Artificially Intelligent Decentralized Autonomous Organization

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Abstract— **Blockchains have enabled a slew of new opportunities, to create decentralized software and organizations. Riding on its tailcoats, we want to create a Decentralized Autonomous Organization (DAO) headed by Artificial Intelligence (AI). In a world where human error is majorly becoming the sole reason for mistakes, as small as a missed medication to huge ones like Chernobyl, it is becoming increasingly important to automate as many actions as possible. Creating automated organizations is only but a first step towards the goal. We decided to make an art organization which sells art to make money. The standard way of doing that would be to create a web platform like Amazon (controlled by humans) that sells art and let human artists upload their artwork. But in the interest of keeping this as automated as possible; we have decided to make a Generative Adversarial Network (GAN) which generates art. Our organization will sell this art created by the GAN and use the revenues to pay for its resources. An AI will be heading it. Hence the DAO will be an entirely human less organization capable of sustaining itself.**

Keywords— Blockchain, DAO, AI, AI DAOs.

I. Introduction

We aim to create a complete human-less and decentralized organization which can sustain itself without any external support. There will be no hierarchy in the organization and decisions related to the organization will be taken by a rational AI agent with great computing powers at its disposal.

We formally define our problem statement for this project as implementing a Decentralized Autonomous Organization (DAO). This organization would sell images of paintings on the internet. In the spirit of keeping the organization as human free and as autonomous as possible, we replace the human painters with GANs, making them the employees of the organization, and we replace the human decision maker with an appropriate AI. This model of an organization thus relies on no humans or state-backed currencies hence making it virtually infallible from human error and free from government control.

Objectives
The following are the objectives of this project

- Showcase replacement of human workers with AI.
- Implement a website to interact with AI.
- Implement smart contracts to automate payments using cryptocurrencies.
- Implement the website using sustainable decentralized infrastructure.
- Showcase replacement of CEO with a decision-making AI.

There have been many advances in the fields of GANs, AI and Blockchain, what we attempt here is to combine these remarkable advances to deliver a proof of concept that a completely decentralized autonomous organization with no human intervention is a viable next step. DAOs have been implemented before, but we attempt to make a DAO that is free of humans in this research project.

The rest of the article is organized as follows: in Section II, we review related work done in the field. In Section III, further description of the problem statement is given. Section IV contains a brief discussion of each of the technologies used in the project and methodology used to implement this proof of concept of the DAO. A clean architecture diagram of the proposed model and its explanation are also presented in it. Section V contains the technology stack, with results, summary and illustrations of future extensions in tow in Section VI, VII and VIII respectively.

II. Literature Survey

Ian Goodfellow first introduced GANs in a paper titled *Generative Adversarial Networks* [1]. It introduced a way of making a neural network, namely the generator, learn the data patterns of the input data and thus generates new data resembling it. This was achieved by using another neural network that acts as the discriminator to give feedback on the data generated, which is used by the generator to improve itself. They were further enhanced by replacing neural networks with Deep Convolutional networks, thereby making DCGANs[2]. Auxiliary Conditional GANs (ACGAN)[3][4] are GANs that can train at once for multiple genres by training the net to output particular genre data according to change in one input variable.

Blockchain and a cryptocurrency, Bitcoin, based on it were introduced by Satoshi Nakamoto[5]. It presented a revolutionary peer to peer network that provides complete

anonymity, data consistency and security to its users. It used a Proof-Of-Work protocol to solve the problem encountered when one has to maintain a single consistent copy of the truth without centralization. It kicked off a barrage of cryptocurrencies, of which Ethereum[6] is the most promising for this research project. It has improved upon Bitcoin by integrating a Turing complete programming language allowing anyone to write smart contracts and build decentralized applications. Blockchain is a relatively new field with many research directions[7] open.

Blockchain enables new organization structures such as Decentralized Autonomous Organizations. Using automation and AI advancements to replace labour and decision makers in the DAO gives us human free and artificially intelligent DAOs. We have implemented a proof of concept of such an organization in this research project. Thus, main components of our project are Blockchain technology, Generative Adversarial Network technologies and related software. We have explored several technology solutions and finally decided to use Auxiliary Conditional GAN (ACGAN) with a Wasserstein metric for the GAN. We used Google Colab platform where we train the GAN model, and Google Drive to store the training images and the art generated by the GAN. For Blockchain, we used Ethereum. To access the Ethereum node, we used Metamask[7] and Web3Js[8]. For building the website, we used VueJS[9].

III. Problem Definition

Consider an e-commerce website which sells art made by artists. The manager (or CEO) of the website charges a fee per transaction to pay for hosting resources and make a profit. The consumer buys any art they fancy using conventional payment systems such as debit or credit cards. A centralized banking system thus mediates the transaction.

Fig 3.1 Current architecture of a typical e-commerce organization.

Drawbacks

The following are the challenges with the above scenario:

- Human workers are not reliable and get tired.
- One entity, namely the CEO, controls the organization.

- Banking system requires users to trust them.
- Centralized infrastructure makes the website highly dependent and prone to failures.
- Human CEOs sometimes make irrational decisions.

Proposed Future Scenario

1. Art will be made by Generative Adversarial Networks (GAN) instead of artists.
2. Payments by the user will be made in Ethers using the Ethereum blockchain network.
3. An Artificial Intelligence will take the place of CEO. The AI will use the money earned to pay for the organization's own infrastructure cost, and the rest is a profit. A sufficiently intelligent AI may invest the profits for improving the business.
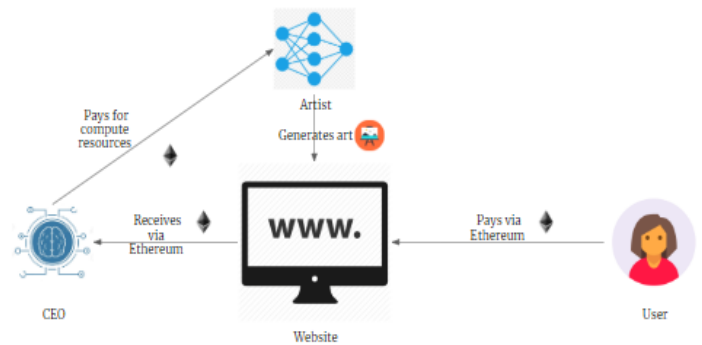

Fig 3.2: The proposed architecture of Decentralized Autonomous Organization.

IV. Methodology

A. Background

    1) Generative Adversarial Networks (GAN)

Generative Adversarial Networks typically consist of two neural networks competing against each other, in which one network acts as a forger trying to generate art (Generator) and the other acts as an art critic or the art inspector who catches the forgery(Discriminator). Both the networks are trained together such that generator trains to fool the discriminator and discriminator trains to identify "fakes" generated by the generator. In this adversarial game, the generator is trained so well that it can now generate art of its own.

    2) Blockchain

Blockchain is a distributed ledger which is generally public, persistent, transparent and append-only. This ledger is maintained in the form of blocks which are linked to each other using cryptography, hence the name. Each block contains its hash value, which acts like a unique fingerprint for each block, some data, and hash of the previous block in the Blockchain. The data in a block depends on what the Blockchain is used for. For instance, the data in a Blockchain-based cryptocurrency consists of transaction details. Since the hash of a particular block also depends on the contents inside the block. This property of Blockchain makes it pretty robust and secure against tampering.

Cryptocurrencies are by far the most popular application of blockchain. Bitcoin is the first ever blockchain based cryptocurrency. We have used Ethereum for this project. It is an open source, public, blockchain based computing platform. Essentially, what Ethereum provides is a "blockchain-as-a-service" model. Using it, developers can make Blockchain based decentralized applications, also known as DApps.

3) Decentralized Autonomous Organization (DAO)

An organization is a commercial business that conventionally uses a combination of human resources and raw material to produce goods and services. A Chief Executive Officer or CEO typically heads the business and calls shots regarding every aspect of it from pricing the good to paying salaries to workers. The organization trades its services or goods for money or currency backed by a centralized government with the consumers as shown in Fig 4.1.1.
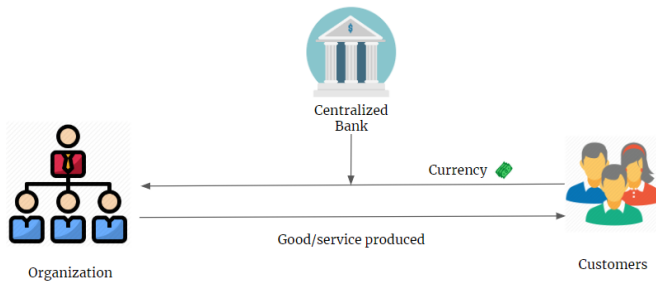

Fig 4.1.1 - A conventional business structure.

One obvious step any organization could take to inch closer to decentralization is to replace the centralized government-backed currency it uses to trade with one of many decentralized cryptocurrencies such as Bitcoin or Ethereum as shown in Fig 4.1.2.
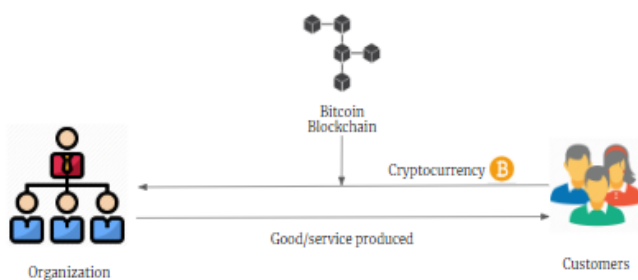

Fig 4.1.2 – Bank in conventional system replaced with cryptocurrency

However, this only eliminates the centralization in the currency traded with, not the organization itself. A truly decentralized organization decentralizes the decision-making power from the CEO to all members of the organization, preferably according to the stake they hold in the organization, similar to how an organization with stakeholders works, instead of shares members of this organization will have "coins". This can be achieved with a blockchain. The whole organization can be moved to the blockchain, where smart contracts and the basic rules of blockchain can keep the system decentralized and transparent. Such an organization

can have humans working in it from all across the world with no compromise of accountability or speed as shown in Fig 4.1.3.
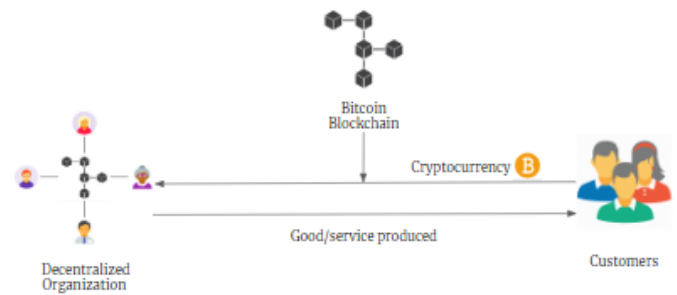

Fig 4.1.3 - A decentralized organization

This level of decentralization is entirely new and unfamiliar to many people. Even if it becomes commonplace, one failing of this organization or any other organization, as a matter of fact, is human error.

To cancel that out we propose introducing AI, which will replace human workers with worker AI and human CEO with CEO AI as shown in Fig 4.1.4.
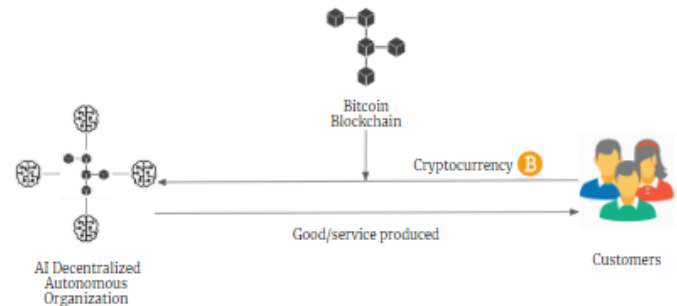

Fig 4.1.4 - A DAO with an AI as its primary decision-making unit.

B. Architecture

Our project aims to create a GAN (Worker GAN part in Fig 4.2.1) that generates its art using web scraped images and creating art resembling that of famous painters. We also aim to provide a User Interface through a website or an app to the user so that he/she can buy the art generated. The website is going to be self-sustainable and virtually indestructible.
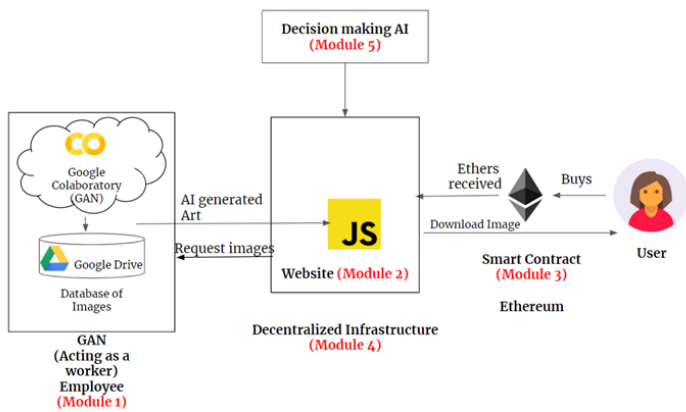
Fig 4.2.1: Proposed Architecture diagram of our Decentralized Autonomous Organization.

Fig 4.2.1 demonstrates the architecture diagram of the organization. We trained the GAN using Google Colab, and the images generated by it would be stored in a Google Drive. These images will be fetched by the website through which a user can buy these paintings made by the GAN employee. The user will pay using ethers. The decision-making AI, which would be the brains of the organization will decide the prices and the content. A brief explanation of individual modules is as follows:

Module 1 - GAN Employee
For the DAO to be an actual organization, it needs to do some work, i.e. have employees. We decided to use an AI model that can create paintings, thus eliminating the need for human employees. We achieve this by creating and training a GAN to produce paintings. The whole training process was done separately beforehand on Google Colab. Images generated by the GAN will be stored in Google Drive, which the users can access via a website.
For the dataset of paintings, we used the wiki-art database. It contains paintings categorized according to various genres, artists and eras. The final dataset obtained was of 32GB. The images were then transformed into a 64x64 resolution to simplify the training process and normalized using mean normalization method, thus bringing all the pixel values in the range [-1,1].
Since training the model required GPUs, and we had a considerable dataset, we couldn't train the model on our systems. Hence, we turned to the cloud infrastructure. We used Google Colab, a service offered by Google, where we can train our machine learning models on their cloud GPUs. The training was done using Nvidia Tesla K80 having 2946 CUDA cores and 12GB of GDDR5 VRAM. Colab allows of training on GPUs for 12 hours at a single stretch.

Module 2 – Website
The website is the front-end interface for the decentralized organization. Through the website, DAO will be selling art images, and users can pay through ethers. The website is implemented using NodeJs[], VueJs[] etc.

Module 3 - Smart Contracts
We've used smart contracts to grant the user access to download the image after the payment has been made. We deployed it using Remix[] online editor. Web3JS and Metamask were used to interact with it.

Module 4 - Decentralized Infrastructure
We want the organization to be an epitome of decentralization, and hence we wanted to incorporate fog computing into the project, but we couldn't as the technology is still in its nascent stages. If the organization becomes more advanced, we will need a lot of computing power. Hence, we cannot rely on traditional cloud computing providers such as Amazon and Google cloud for these to two reasons. Decentralized cloud computing services such as Golem and iExec should be used to achieve decentralized computing power for the organization.

Module 5 - Decision-making AI
As stated earlier, the organization is human-less. Thus, decisions regarding the organizations have to be taken by an AI too. The AI can be trained to make decisions such as how to allocate revenues, genres of paintings to produce, which architecture of GAN produces images that sell the best etc. The only limit here is one's own imagination and limitations of technology. We do believe it is an area of many possibilities and deserves further research.

V. Technology Stack

For Module 1, we have used Tensorflow to write the code, Google Colab to train the model, and Google Drive to save the images. For Module 2, we used VueJs. For Module 3, we used Remix editor to write and deploy the code and Metamask and Web3 to access it. For Module 4, due to technology constraints, we have settled for Google Cloud Platform. For Module 5, you can use any of the AI technologies available.
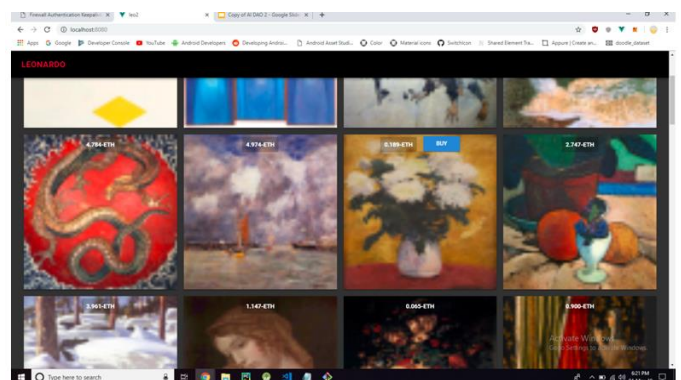
VI. Results

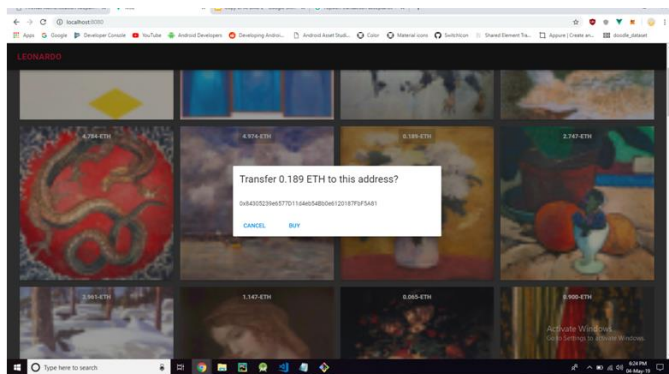Fig 6.1 Screenshot of Website buy option

Fig 6.2 Screenshot of Website dialog box

VII. Summary and Conclusion

For module one, we used the wiki-art database to train an ACGAN using a Wasserstein Metric on the GPU offered by Google Colab. We hosted the produced art on Google Drive. Thus, a GAN has been created to act as the worker for our organization who produces goods, i.e., art.

For module two, we created a website using Nodejs, Vuejs and Veutify. The website is the frontend through which the user can interact with the organization. The user can see the various art image generated by the employee GAN and can purchase them with Ethers. Once purchased, the user will be able to download the image on their system.

For module three, we deployed the smart contract using Remix. To interact with it using the contract address and ABI, we tried running a full node and a light node using Geth but were not successful due to memory issues and software problems. Then we used Metamask to communicate with a full ethereum node hosted on Infura using WebJS.

For module four, we looked up and tried to use iExec, Golem or SONM, but since all the projects were in their very nascent stage, we couldn't use decentralized infrastructure. We used Google Cloud Platform to run the website instead and directed the ethers earned by selling art to pay for the Google cloud platform, hence making it self-sustainable.

VIII. Future Improvements

GAN can be further improved by appending a Stack GAN[9] that will improve the resolution of images produced. In this way, we can generate a higher size and quality images.

Module 5 (Decision-making AI) is an ambitious effort to make the organization completely human free and also self-improving. The AI would take all the decisions regarding the organization that usually, the CEO of the organization does. Thus, once this feature gets implemented, the organization will be a single decentralized entity capable of not only handling itself but also evolving into better versions of itself

without any human intervention. For example, AI can be implemented that can:

- Dynamically change pricing.
- Pit GANs against each other by changing their architecture.
- Do search engine optimization.
- Do AB testing.
- Get better deals for infrastructure.
- Learn trends by web scraping.
- Even improve itself.

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