DArt: Blockchain applied to Cultural Heritage

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Abstract / **DArt** is a *decentralized application* based on **Algorand/Ethereum** for *Culture Heritages.*
DArt proposes to apply **Blockchain Technology** to change the managment of any type of *Cultural Asset* in the real world.
Any useful information and update about *Artwork* can be written in **DArt,** and each user can consult it; constituting an element of *Study, Analysis and Monitoring* for the *Art World.*
Any Artwork is represented by a **Token** and using **Smart Contracs' Technology** is possible to limit token writtability to only *Verified Sources⋆.*
QUESTA PARTE SI POTRA' SCRIVERE MEGLIO PIU' AVANTI NEL PROGETTO

Keywords / Blockchain, Distributed Ledger, Distributed Systems, Ethereum, Cultural Heritage

1. Prior knowledge

This section introduces some useful knowledge and notion to understand the paper and how DArt works. These knowledge are the starting point of DArt project.

1.1. Blockchain

A blockchain is an open and distributed ledger. It's a chain of blocks composing a connected and acyclic graph with only one leaf. Each block can contains many transaction that represents the information in the ledger. The transaction and the blockchain structure are immutable.

1.1.1. Web 3.0

1.2. Bitcoin

The bitcoin is the most diffused application of blockchain technology. Bitcoin is a protocol.

1.2.1. History

1.3. Ethereum

1.4. Algorand

1.5. DApp

2. Context

This chapter describes the context of application of **DArt**, the developed dapp and the subject of this paper, i.e. the world of cultural heritage management and its digitization, in order to better understand the needs and potentials.

2.1. Evolution of management of Cultural Heritage

The **idea** to take care of a *State's Artistic Heritage* (that it's a completely Contemporary Goal) it is often very widespread, but this does not correspond to the *Historical Truth.*

Humanity has manifested interest on *Management of Cultural Heritage* since ancient age, and since the XV century the *Pope* has designated a specific cardinal for the only purpose of *Managing the Registers of Works of Art* belonging to the *Papal State* to **Verify** their **Movements** and **Status.**

Our approach to *Cultural Assets* has totally changed in the last centuries and still today *Academics* and *Art Critics* discuss about it. An **Example:** only in 2019 many academics have raised criticisms about the **overstress** of *Vitruvian Man,* involves by **Transportation** and **Continuous Exhibitions** in different museums and galleries that **Compromise Irreversibly** its **Ink.**

The idea of how an **Artwork** should be made *Available* and *Managed* is constantly evolving and presents **Differences** from culture to culture even today in which we live in a highly globalized world, despite being much closer to an *International Standard.*

The *Collaboration* from different countries and the *Cultural Exchange* have permitted *Management of Cultural Heritage* to involve, fueling the debate, and in many case saving very important *Cultural Heritage* from **Irreversible Damage** or even **Destruction.**

Also the **Restoration Techniques** are continuously evolving, using new *Chemical Products* and observing their *Effects* in the time. **Keeping Track** of which *Compounds* have been *Applied* to a work, *How Long* and in *Which Conditions* it has been preserved, such as humidity, temperature and lighting, are fundamental elements for understanding the *Behavior* of these products and progressing in development of bet-

ter *Restoration Techniques.*

2.2. Third parts controllers[BOZZA]

The most important (legislative) authority in the world of cultural heritage is the UNESCO, an agency of United Nations, which operates all over the world. It's an inter-governmental agency ... Since 2018,due to some political friction, USA and Israel

2.3. Digitization in the World of Art

In the last decade, **Digitization** in the world of culture has become an important subject of study and research, developing fields such as *Digital Museology* and *Digital Literacy* to make *Cultural Heritage* more **Accessible** to anyone.

In addition to giving us the *Ability to Remotely Access Entire Libraries* or the *Ability to Digitally View an Art Gallery,* **Technology** is also revolutionizing the way *Cultural Heritage* is **Archived** by **Digitizing** what were once **Huge Physical Paper Ledger** around the world, subjected to **Errors, Wear and Tear** and **Difficulty in Consulting.**

In particular, in recent years there have been questions about how the **Blockchain** can impact on the *Management* of the *Registers of Cultural Heritage,* so much so that already today it is possible to find several papers on this topic online.

3. Goal

The goal of this project is to build a **public ledger** to **take trace** about the *management* of each *cultural heritage* and **who is the author.** Contrary to many modern projects, **DArt** does **Not** propose itself as a **Digitization of Artistic Material,** but as a **Tool** for **Managing** it in the **Real World.** The goal of DArt is Not to impose a Digital Point of View on Art, but to put **Modern Technologies** at the *Service of Humanistic* and *Artistic Culture* for the **Management of Cultural Heritage** according to what is *Modern Ethics.*

3.1. Actors

The DArt's goal is to be a verified source for any person to analyze and study the management of art in world, looking at museum's practice, The information in the ledger are written only by verified source like museum, art gallery, private collectors and restoration groups. Each person can read these information and look at the source. On the ledger will be possible to analyze information about any artwork in the chain, and also look at any action of the actors.

3.2. Applications and uses

The applications of DArt in the management of cultural heritage can be many, in this section some of them are proposed in order to understand the possible impact of DArt on cultural heritage world.

- **Restoration**: Dart allows you to keep track of all the restoration works carried out over time, allowing you to verify the good work of the managers and in the case of future restorations, to know which chemicals have already been applied on the work, in order to avoid unwanted reactions.
- **Stess**: DArt can be used to track the stress factors to which a work of art has been subjected, thus being able to measure the level and predict or measure the implications.
- **Exhibitions**: Using DArt it will be possible to keep track of where a work has been exhibited, but at the same time know the history of museums and art galleries, thus giving a tool for a critical analysis of them and to measure the overexposure and under-exposure of the artists, for example knowing which galleries host the most exhibitions that give more space to female or non-Western artists.
- **Forgery**: Having a trace of the status over time of a work of art can help make its falsification more and more complicated.

4. Design

In the **Design Part** we have the need to understand *How Design* and *How See* the *Environment* and the *System* for an *Abstract Point of View.*

4.1. Use Cases

The **Use Cases** are one of the most important part of our project, because they explicit which are the *Possible Actions* and *Functions* for our *Users.*

4.1.1. RequestId

Always we need to add *ArtWorks* in the *Blockchain.* This can happen according two different cases:

- **New Artwork** created by an *Artist,* so we need to **Store** it;
- An **Old Artwork** put in *blockchain* only now, but it is an old one. This can happen because before there isn't any other insertion in the *Blockchain* (no **Digitalization** of it).

So we need to check that the Artwork isn't already in the *Blockchain* and then we insert this *Artwork* in it. In this way we compute an **Hash** of the name of the *Artwork* to have a **Global Identifier** of it and it's also important to *Memorize* the correct *Position* of the *Artwork* in that specific moment (*eg.: in Louvre in Room A6 third place*).

We can show you the image of **Diagrams** for this *Use Case,* namely the **Flowcharts** and the **Other Ones** (we will do this only for this *First Use Case,* the other ones you will find in the *Appendix*):
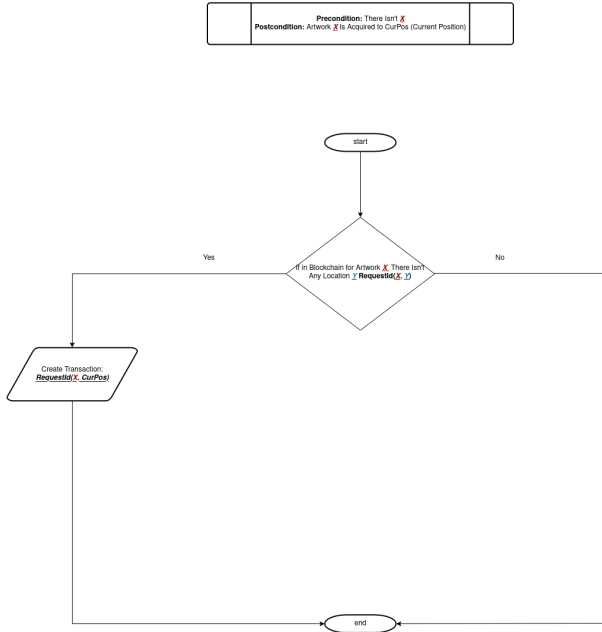
Figure 1: Request Id FlowChart

4.1.2. Restoration

DArt allows you to *Keep Track* of all the **Restoration's Works** carried out over time, allowing you to:

• *Verify* the *Good Work* of the *Managers*;
• In case of *Future Restorations,* to know which *Chemicals* have already been applied on the work, in order to *Avoid Unwanted Reactions.*

4.1.3. Stress

DArt can be used to Track the **Stress Factors** to which an *Artwork* has been subjected, thus being able to measure the *Level and Predict or Measure the Implications.*

4.1.4. Exhibitions

Using **DArt** it will be possible to *Keep Track* of:

• **Where** an *Artwork* has been *Exhibited;*
• *Know* the **History** of *Museums and Art Galleries,* thus giving a **Tool** for a *Critical Analysis* of them and to *Measure* the *Overexposure and Underexposure* of the *Artists*[⋆]

  We can do two Possible Things:

• *Put* the *ArtWork From* the *Warehouse* of a specific *Place δ*[⋆⋆] to the *Exhibition Place of δ*
• Some time we need to *Remove* the *Artwork From the Exhibition Place of δ* and this means that then we leave the *Artwork* in the same *Place δ,* but we put it in the *Warehouse, for e.g.* so *Hidden for Normal Visitors.*

[⋆]*e.g.: Knowing Which Galleries host the most Exhibitions that give more Space to Female or Non-Western Artists, to Understand Where it's better to go.*
[⋆⋆]*e.g.: Museum*

4.1.5. MoveId

We need to **Move** the *Artwork* from one *Place δ* to another *Place δ'* (*Temporarily or Permanently*) and we *Identify* the *Artwork* with the usual *Hash Value* of if, obviously.

4.1.6. Forgery

Having a Trace of the *Status Over Time* of an *Artwork* can help make its **Falsification** more and more *Complicated.*

4.1.7. Property Passage

DA SISTEMARE

It's important to understand that we have two important things to fix: namely we have that an artwork can be in a specific place and it can be of a specific entity: so we have two different concepts, namely the location where an artwork is and the property assigned for that specific artwork. So for example we can have that:

- Monnalisa is of property of the Louvre Museum, instead it is exposed in the Prado's Museum.

Obviously we have an high problem, in fact a thing that we need to fix is that only the who has the property of the artwork can do everything, instead who has in its collection the artwork cannot do everything, because the artwork isn't really of its property. So we need to do some permissions according to who can do the actions and who cannot do them.

For the property's passage we have the follow things:

if the actor[⋆⋆⋆] γ wants to give a certain artwork to another actor γ', then we need to check if γ has really this artwork and we need to pass some rights, that we need to understand, for this specific purpose.

In this case we have a property's passage, so we need to understand for which reason an entity has this need to sell a property, so maybe we have that we can also monitor the money passage for the acquisition of the artwork. We can have that each entity has the need to be authenticated by an external service (like as the Spid for the normal users) and each entity has an amount of tokens to but artworks and so on. Obviously each entity has an amount of "NFTs" to understand which artworks are of a specified entity γ.

ADD: We can have also an idea more clever so that we are the central unit that certify the various artworks of all the γs.

5. Strategy

In the previous section what the issue are that DArt wants to resolve, so in this part of the report it's described the strategy choices to solve this needs, choosing the best technology for this use case.

[⋆⋆⋆]e.g. Museum

5.1. Technology

From the analysis made we can deduce that one of the main needs is to manage a large amount of data, coming from actors scattered all over the world. Cultural assets travel from country to country and can be managed by both private and public entities. This raises the need to establish a close relationship of trust and collaboration between the actors of art world.

The development of a **decentralized application** on blockchain was therefore chosen to meet these needs.

5.1.1. Smartcontract

5.2. Methods

5.3. Example

6. Development

We have explained in the *Appendix* the reasons of **Why** we need a *blockchain,* **Which** *Type of blockchain* is more *Indicated* and **Which Specific Type** of *blockchain* is more Related to our *Purposes.*

6.1. Transactions For Use Cases

We have different types of possible transactions for any possible block, in fact we can have transaction to specify if an artwork was moved, if it is gone in restoration amd so on. So the most important things to see are:

- Restoration: It is a specific use-case and action that we can have for a specific artwork and for it we have that we insert from determined entities if or not a specific artwork is going to do in restoration **or** it's finished, in which date, what it is done, for which reasons, the amount of money needed and so on. So a new transaction of this type we need to have when a new restoration begins or when a restoration ends;
- Damage: We have that when an artwork has a damage (strong or mild) then we need to understand what it's damaged, in which forms, timestamp, what we need so to do, money needed and so on. With it we can suggest a successive restoration, but it is not mandatory. Obviously a restoration can be linked to a certain damage;
- Exhibitions: We have a transaction when an artwork is exposed in a new place (a new city, a new room, a new museum and so on)
- Forgery: We have an inserted transaction in the Blockchain to avoid that we can have fake artworks and to permit this we need some identifiers on the same artworks (for example the representative signs, dimensions of artwork and so on). So, in other words, we have some key informations or we can add the correspective hash value of the artwork hidden in the artwork, for example behind it. In this way only the entities that can can work on the artwork can know the correspective hash Value (or a key value) and these entities are trusted, so we assume that they don't tell this important identifiers to anybody. A more interesting thing that we can add is an adhesive that it has a value to understand the uniqueness of the artwork and this adhesive is putted behind the artwork or under or in a place that hasn't problems for the persons. This adhesive has an unique value not known and it is signed by the director of the museum (or similars) that has the original one (initially the original one has to be certified by professionists, obviously). Obviously this adhesive and the correspective sign can be hidden, it is preferrable, as much as possible;

- Grant Permissions: Obviously it's possible that a certain entity sells a specific artwork or that it wants to grant some permissions also to other specific entities because, for example, a specific artwork goes in exhibition to another museum and so we need to grant to this other entity the permissions to create transactions for the specific loaned artwork. To do this we can implement a functionality in the Smart Contract, called only from the specific original museum, so

- Generation of a New Artwork: When we have a new artwork to insert in the blockchain, we need to be sure that we have the original one (certified like as usual. We have to build and to call the Smart Contract for the Blockchain of the Artworks to insert precisely it.

We have also that we can compute and establish the stress of each artwork according to the restoration made, the damages and so on!

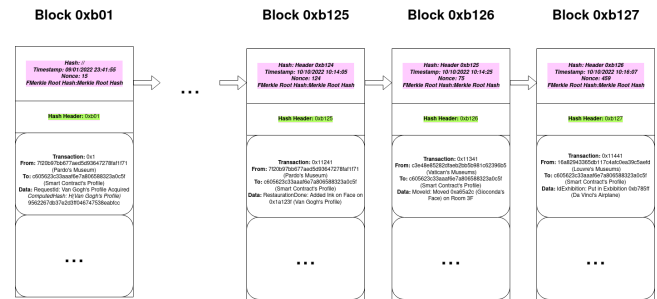### 6.1.1. A Costruttive Example: Blockchain

Figure 2: Costruttive Example

We can see in this costruttive example, that we have:

- An initial block (this is needed because each Blockchain needs to have an initial block) that it is the 0xb01's block
  We have:
  ◦ The Header With:
    · Hash of previous block (in this case nothing, because we have the first block)
    · Timestamp of the miner that has mined this specific block
    · A Nonce
    · Merkle Root Hash that it's an hash of the list of transactions of the current block
  ◦ The Hash Header, that it's the hash of the entire block exactly

- ◦ List of Transactions, for example:
  - · ID of Transaction
  - · The From Address (of 32 bytes), so a museum, private exhibition or so on
  - · The To Address (of 32 bytes), namely the address of the Smart Contract's Profile
  - · Data, namely which operations are done on specific artworks (each artwork has an ID computed by means of hashing the name of the artwork (in the specific example we hash *Van Gogh's Profile* with a certain Hash Function, for example SHA-256)
- • And same story of before for all other blocks with connections, adding the use for our case, in practise

7. Software Architecture

8. CITE

Ciao *Giordano*, so che mi stai **Leggendo**. Non ho *Levato* i **Link** che `Avevi` messo, li ho Solo **Commentati**.

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