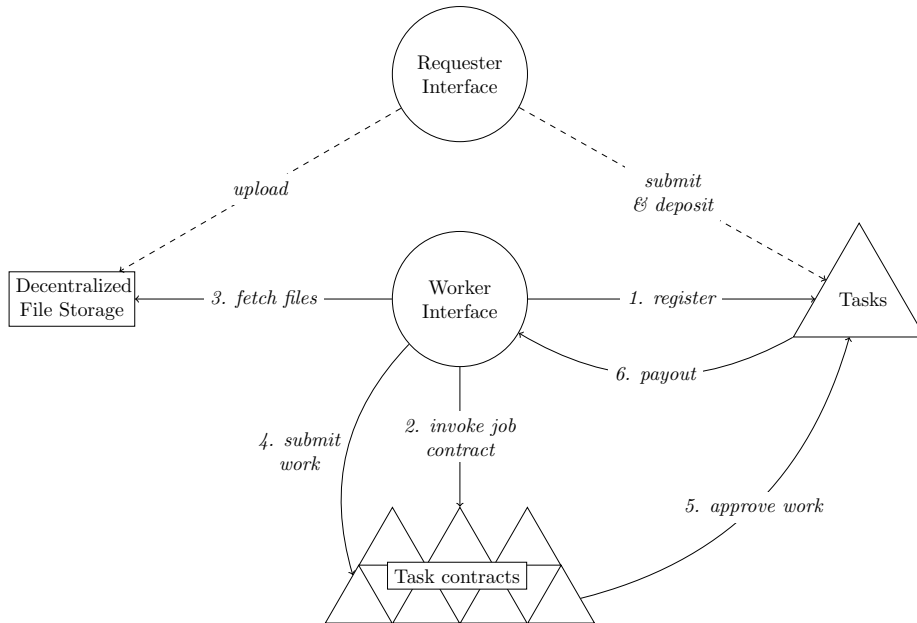


Figure 1: Process of submitting tasks on the *Effect Mechanical Turk*

¹<https://www.mturk.com>

²<https://www.fiverr.com>

³<https://www.crowdsourcse.com>

⁴<https://www.guru.com>

2.1 Requesters

Effect Requesters can put tasks (see section 2.3) on the *Effect Mechanical Turk* platform to be completed by workers. The requesters can decide how many AIX the workers will get for each completed task. The requesters can retrieve the results from the *Effect Mechanical Turk* platform and use these results to, for example, train their AI algorithm. *Effect Mechanical Turk* gives requesters access to an on-demand, scalable and distributed workforce.

2.2 Workers

Effect Workers can complete the tasks from the requesters in exchange for the AIX tied to these tasks (see section 2.3).

2.3 Tasks

A task represent a piece of work that has been submitted by a requester, and can be accepted by workers that match its requirements. Each task points to a data set that can contain any amount of media assets. The contract ID of the task will validate the format of the data. Extracting and presenting examples from the data set is done by the user interface.

A task has at least the following properties:

Data set	URL
Description	description of the task
Contract ID	smart contract that will handle task
Blueprint	data for the contract
Required <i>honor</i>	require trusted users
Reward	rewarded AIX upon completion
Num. ratings	number of ratings per user
Rating timeout	timeout on performing a rating
Expiration	block ID after which task expires
Sequence id	for sequencing examples (optional)
Data credentials	to unlock private data sets

Table 2: Properties of a task

The structure and required feedback for a task is defined by the contract ID and the blueprint. Each type of task requires a smart contract to handle interaction. *Effect* maintains a database of deployed smart contracts to make it easy for requesters and workers to interact with the network. Adding smart contracts to the network is handled through governance (section 5.3). Affiliate programs will cover costs of deploying new contract types.

2.4 Data sets

Data sets are often large and consist of various types of media. A blockchain is not a suitable database for storing this kind of information. Other decentralized storage options, like BitTorrent⁵ and IPFS⁶, are specialized in these types of assets. For this reason the network will use such a hash-based distributed file storage, where each media asset can be referred to by a single hash.

Note that the feedback on a *task* can also involve storing media assets, for example in tasks like image segmentation. In this case the ratings asset will be stored on the distributed storage, and a hash and checksum of the rating are stored on the blockchain.

Requesters will also be able to supply data sets through traditional channels, like Amazon S3, Google Cloud Storage and FTP.

2.5 Privacy

The blockchain is decentralized and open by nature. These properties are not always desirable, for example when privacy is concerned. There are several measures that must be taken to make sure the Effect network can be used for sensitive information. The network can provide privacy for the following cases:

Datasets Requesters can provide their data set in encrypted form. Only selected users will be able to decrypt or access the data. This is determined by network smart contracts using Public Key Encryption, where selected users can decrypt the data set credentials.

User ratings Ratings of tasks performed by workers are stored on the blockchain, using Public Key Encryption. The public key of the owner is used to sign the ratings, so only the owner of the task can view the ratings.

Tasks that involve privacy features will be more computationally expensive, thus will also have a higher network fee.

⁵<http://www.bittorrent.com>

⁶<https://ipfs.io>

I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.

Alan Turing

3 Phase 2: Decentralized AI Exchange

The *Effect Exchange* is a decentralized marketplace where AI algorithms can exchange their services. An application owner can register on the exchange by specifying a public endpoint of his application, following our data interchange format and specifying a usage fee for consumers. This application can now be invoked through smart contracts on the blockchain. The caller of the contract will have to transfer the required funds to the owner of the contract to get an authorization token that allows him to interact with the application.

Thanks to the application registry, algorithms are able to explore possible collaborations over the blockchain. It also encourages standardization of data exchange formats, as interoperability with other applications means more interactions: a financial incentive.

3.1 Application registry

The network will maintain a registry of available applications. This registry will be enriched with a semantic ontology that describes the application, as well as a technical schema of its inputs and outputs.

3.2 Endpoints

Application endpoints on the *Effect AI Exchange* communicate over the HTTP protocol. Data is exchanged in JSON format and should strongly confirm the defined RDF schema.

Requests signed with the private key of the buyer will be accepted by the endpoint. Issuing authorization tokens and checking their validity can be done by public APIs that hold a partial index of the blockchain. They could request small fees for providing this service.

4 Phase 3: Decentralized AI Algorithms

Phase 1 and 2 of the *Effect* network decentralized the data gathering and usage of AI algorithms. Up to this point the algorithms themselves still run on centralized servers. In the final phase of the network the actual computation

will be distributed, so that the algorithms run globally without a single point of failure. To achieve this we use the fact that most machine learning algorithms have rigid structure, and operate on sets of weights. These types of algorithms are relatively easy to distribute. The *Effect* decentralized compute engine is based on popular deep-learning networks like *Caffe*, *MXNet* and *Tensorflow*, where the network structure can be defined as a declarative graph and weights are stored as matrices of real numbers. These matrices can be distributed over a decentralized file system and be processed at different compute nodes on the network.

5 Community

The described network can be deployed and used as a decentralized application as-is. However, in order for the network to grow and be sustainable, we believe there has to be a form of governance. Parties should have incentive to use the AIX token for the purpose of AI tasks. Investors looking for quick monetary gain should be discouraged and pump-and-dump schemes should be avoided, in order for the network to grow and slowly take market value from the existing centralized services.

5.1 AIX and the Galaxy Pool

It is important to maintain liquidity in AIX, especially during the early days when there is no listing on exchanges. Ideally the following actions should always be possible:

1. Workers are able to sell their AIX rewards for native tokens
2. Requesters and network users should be able to buy AIX

For a new token on the market this kind of liquidity can be hard to achieve and can be hurt by speculative trading.

The Effect Network will maintain a central pool of tokens to provide liquidity, encourage adoption and stabilize network fees. This pool is called the Galaxy Pool and consists of a mix of AIX and native tokens. Several rules will drive the Galaxy Pool towards an equilibrium. These rules can later be refined by means of governance as is discussed in section 5.3.

The Galaxy Pool ensures stable exchange rates for users of the platform at all times. The pool is not suitable for day traders, as only *tainted* coins can be bought. Any coin that is bought from the Galaxy will initially be tainted, and a tainted coin can not be sold back to the pool. A tainted coin is *washed* (converted to a regular AIX token) by spending it through an *Effect* service contract. These are the service contracts from the tasks and service registry. This protects the Galaxy Pool from external manipulation and keeps exchange rates stable for workers.

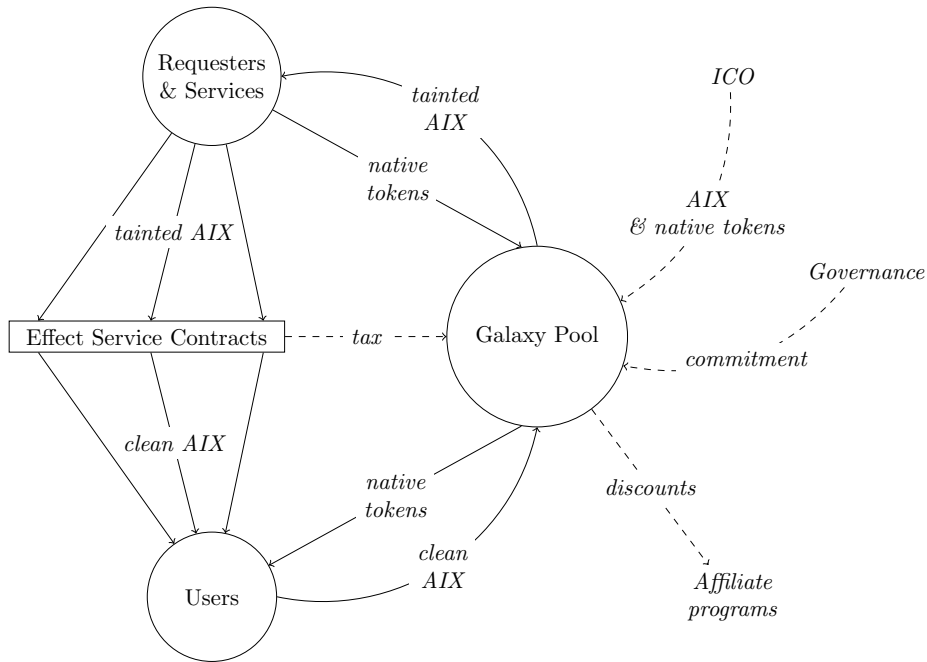


Figure 2: Diagram of the *Effect* governance model and construction of the Galaxy Pool

5.1.1 Proof of Commitment

- In conceptual development -

5.2 Honor Tokens and Fraud

On the *Effect Mechanical Turk* workers are rewarded tokens for their effort. This could make malevolent users to gain wealth by submitting a large quantity of tasks with poor quality. To avoid this, the network will appraise users by their quality of work. Users that put in good effort will be rewarded with *Honor Tokens* (HNR). These tokens can not be traded or sold, but will gradually expire over time. Workers with a large number of honor tokens will be able to apply for more high rewarding tasks and will have to pay less tax to the Galaxy Pool.

HNR tokens are credited to users ad-hoc when they are rated for good work. There are 2 ways this can happen:

1. The task owner can add ground-truth ratings of examples. If a worker rates an example with a ground-truth similar to the ground truth, they are rewarded 1 HNR, else they lose 1 HNR. Ground-truth examples are stored encrypted on the blockchain and the decryption key is shared by the requester after the task has expired. Thus the rating takes place after task expiration time.

2. Workers that give similar ratings on the same HIT are credited with 1 HNR. This is done periodically and at random. Workers that consequently give deviant feedback are subtracted HNR.

5.3 Governance

The blockchain is immutable by nature so the network needs a way to apply changes to its components. There are 2 types of changes that can be applied. First are the variables defined in smart contracts that can change over time, for example the exchange rates in the Galaxy Pool and the tax over service transactions. The second are the smart contracts themselves; introducing new service contracts - like new task types - and amending existing contracts will be necessary in the future. As the *Effect Network* is decentralized there can not be a single person or organization authoring these changes. To fix this the network has a governance system that allows prominent people in the community to propose and vote for improvements, as explained in 5.4. Right to vote is at first acquired by selected individuals as discussed in 5.5.

5.4 Improvement Proposals

Both smart contracts and service variable adjustments should be submitted to an improvement proposal system. Each proposal contains logic for adjusting parts of the ecosystem. A proposal is only executed if a majority of the council members voted in favor of it within a time limit.

5.5 Council

The *Effect Council* is an group of 51 individuals that are allowed to cast a vote on improvement proposals.

6 Implementation

This section contains examples of how the platform would function when built on the NEO blockchain. NEO is a blockchain that uses Delegate Byzantine Fault Tolerance (dBFT) consensus and features Turing-complete smart contracts. It also has features for user identification and file storage that make it a very suitable host for the *Effect Network*.

6.1 Galaxy Pool: NEO and GAS

In NEO there are 2 native tokens: *NEO* and *GAS*. The *GAS* is a utility token that is used for paying network fees; which are deploying and executing smart contracts. *NEO* acts as a share in the platform; holding *NEO* gives a payout in *GAS* from network usage. In this setup, the Galaxy Pool should hold a combination of *AIX*, *NEO* and *GAS* to function correctly. The *NEO* is used to payout workers at a stable exchange rate and to increase the *GAS* stake by

collecting dividend. As NEO is indivisible the rate should be defined in $\frac{AIX}{NEO}$. The GAS is used to pay any network fees to users of the network, so workers will not have to go to an exchange to use the platform. The GAS is also used to deploy new smart contracts and amend existing smart contracts. This is crucial as the *Effect Network* will be developing all the time.

*Control is as much an effect as a
cause, and the idea that control is
something you exert is a real
handicap to progress*

Steve Grand

7 Conclusion

Having an open, accessible and affordable platform for intelligent algorithms to operate and develop will be a key component in the coming century. Artificial Intelligence and decentralization are a natural match. Along with the rise of blockchain technology and the surge in the global AI-market this enables big opportunities. The *Effect Network* effectively combines the two technologies. It will replace a significant portion of the 3.1 trillion USD AI-market by a decentralized platform, giving immediate practical and monetary value. It also has the potential of becoming the breeding ground for emerging AI-technologies and will be at the front of AI emancipation.

Registering AI interactions on the blockchain also has benefits for society. Bill Gates had the idea to tax labor performed by AI-algorithms, to compensate for the loss of jobs in many sectors. This idea seemed science fiction at the time, but this can be realized on the *Effect Network*; where algorithms are registered, can control their own bank account, and have transactions published on the blockchain.

The long term success of the project will depend on many factors. Most important is the initial implementation of the concepts described in this paper, and the performance of the governance model proposed in section 5.3. The effect of this network will define the future relationship between humans and AI.

8 References

- [1] Neo: A distributed network for the smart economy, 2014.
- [2] Satoshi Nakamoto. Bitcoin: A peer-to-peer electronic cash system, 2008.