Whitepaper V1.0

Transforming the most precious natural and human heritage into digital commons.

Introduction

Manifesto

We live in an era of digital transformations that are both rapid and profound, where blockchain, extended reality (XR), and artificial intelligence (AI) technologies are constantly redefining our relationship with distance, time, knowledge, and society.

In parallel to these technological advancements that propel us into the future, current events regularly remind us of the fragility of humanity's heritage, that precious link to our past, even paradoxically when it is centuries-old. Whether due to various causes, such as the fire at Notre-Dame Cathedral in Paris or the destruction of the temples in Palmyra, entire cultural elements disappear, becoming inaccessible to future generations. Therefore, it is essential to preserve what has been, ensuring the continuity of human culture and civilization.

The Napoleonic expedition to Egypt has provided us with engravings, sketches, and later, photography, laser measurement, photogrammetry, and so on. The creation of archives of the past has followed technological evolution, continuously enriching and refining these traces so that they can be used by others for study. We firmly believe that we are now at a turning point in a new technological leap.

The two previously mentioned examples also illustrate this point. In the case of Notre-Dame Cathedral, renovation work was greatly facilitated by the creation of a digital twin, which aggregated various previous captures. In the case of Palmyra, artificial intelligence was employed to virtually reconstruct the ruins, simulating the trajectories of each fallen block on the ground.

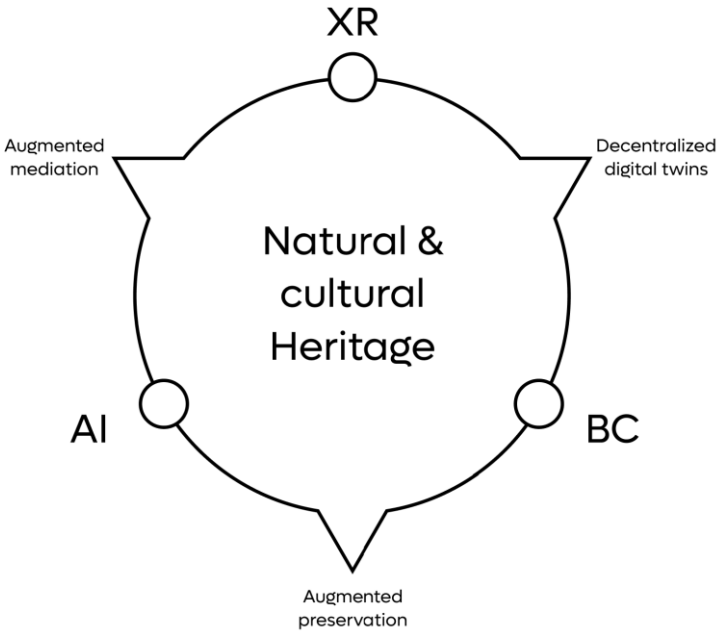
Given the relevance of such use cases and the observation of the fragility of these elements in an increasingly volatile context, it is urgent to archive the most precious aspects of our world. This will ensure that these cultural building blocks remain accessible to future generations worldwide.

Based on this realization, how can we leverage technology to overcome this fate and make this knowledge accessible to everyone today and in the future? What if AI could be used to reconstruct digital twins of what is most valuable to those committed to preservation? Could we create accurate digital replicas of existing, destroyed, or lost historical sites and artworks?

Could blockchain offer a transparent and secure infrastructure to ensure the persistence of digital twins' data, which is crucial for long-term preservation and not reliant on a third-party operated service? Could its decentralized nature enable new forms of public engagement in preservation by establishing digital twins as a common digital good?

Could different forms of extended reality (AR, VR, MR) enable people from all backgrounds to discover and interact with cultural heritage in personalized and immersive ways? Can extended reality be a means to broaden access to culture while reducing its environmental impact associated with transportation and the preservation of physical objects?

By combining these technologies, we have the opportunity to create powerful tools for the sustainable and environmentally friendly preservation and valorization of cultural heritage. The future of heritage is within our reach, and it is more exciting than ever.



The European Union has understood the importance of preservation and, in a 2021 report, urged its member states to create 16 million digital twins of their architectural historical heritage by 2030. However, after 2 years, only thousands of these creations have been made. It is therefore urgent to take action to make this ambition a reality while also considering not only the archival aspect but also the dimensions of economic models and the usage of these twins.

Problems that Lay3rs seeks to solve.

Fragility of heritage and archives

By nature, both natural and human heritage, as well as the archives created from them, are constantly under threat from time, natural disasters including climate change, and the consequences of human activities, be it economic, urbanistic, or conflict-related such as war. It is crucial to find effective and sustainable ways to preserve these precious elements for future generations.

Accessibility and engagement

Over time, the understanding of accessibility in our society has changed. What was once purely a physical concept has now become cognitive and sensory. We must not only provide physically accessible buildings for everyone, regardless of their physical condition, but we can and should also build digital worlds that ensure access to culture (architecture, sculpture, painting, museum visits, etc.) regardless of the country we live in, our economic resources, or our physical condition. While access to cultural and natural heritage may seem like an inalienable human right, in reality, it is a privilege

reserved for a few. Access to this heritage comes with economic, social, and ecological costs that inherently limit its accessibility.

Similarly, the opportunities for individuals to engage in the preservation of this heritage are limited. In this context, it is necessary to empower the public (both existing and new audiences) in their actions of discovery, learning, conservation, and preservation.

Funding heritage preservation

Funding is a major challenge for heritage preservation, regardless of its forms, and the means to secure funds for preservation institutions are often limited. In France, for example, a historical monument can rely only on public assistance, ticket sales, and marginally on sponsorship and events. While this equation may still be relevant for major monuments, what about lesser-known architectural works that are more difficult to access or not suitable for public visits? With such crowd-appealing power, history and nature can create much more value.

Anchoring and authenticity

Historical-style 3D models are flourishing on marketplaces. However, too often, they are merely a fantasy of what a historical or natural subject could have been from the perspective of a 21st-century creator. Much of the subject's richness is lost in this reinterpretation. To move towards increasingly immersive virtual environments, it is essential to anchor them in plausibility by incorporating elements that are ever more meaningful.

Sustainability

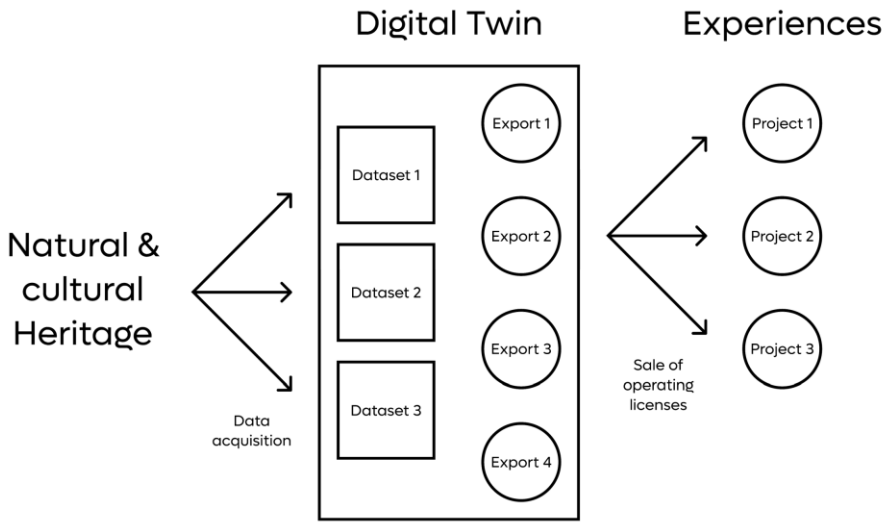
If we consider the risks of disappearing elements or places of our cultural or natural heritage, the question of their archival becomes crucial, whether for their preservation, transmission to future generations, or non-destructive digital exploitation. Blockchain technology, although still imperfect for storing heavy data (IPFS), opens up highly relevant possibilities, thanks to the principles of decentralization and redundancy, allowing this digital heritage to be stored permanently and independent of a public or private organization. Efforts are still needed to address the ecological impact and speed of data access.

The lay3rs solution

To address these various complex issues, Lay3rs assumes that part of the solution lies in empowering stakeholders (preservation institutions, digital creators, and communities) with the organizational and technological means to contribute to common projects. It is through this collaboration that new alignments of respective interests and concrete solutions to preservation, conservation, and mediation problems will emerge.

In this regard, we are convinced that digital twins are particularly relevant digital assets around which the contributions and benefits of these different types of actors can be coordinated. This coordination of actors and the distribution of value recalls the principles developed by Elinor Ostrom in her book "Governing the Commons" published in 1990 and, more broadly, in all her work on the commons.

Let us extend her reflection and acknowledge that cultural and natural heritage belongs to all those who wish to invest in it, and that its digital twin, resulting from the collaboration of stakeholders, can be considered a digital common good.



Lexicon

Digital Twin

What is a Digital Twin

The digital twins created by Lay3rs consist of two types of data:

- Raw data, derived from various types of captures (geolocated point clouds, photogrammetry, videos, acoustic maps, etc.) or archives. These data allow us to aggregate an increasingly large and precise set of data over time about a monument to be preserved. These data are then assembled into an extremely accurate but complex and heavy global 3D model. It is then semantically segmented to isolate all parts of the monument (architectural elements, objects, textures, etc.).
- These subsets are optimized and packaged for specific digital creations and business processes. These ready-to-use models are called exports, and it is these elements that are distributed to creators in the form of exploitation licenses. Over time, they generate value around the digital twin.

Thanks to blockchain technology, the aggregated data will create the largest and richest library of resources on monuments worldwide, serving as a permanent archive beyond the natural or human risks that threaten cultural heritage every day.

What are the uses of a digital twin?

There are numerous applications that benefit from the creation of digital twins. Firstly, this faithful reproduction serves as an ideal tool for scientists and architects in their preservation and maintenance missions for monuments.

The emergence of virtual or augmented tours, as well as services in AR, VR, or MR, rely on digital twins to immerse users in an environment or enable spatial orientation in the absence of GPS signals, for example.

Two major entertainment industries, film, and video games, utilize many 3D resources derived from reality captures to anchor their creations in a meaningful environment. The different exports from the digital twin can be used for visual effects in movies or as real-time 3D assets in video games.

XR

Extended Reality (XR) is a broad term that encompasses Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR).

- Augmented Reality (AR) is a technology that overlays digital information, such as images or data, onto our view of the real world. For example, an AR application could display information about a monument when you look at it through your smartphone screen.
- Virtual Reality (VR) is an immersive experience that places you in a completely digital environment. With a VR headset, you can look around and interact with a virtual world.
- Mixed Reality (MR) is a combination of the previous two. It allows you to interact with virtual objects placed in the real world as if those objects were actually present.

XR technology aims to combine or reflect the physical world with a digital twin capable of interacting with it. The fields of virtual reality and augmented reality are rapidly growing and are applied in a wide range of industries, including entertainment, marketing, real estate, training, and remote work.

Fungible Token

A fungible token is a type of cryptographic token that is interchangeable with other tokens of the same type. This means that each unit of this token type is identical to every other unit. Fungible tokens are often used as currency because their interchangeable nature makes them useful for transactions. Examples of fungible tokens are Bitcoin (BTC) or Ethereum (ETH). Each Bitcoin is identical to every other Bitcoin; they all have the same value and can be freely exchanged with one another.

Non-fungible Token

A non-fungible token (NFT) is a type of cryptographic token that is unique and non-interchangeable with other tokens. Each NFT has information or attributes that make it different from other tokens, which can give it a different value. NFTs are often used to represent ownership of unique digital assets such as digital artwork, digital collectibles, and even virtual land parcels. An example of an NFT is CryptoKitties, where each cat is an NFT with unique attributes.

DAO

A decentralized autonomous organization (DAO) is a form of organization that is managed by rules coded as smart contracts on the blockchain. A DAO is collectively owned and controlled by its members, rather than by a single entity or a small group of individuals. In a DAO, all decisions are made through consensus or voting, with each member having a proportional vote based on their ownership stake in the organization. The governance rules of the DAO are encoded on the blockchain, which means they are transparent and immutable.

DAOs can be used for a wide range of purposes, from managing digital assets to organizing collaborative workgroups. They are designed to be fully transparent, thereby avoiding issues of corruption and conflicts of interest that may arise in traditional organizations.

Project impacts

The Union of Preservation and Creation

Lay3rs pushes the traditional boundaries of heritage preservation and cultural creation by creating bridges between these two domains. Through our innovative approach, we propose a convergence where heritage preservation and the creation of new forms of mediation mutually enrich each other.

Creating Digital Twins

At the core of Lay3rs are the digital twins. We enable the creation of faithful digital representations of the most precious heritage elements, whether they are historical monuments, fictional environments, natural sites, flora, fauna, or traditional craftsmanships. These digital twins capture the essence, beauty, and meaning of our heritage, thus preserving their authenticity for future generations.

Decentralized Investment and Governance

Lay3rs offers everyone the opportunity to actively participate in the preservation of what they hold dear. Through decentralized financing and governance platforms based on blockchain technology, we democratize access to heritage preservation. Holders of our fungible token, LAY, can invest in the creation of digital twins and participate in governance processes, ensuring collective and equitable decision-making. They are rewarded for their contribution, as are the various stakeholders in the value chain, through a redistribution of the proceeds from the sale of export licensing.

Empowering Digital Creation to Renew Cultural Mediation

The digital twins created by Lay3rs are not intended to be static archives. On the contrary, we provide digital assets suitable for different creative industries, such as 3D elements, environments, textures, and much more. Creators, whether they are artists, video game developers, filmmakers, or advertising professionals, can draw from this wealth of resources to breathe life into new captivating experiences, renewing the way we interact with culture, nature, and history through emerging immersive virtual environments.

Sustainability and Responsible Cultural Dissemination

Lay3rs is firmly committed to sustainable and responsible practices, offering an ecological alternative to traditional methods of preservation and cultural dissemination.

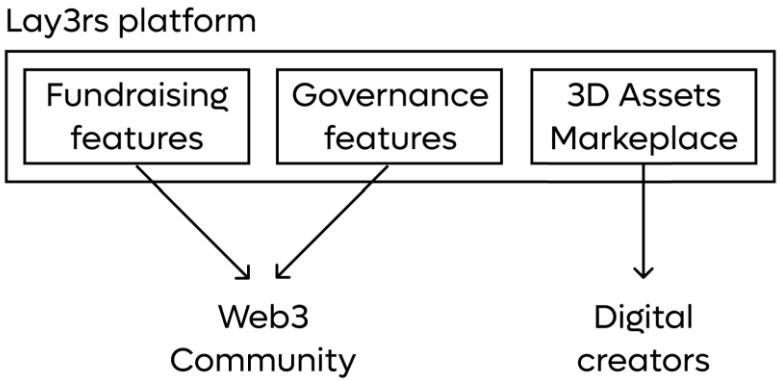
- By creating digital twins for a multitude of uses, we promote an efficient economy of data creation and storage.
- Digital twins eliminate the need to manipulate physical heritage elements, thus reducing the risks of damage and degradation.
- Furthermore, by providing digital assets suitable for different creative domains, we stimulate a wider dissemination of culture without the logistical constraints and carbon footprints associated with physical travel.
- Lastly, by developing AI algorithms, we open up the possibility of continuously aggregating and processing heterogeneous datasets. By incorporating more and more pre-existing data and automating their processing, we consolidate the technical effort to acquire and transform them, drastically reducing their ecological footprint.

Through Lay3rs, culture becomes more accessible and can be appreciated by a broader audience, transcending geographical and economic barriers. By facilitating the creation of immersive and interactive experiences based on digital twins, we encourage the discovery and preservation of our heritage while minimizing environmental impact. Thus, Lay3rs positions itself as a driver of responsible cultural dissemination, contributing to the preservation of our heritage while reducing our collective carbon footprint.

Product description

The Types of Products Offered by LAY3RS

Lay3rs develops, deploys, and enhances various platforms that are based on a project financing mechanism for the creation or development of digital twins using a crowdequity model, decentralized governance of each twin by its contributors, and the dissemination of exports through the sale of smart exploitation licenses.



In addition to these platforms, we envision the creation of a desktop tool for creators. This tool will aggregate the export libraries from different platforms, making them simultaneously accessible to creators in the most integrated way with their workflow and tools.

Platforms

We plan to develop multiple platforms dedicated to specific types of heritage and their user communities. This allows us to continuously expand the use cases of the LAY token, to contribute to the preservation of a growing variety of heritage subjects, and to address the technical specificities associated with the intrinsic characteristics of these subjects.

Build3rs

The most precise digital twins of monuments generated from heterogeneous databases to travel through time.

Support3rs

Dynamic digital twins of the most iconic sports sites and events to perpetuate their legacy.

Fashion3rs

Digital twins of iconic fashion creations or traditional costumes from around the world to dress avatars of all types.

Dream3rs

Fragmented digital twins of fictional environments for generating global thematic environments.

Explor3rs

Locations, minerals, and flora: Digital twins of the most beautiful natural sites and their components to procedurally generate evolving environments.

Fauna: Digital twins of current or extinct animal species to create autonomous digital beings.

Craft3rs

Digital twins of gestures and craftsmanship to create digital beings capable of interacting with and modifying their virtual environment.

Exports

Exports are digital files containing a set of data derived from raw data and optimized for a specific use case. These files can be of various types:

- Complete models: to dress a virtual landscape, develop a geolocated application, or enable 3D printing, for example.
- Individual elements: to create completely new environments using elements from reality, but reassembled for the specific needs of a project.
- Textures: to dress or integrate various creations into a visually immersive environment.
- Custom requests: for specific use cases, each creator has the means to make a request to the Project DAO for the creation of a unique and exclusive export.
- This non-exhaustive list is expected to expand to adapt to future developments in the immersive digital creation market.

Each of these files is linked to a smart contract that acts as an exploitation license, setting all the rules related to its distribution and integration into digital projects. All these rules are established by the Project DAO in accordance with the agreements made with the rights holders of the real subject.

Digital Twins Governance

Human, natural, and cultural heritage can be associated with a common good, and by extension, its digital twin as well. Therefore, it seems relevant to consider a new governance model for this specific type of asset. Decentralized autonomous organization (DAO) models are perfectly suited for this use case. To ensure the proper functioning of the service, allowing real community engagement in projects related to each individual's personal commitments, we have decided to create a multi-stage governance structure.

DAO Master

- Validates the attributes and metadata of raw data and 3D exports.
- Votes on the creation of new projects (smart contracts).
- Can activate specific emergency functions within project smart contracts.
- Sets the quorum for decision-making.

DAO Project

- Can update certain attributes of Dataset and Export smart contracts (e.g., Rarity level).
- Sets the conditions for using exports.
- Sets the price of exports based on file size.
- Defines data acquisitions and future export creations.
- Creates new funding calls for data acquisition or export creation projects.

- Determines the distribution keys for value allocation between subsequent project stages and the redistribution to different contributors and rights holders in the value creation chain.

Each contributor has a weighted power based on their investment in LAY within the project for DAO Project governance, and an aggregation of their various powers over DAO Projects within DAO Master. Each decision is subject to voting, and every contributor can submit a vote to the community.

Technology and Infrastructure

Blockchain choices

As for the choice of blockchain technology, we have decided to choose the Polygon network for the following reasons:

- **Scalability:** Polygon is a scaling solution for Ethereum that reduces transaction fees and confirmation times. It offers increased processing capacity, allowing a greater number of transactions per second to be processed.
- **Reduced transaction fees:** By using Polygon, transaction fees are significantly reduced compared to the Ethereum mainnet. This makes transactions more cost-effective for users, which is particularly advantageous for decentralized applications (dApps) that require numerous transactions.
- **Faster confirmation times:** Blocks on Polygon are generated faster than on Ethereum, resulting in faster transaction confirmation times. This improves the user experience by reducing waiting times.
- **Compatibility with Ethereum smart contracts:** Polygon is compatible with existing Ethereum smart contracts. Solidity, one of the most standardized and widely used programming languages by developer communities, can be utilized.
- **Interoperability:** Polygon offers interoperability with other blockchains and networks. It allows users to transfer assets and data seamlessly between different blockchains, opening up possibilities for collaboration and exchange between different platforms.
- **Ecosystem and adoption:** Polygon has a growing ecosystem with numerous projects, dApps, and users adopting the technology. This provides developers with a wide range of tools, libraries, and resources to build and deploy applications on Polygon.
- **Security:** Polygon benefits from the security of the Ethereum blockchain, which is one of the most secure and proven blockchains. Users can enjoy robust security while taking advantage of the scaling benefits offered by Polygon.
- **Developer-friendly:** Polygon provides development tools and frameworks that facilitate the creation of decentralized applications. It offers comprehensive documentation, libraries, and code examples that allow developers to quickly get started.
- **Portability:** Applications and smart contracts deployed on Polygon can be easily moved to other Layer 2 solutions or the Ethereum mainnet if needed. This offers flexibility and portability for developers and users.
- **Decentralized governance:** Polygon is decentralized and offers community governance mechanisms. Users and token holders can participate in decisions regarding the platform's evolution and governance.

Twin technological choices

The production of 3D models currently relies on photographic and/or laser capture and the use of 3D graphics software. Although advanced technological devices and software are used, the methods remain relatively artisanal, and the workflow is not highly automated.

- For photogrammetry workflows, the capture process requires expertise in image overlap, multiple angles of view, lighting, focal length, exposure time, and more. This is because 3D reconstruction software such as Reality Capture and Metashape demand precision in these aspects for successful reconstruction.
- Drone image capture is regulated, requiring pilots to obtain accreditations and undergo specific training. Drone operators are experts in piloting drones for capturing images of monuments to perform photogrammetry.
- Laser scanning capture is less demanding than traditional photography, but it requires expertise in cleaning and assembling point clouds.

Graphics software is primarily designed for use by 3D artists, and although it is possible to develop code to automate tasks, this is rarely done outside of major entertainment companies that have the resources to augment their 3D artists teams with technical artists capable of developing code to automate the software pipeline. It should be noted that finding training programs to enhance technical artists' coding skills on these software platforms is also challenging.

- Modeling software like ZBrush has gained popularity by allowing artists to utilize traditional techniques in a digital environment. However, tasks still rely on manual work, and the complexity of the software necessitates specialization to achieve quick results.
- Asset production management tools like Shotgrid are primarily designed for collaborative work and rapid validation, rather than industrial-scale interaction with large databases of 3D models hosted on cloud services.

The current ecosystem is mainly composed of small companies that handle the capture process and provide 3D models as services, or larger players that can internalize the entire workflow. To our knowledge, demand solely for the capture process is atypical. However, such a service offers greater freedom and better control over the quality of the 3D models. Methods and tools for quality control of the 3D models provided by these service providers are a recurring topic of consideration for studios.

The fragmentation of the 3D model production workflow, along with the resulting specialization of roles, leads to complexity and significant costs. To simplify the workflow and significantly reduce production costs, we believe in utilizing AI-based tools. The objective is not to replace 3D artists but rather to provide them with new tools that enable them to reduce the time spent on repetitive and/or low-value tasks, allowing them to focus more on tasks where human intelligence is uniquely valuable.

To illustrate this, here's a concrete example that applies machine learning tools to a real issue in computer graphics. When reconstructing a large-scale scene (e.g., a 1000 m^2 monument), photogrammetry software only yields usable results when provided with tens of thousands of photos. They are much less effective for reconstructing individual 3D assets. Furthermore, aligning georeferenced laser point clouds with the photogrammetric point cloud must be done on the complete scene. The workflow of reconstructing individual 3D assets and then assembling them is counterproductive. However, studio organization relies on task separation because a complete scene is typically not usable with standard computation ressources, and 3D artists work on unique 3D assets. Therefore, we need to provide the studio with both the 3D assets and the elements required to easily reassemble them into a scene. Thus, starting from the complete scene, a Lay3rs 3D artist must segment the 3D scene into individual 3D assets, which significantly increases production time. To reduce this time, we have begun developing AI-based tools that can automatically detect and segment the relevant 3D assets within the complete scene.

This example fits into the current workflow of 3D artists by providing assistance in a specific area. However, we have a much more ambitious vision. Our goal is to provide a universal solution to a 3D artist, as well as an entire team of artists, encompassing multiple machine learning and deep learning tools that enable them to achieve things currently unimaginable with available solutions.

To succeed, we rely on a set of optimization methods in Visual Computing called Neural Field. "Field" refers to the physical concept of a field in which a quantity is known at every point in space and/or time. A Neural Field is a field that is fully or partially parameterized by a neural network (coordinated-based neural network). The recent successes achieved by neural networks have renewed interest in their applications to visual computing problems, as they provide more precise, faithful, expressive, and efficient solutions for 2D images, 3D models, scene visualizations, and characters.

One of the great strengths of deep learning-based approaches compared to previous solutions lies in memory usage. Traditional 3D sampling-based solutions encounter a memory wall. While it is possible to produce individual 3D assets with sufficient resolution using these methods, reconstructing a large-scale 3D scene, such as monuments in our case, becomes prohibitively memory-intensive. In other words, the major problem with 3D sampling is the scalability of memory when the required resolution increases. In contrast, neural fields are inherently continuous and adaptive. Thus, the memory required for neural fields scales with the number of parameters in the neural network, rather than the dimension of the scene. This allows us to address the memory problem by utilizing parameters only where details are necessary.

Furthermore, by combining a neural field and a generative model within an architecture, it is possible to leverage the advancements of generative models for generating 2D images, 3D objects, the shape and appearance of 3D objects, and even multimodal visual and acoustic representations.

The applications of Neural Fields to 3D reconstruction and rendering are collectively referred to as NeRF (Neural Radiance Fields). In this specific case, the radiance field is encoded within the neural network. Radiance provides information on how light emitted from a surface is perceived by the eye, indicating whether an object in a scene appears bright or not. Based on sparsely captured spatial coordinates and viewing angles, the neural network learns to generate, in a continuous manner, the optical density encountered by a ray of light traversing the scene and the radiance seen at each point of the scene. In other words, it can generate any viewpoint within the scene.

In a nutshell, NeRF encodes 3D scenes with a neural network mapping 3D point locations to color and volume density. This allows the scenes to be represented with a compact memory footprint without limiting the resolution of synthesized images.

NeRF has been actively studied for the past three years by researchers in both public and private laboratories because it allows for the automated resolution of several known problems in computer vision and computer graphics. Building upon the abundant literature, numerous available codes, and our initial work at Lay3rs, we will focus on the following projects until the end of 2025.

NeRF

Objective: Develop a universal solution tailored to the needs of 3D Artists.

Challenges: The research effort has led to significant progress in terms of rendering quality, the ability to create large-scale scenes, and the acceleration of training and inference times. However, each algorithm is specialized for a particular task, which has two main consequences:

- A model that has been optimized to reduce inference time for real-time use experiences a significant degradation in rendering quality. Conversely, a model optimized for producing 4K visualizations requires training and inference times that are 1000 times longer.
- There is no universal solution that can simultaneously achieve high-quality rendering, extract lighting information, and insert 3D objects into the scene, among other tasks. A 3D Artist needs access to these different characteristics in order to modify them.

Preferred solution: Many models have been developed over the past three years, with numerous open-source codes available. The task at hand is to identify relevant codes, understand the tasks for which they were optimized, and adapt them to combine multiple tasks effectively.

NeRF Editing

Objective: Provide a NeRF-based solution that allows access to all relevant properties for a 3D Artist.

Challenge: The success of NeRFs primarily stems from their ability to synthesize new photorealistic views. However, to integrate seamlessly into a studio's real-world workflow, it is essential to extract and modify properties of a 3D scene, including geometry extraction, adding or removing lighting, adding or removing objects, and generating a mesh. The original NeRF architecture was too rigid, making these pieces of information inaccessible.

Preferred solution: A NeRF produces an initial representation of the scene, which can then be used to incorporate a mesh for modeling specific features of interest. For example, to obtain a high-quality mesh, the representation is directly baked into the mesh. Similarly, to modify lighting, a mesh reconstructed from the NeRF is used to model secondary beams that produce lighting effects such as shadows or specular reflections.

Inputs preprocessing

Objective: Reduce the number of images and camera poses required for training a NeRF.

Problem 1: Photogrammetry requires a minimum overlap of 60% between two images to function properly. As a result, a significant quantity of images is needed, ranging from a few hundred for an object to tens of thousands for a building. The capture time is consequently long, leading to substantial costs and, less obviously, difficulties in capturing public-accessible monuments under optimal conditions. Heritage institutions cannot immobilize a monument, especially if it is highly visited, and being able to minimize the capture time greatly facilitates the feasibility of a capture project. For these two primary reasons, there is a strong interest in reducing the number of images required for NeRF reconstruction.

Preferred solution 1: Generate new views from a small number of images using generative models such as GANs (Generative Adversarial Networks) or Diffusion. The basic idea is to synthesize and refine a set of virtual views based on one or a few available images.

Problem 2: A current limitation of NeRFs is the need to provide camera poses as input to learn the NeRF how to represent the scene. Obtaining these camera poses after the capture stage typically requires conventional techniques using software such as Reality Capture or Metashape. This step is time-consuming and can introduce errors. Furthermore, if multiple sensors have been used for the capture (e.g., public-contributed photos), the camera pose data can be erroneous or incomplete.

Preferred solution 2: This problem is a classic challenge in computer vision and has been extensively studied over the past 30 years through the class of algorithms known as SLAM (Simultaneous Localization and Mapping), which simultaneously determine the sensor's position and reconstruct the

captured environment. Adjustment techniques derived from this research can be employed in the NeRF context, allowing the model to learn both the scene representation and camera poses.

Generative Modeling of 3D

Objective: Generate elements of the scene that were not captured.

Problem 1: NeRFs can interpolate between captured views in a scene, but they cannot extrapolate to infer parts that were not captured. During a capture process, even with meticulous effort, it is not possible to capture every part of the scene without occlusions, as the required time quickly becomes prohibitive. At best, this reduces the rendering quality, and at worst, it creates gaps in the scene. In such cases, a specialized 3D Artist (sculptor/modeler) must intervene to create the missing parts, which is extremely time-consuming and costly.

Problem 2: NeRFs need to be optimized for a specific scene. A fundamental limitation of NeRFs is that they cannot represent multiple scenes within a single model. Therefore, in the case of monuments that contain multiple separate rooms with openings and require to follow a trajectory, it is currently not possible to represent all the rooms using a single model.

Preferred solution: It is possible to create an architecture where NeRFs and a generative model are linked to aid in the generation and fine-tuning of 3D views. The generation of new virtual images can directly contribute to the process to improve areas where data are missing. It is worth noting that prior to the advent of NeRFs, the resolution and quality of 3D renderings obtained using generative models were inferior to those achieved in 2D. This was due to the limitations of previous architectures used for 3D generation and rendering. Both types of models are thus naturally linked in order to obtain most accurate results.

Dynamic Scene

Objective: Add dynamic 3D objects to a static 3D scene.

Problem: By design, NeRFs are only applicable to static scenes. This poses a major problem when it comes to integrating moving objects into the scene or deforming elements of the scene. Resolving this problem is particularly important for the cultural and creative industries, which have produced a vast amount of images (films, series, sports events, concerts, etc.) that could be used to reconstruct immersive 3D experiences using NeRF and generative models. For example, it is conceivable to be immersed in a series from a chosen point of view rather than the camera's. However, to achieve this, it is necessary to be able to reconstruct and track humans and moving objects in 3D.

To understand the complexity associated with introducing the temporal dimension, let's provide two examples:

- The spatio-temporal signal is more sparse than the spatial signal. While it is possible to generate additional views for a static scene (as discussed in inputs preprocessing), it is more complex for a dynamic scene, and therefore, less input data are available.
- The dynamic content in a video typically changes significantly from one frame to another, while the background changes little. An inappropriate temporal frequency will result in poor interpolation along this dimension.

Preferred solution: To successfully add the temporal dimension, it is necessary to code at least one additional field to the NeRF, which learns the dynamics of the scene and can predict the future positions of each point in the scene. It is evident that from a computational power standpoint, adding the temporal dimension is demanding, as it requires at least doubling the computational requirements.

Organizational Approach

To ensure a true decentralization of the model and decision-making processes that lead to the creation of a large, rich, and sustainable library of twins, this project operates through three entities:

Lay3rs: A French Simplified Joint Stock Company

- Issues LAY tokens
- Deploys thematic platforms
- Develops new services for contributors and creators

DAOsting: A French nonprofit association

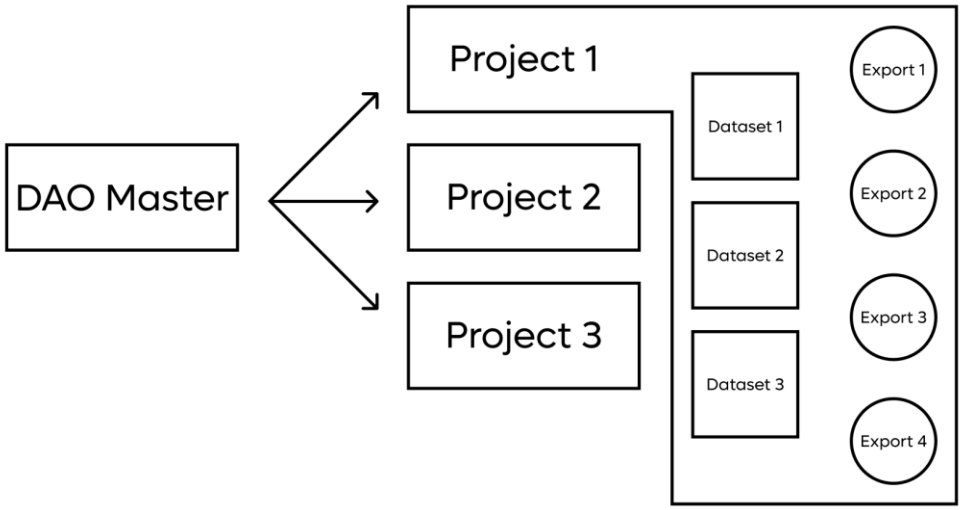
- Organizes all DAO Masters and Projects
- Bridges the gap between DAOs and the real economy
- Mints smart contracts for Projects, Datasets, and Exports

Zigg-E: A French Simplified Joint Stock Company

- Aggregates twin data
- Creates exports
- Verifies the quality of acquired data
- Develops twin processing AI tools and universal solution

The decision to host these entities under French law stems from the belief that the French legislative framework, despite its constraints, is capable of fostering fair market regulation and widespread adoption of cryptocurrencies without causing harm to the real economy. The French government's reiterated political will in this direction has been proactive in anticipating European regulations.

Smartcontracts organization



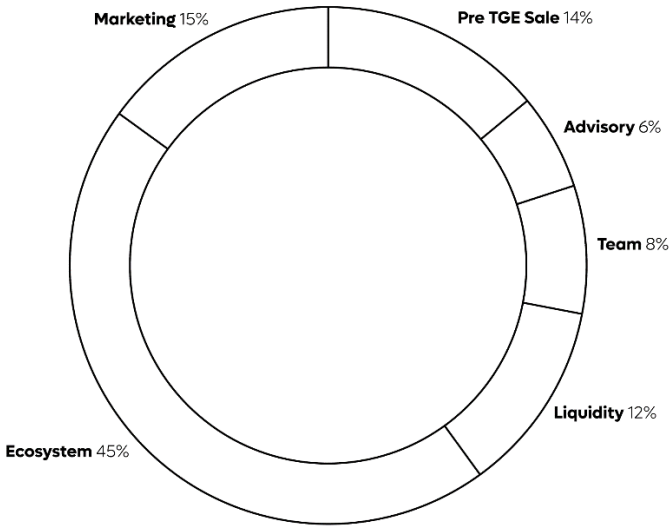
Token LAY (ERC-20)

We intend to deploy a fungible token with the following characteristics:

- Total supply: 1,000,000,000 tokens
- Decimals: 18
- Name: Lay3rs
- Symbol: LAY
- Burnable, Non-Mintable

This token has a utility purpose as it will serve as an investment token within the DAOs to fund point capture for producing 3D assets. It is also a means of purchasing exports, enabling automated royalty payments to rights holders. When this token is invested in a project, it will also serve as a governance token to weigh votes within a decentralized community of contributors.

Token allocation



NFT Dataset (ERC-721)

Each dataset contains a certain amount of data related to a digital twin and can be uniquely identified through a non-fungible token.

That's why we have repurposed the ERC-721 standard and customized it to adapt to our use case.

Indeed, different levels of rarity will qualify each dataset and have an impact on the share of royalties that will be distributed to the rights holders, namely the data providers.

The file size, measured in kilobytes, will also be tracked for each dataset, along with the governance smart contract of the project, which will be detailed further below.

Thus, each mint of an NFT will associate a structure of objects defining a dataset in a unique way, to which we link a URI that is hosted via IPFS to define additional metadata.

Multi-token Export (ERC-1155)

The purchase of an exploitation license for a 3D export will be digitized using the ERC-1155 standard, which defines the multi-token functionality.

In practice, it involves a NFT that can be minted multiple times for one or multiple addresses representing buyers. It also allows for bulk purchases of exploitation licenses for different export IDs within a single transaction, which streamlines usage and reduces gas fees.

Each exploitation license for an export is uniquely identified by an ID, which is associated with the following data:

- The owner of the export
- The smart contract of the project it depends on
- The file size in kilobytes
- The list of different NFT dataset IDs that were used to create this export, along with their weighted contributions to quantify their shares within the file.

The purchase price of the license linked to the export is calculated by multiplying the corresponding file's kilobyte quantity by the price per kilobyte in LAY (information defined and updatable within the smart contract of the project it depends on).

It is important to note that an export can be composed of multiple files, which will require the existence of distinct NFT Exports with different identifiers to offer a higher level of granularity for buyers who only wish to pay for the formats they need.

The purchase of the exploitation license is represented by minting a new NFT Export, and the royalties are automatically distributed to the wallets of the following types of actors:

- The owner of the NFT, representing the wallet of the associated Lay3rs Association.
- The smart contract of the project related to the purchased NFT Export, allowing contributors to claim their share.
- The data providers of the different datasets used to create the export.

Smartcontract Project

The smart contract related to a project defines a specific DAO operation for a community of contributors who wish to pool their resources together to finance the creation of 3D exports collectively.

After each sale of an export funded by this smart contract:

- A portion of the royalties from the sale is retained within the contract to finance future exports.
- Another portion is distributed to the different shareholders of this smart contract proportionally to their investment in LAY tokens within the organization.

When a contributor to one of these smart contracts is eligible to "claim" royalties following the sale of an exploitation license for an NFT export, they have two options:

- They can claim the amount in LAY corresponding to that sale.
- They can reinvest these LAY tokens in the smart contract to increase their investment share and voting power.

It is also important to note that each LAY token invested in a smart contract Projet grants voting rights within that contract, as well as within the defined DAO Master smart contract described below.

Smart Contract DAO Master

The DAO Master smart contract governs the common organizational rules for all smart contracts related to the Lay3rs project.

Each token invested within one of the project smart contracts grants voting rights within that specific contract. Similarly, each token withdrawal within a project contract decreases the "voting power" within the DAO Master smart contract by the same amount.

Business model

The ReFi Model

ReFi, or Regenerative Finance, is a concept that relies on blockchain technology to create decentralized financial systems designed for their positive externalities, whether financial or non-financial. It aims to democratize access to financial services, make the financial system more transparent and equitable, and also provides opportunities to fund preservation initiatives. It leverages the possibilities offered by blockchain technology to apply them to use cases that have an impact beyond their own model and community.

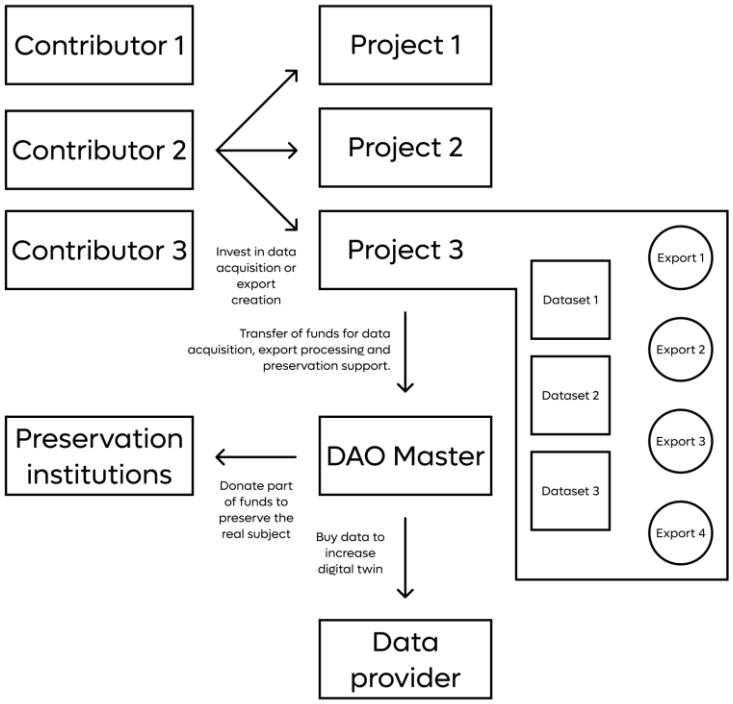
The emergence of ReFi highlights the fact that current financial systems operate in an extractive and exploitative manner, which does not allow for equal accessibility and distribution to the various stakeholders who contribute value to the project, and we strongly disagree with this observation.

The Lay3rs project fully aligns with the ReFi ideology for the following reasons:

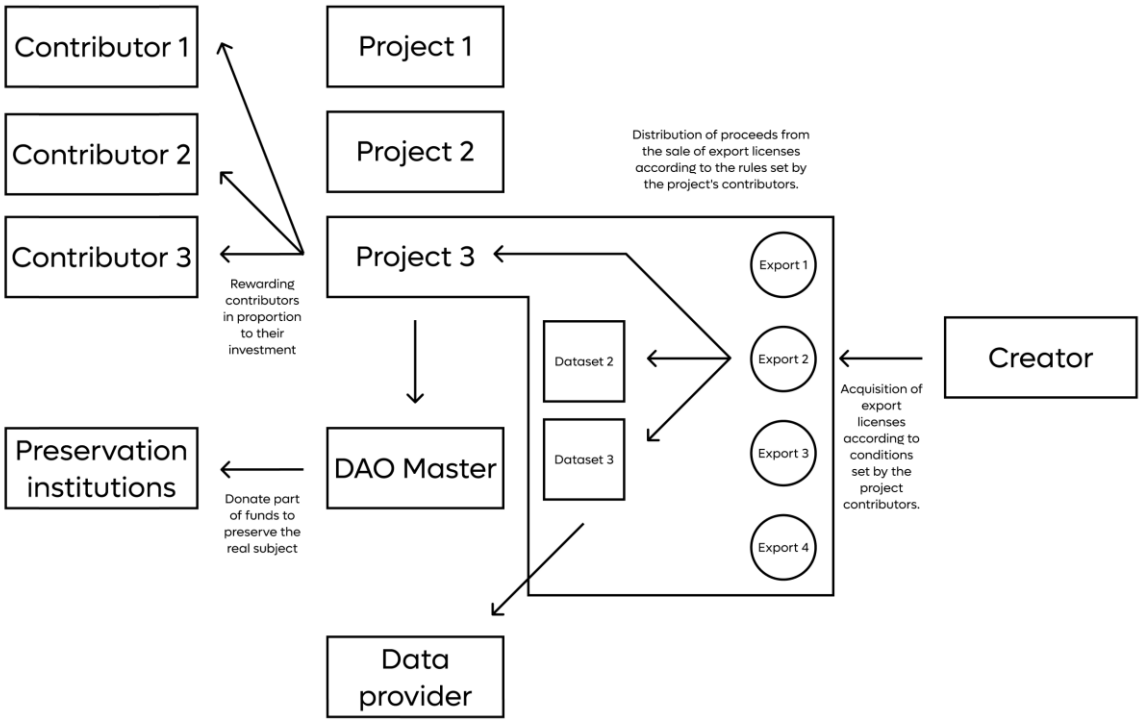
- Providing an additional source of income to institutions responsible for the preservation and promotion of cultural heritage in all its forms. These foundations will be able to benefit from royalties generated from the sales of exploitation licenses related to NFT Exports, enabling them to have a larger budget for renovation or the creation of new mediation initiatives.
- Improved transparency and fair distribution of value to creators of 3D exports and datasets, through the automated payment of royalties after each sale.
- Offering a virtuous investment product with inclusive dimensions to different types of savers. Each holder of LAY will be able to participate in projects without the need for a significant capital requirement.

A 2-phase business model

Investment phase



Run phase



Roadmap

	R&D	Product
2023	Q3 2021: Initial partnership with CEA List	
2024		**Build3rs Launching**
		DAO Launching & LAY Token Generation Event
		Assets Marketplace features
	NeRF-based 3D Reconstruction	**Data Providing Features**
		Support3rs Public Launching
	NeRF Editing Tools for 3D Artists	
2025		**Fashion3rs Public Launching**
	Generative modelling of 3D	**Digital twins library Desktop tool**
	Human Reconstruction and Tracking in 3D	**Dream3rs Public Launching**
	NeRF universal solution for 3D Artists	**Explor3rs Public Launching**
2026	**NeRF for Multi & Hyper Spectral**	**Craft3rs Public Launching**

Team & partners

Core Team

- **Sébastien Malcotti** CEO
- **Xavier Aubert** CTO AI
- **Benjamin Jornet** CTO Web3
- **Yann Toullec** CSO
- **Sebastien Casaert** Head of Product
- **Ugo Sohier** Lead Technical Artist
- **Anabelle Sellame** Business développement
- **Mathieu Da Silva** Communication

Advisory Team

- **Lou Yu** Web3 Strategy Advisor
- **François-Xavier Petit** Public Partnership Advisor
- **Emmanuel Ea** Development Advisor
- **Adrien Basdevant** Web3 Legal Advisor
- **Clara Benyamin** IP Legal Advisor

Partners

CEA List: Since 2021, we have been collaborating with the Ambient Intelligence and Intelligent Systems department of CEA (French Alternative Energies and Atomic Energy Commission), which is the main applied research center in France. We work daily with different laboratories to provide LAY3RS with access to a range of expertise that is both specific and rare. This already fruitful partnership will continue to develop in the coming years, enabling LAY3RS to achieve its most ambitious and innovative technological goals.

Univers: Since we realized the potential of Web3 for our project in early 2022, Univers has been working with Lay3rs on the development of services that effectively address the specific challenges of Web3 and new creative environments (VR, AR, Metaverse, etc.). As a hub between different metaverses, Univers has incubated the project, placing interoperability and decentralization at the core of its approach and services.

Centre des Monuments Nationaux (CMN): The Centre des Monuments Nationaux (CMN) is a French institution that manages over 100 monuments throughout the country. These monuments include historical sites, castles, gardens, arches, and towers. The CMN organizes various events and activities to promote these monuments and raise public awareness of their significance. The CMN is also active in the field of innovation and actively supports Lay3rs by providing access to monuments for experimentation and aims to initiate work on opening the management of digital twins through a DAO model.

Matrice: Matrice is a French institute for technological and social innovation founded in 2016. It operates entrepreneurship and digital training programs, startup incubation programs, as well as research and technology transfer programs. Matrice distinguishes itself by bringing together students, entrepreneurs, researchers, and artists within a single community, transcending disciplinary boundaries. In addition to its teaching and incubation activities, Matrice is also a research center and a place for artistic creation. Matrice was the first partner to believe in the project by supporting the company's structuring and securing initial funding.

Caisse des Dépôts et Consignations: The Caisse des Dépôts et Consignations (CDC) is a French public financial institution established in 1816. Its main mission is to safeguard the savings of French citizens. However, over time, its functions have diversified to include areas such as housing, insurance, transportation, and pensions. With 22 subsidiaries and a total balance sheet of 1.2 trillion euros, the CDC is now the world's largest public financial group. It constantly works in the public interest with the ambition to "contribute to the growth of France." It is currently Lay3rs' primary financial partner.

Ministry of Culture (France): As the organizer of the "France 2030" call for projects on the theme of "digitization of architecture and heritage," the French Ministry of Culture has supported the project, which was awarded laureate status in recognition of its relevance to the addressed issue and the means put in place to address it.

Awards and distinctions

- Winner of France 2030 on the theme of "digitalization of heritage and architecture," which identifies and funds the most promising startups to address priority issues for innovation in France.
- Ongoing Deep Tech labelization by BPI France.
- Ongoing Young Innovative Company (JEI) labelization.