ARTIFICIAL INTELLIGENCE AND DIGITAL REPRODUCTION IN ART

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1. Introduction

In recent years, AI (artificial intelligence), seen as a set of different technologies employed in the most diverse fields in emulating human intelligence, undoubtedly represents an extension of human capabilities, but nevertheless cannot substitute it [1]. Its application can be found not only in the management of civil and social life and economic and political organization [2-3], but also in art and culture [4].

Indeed, as far as AI is concerned, in an area considered unique to human nature, i.e. creativity, today AI is used in art, a situation which generates both enthusiasm and perplexity. It is now seen as stimulating creativity, after being considered as having no value in evaluating that faculty of which human beings are so proud, namely creativity, in particular, artistic creativity.

Hence the question: "Compared to digital ecosystems that integrate enabling technologies, such as the IoT (Internet of Things), big data, the m etaverse and artificial intelligence, are personal initiative, pluralism and solidarity still decisive factors and, can they, nevertheless, contribute to determining a result and/or a choice in the final decision-making?". This is a challenge that involves very different levels: both cultural and scientific, as well as economic and political. The heart of the problem, then, is to prove that highly digitalized models are compatible and that they indeed, make an additional contribution to arriving at the truth. It is also true that such widespread intelligence can only grow in organizations (universities, companies, public administrations, schools, hospitals, the media) that do not limit their employees to being mere executors of protocols and procedures but, on the contrary, value the creativity, responsibility, and autonomy of judgement they express in their work.

2. The application of AI in art and culture

The fields of application of AI in art and culture can be found in the production of works of art and cultural events and the critical-aesthetic evaluation of artistic products.

In truth, when talking about artworks, whether they are produced using AI or

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executed by an artist, the fundamental problem that arises revolves around the concept of creativity [5] and brings us to the question posed in the introduction: the attribution and authentication of the work of art based on an assessment – a point that will be focused on later – which must not only be critical-aesthetic and therefore subjective, but also objective, i.e. evaluated through the use of diagnostic-analytical technologies.

Hence, the next question: "Within this subjective and objective assessment, where does the intervention of AI stand and how can it be considered valid and reliable, in its correctness and completeness?".

In this respect, one cannot fail to underline that with the advent of AI, another aspect arises concerning the authorial identity of the work of art and the heated debate it generates, which is not only of a historical-technical nature, but also legal.

Before dealing with this topic more in detail, and to provide a framework, albeit a limited one, some applications of AI are given.

a.   In the creative and cultural industries it is used, in particular, in scriptwriting, film presentation and in the interactive film industry, as well as in the extensive sector of video games.

b.   In music algorithms are used in the most diverse musical genres, from choral arrangements to real-time soundtracks. The involvement of digital companies, as well as major digital players, has resulted in the successful production and enjoyment of culture through the use of intelligent agents.

c.   In libraries and archives, with AI, the development of an open access system enables the digitization of documents with respect to the traditional criteria of cataloguing and usage, and systems are already in place that independently propose new reading paths for both book and art collections. Different projects have also been developed with the intention of breaking away from the extensive consultation of documents by allowing them, on the basis of pre-established models, not only to be read, but by providing links and connections to aid further examination of a chosen topic.

d.   In exhibitions and displays, a particularly developed field of applications of AI, the themes addressed in many important national and international museum venues aim to make it easier for the public to approach and be directly involved in the work of art itself. And this objective is not only directed towards accompanying, describing and/or simulating the works of art for the visitor during the museum tour, it also presents some particularly topical themes, such as the relationship between man and machine or between different cultures and/or identities, the impact of new technologies, and AI itself, on life. In addition, during their emotive and emotional involvement, digital devices are used to qualify and quantify the intensity of the spectators' sensations during the museum tour in their silent conversation with the work of art.

e.   With the impact of AI in art, the accumulation of digitalized cultural data has enabled the introduction of intelligent agent-guided learning and classification systems.

Some results are mentioned below.

One such example is a video installation in which AI manages the integrated spectacularizing of a stream of numerical, textual, visual and sound data that envelops the viewer in an immersive environment. Another methodology that has been developed is based on the fictional world of cinema. An example of this is *A woman with the technology* by Ziyang Wu which involves in the creative process the very life of the artist whose work is to be produced: in particular, her recorded everyday activities which become a video that an AI agent transforms into a product.

And more inherent to the art sector, with great media impact, was the auction sale at Christies in 2018 for $432,500 of a painting produced by AI entitled *Portrait of Edmond Belamy* (Figure 1). Its aim was to connect the artwork to the tradition of great portraiture by imitating the painting of past centuries. To achieve this, specific algorithms were used for which more than 15,000 portraits from the Renaissance and modern periods were examined.

Figure 1. Portrait of Edmond Belamy

3. AI generated art and digitally reproduced art

With the emergence of AI as a means of producing works of art, it has become necessary to question how the canons, rules and the very idea of artistic beauty emanating from a work of art produced by a designer of generative AI algorithms compares with a work of art executed by a human.

It must therefore be asked:

a. whether it is appropriate, in view of human creativity and, therefore, products made by artists, to give rise to a new creativity for which automation and, therefore, products made by AI are considered.
b. whether the viewer, in contemplating the work of art produced by AI, and possibly

experiencing a non-positive influence or reducing the level of their enjoyment of that work of art, is inclined to approach it in the same way as a work of art produced by a human hand, thereby opening up to new perspectives of visual forms and the corresponding content.

This brings us to the concept mentioned above and will be discussed in more detail later, a concept related to the topic of art work attribution and valuation, that is, art executed by an artist, which has been the subject of heated debate for years. This topic in turn also raises, in the context of the different degrees of certainty in attribution, the problem of its digital reproduction, giving rise, as with an AI-generated work of art, to a legal debate on copyright.

4. Attribution of a work of art

To start with, it should be said that the attribution of a work of art is a fairly complex operation, in which it is very easy to be misled. It is therefore essential that an in-depth study of the work in question is carefully carried out.

The difficulty arises from the fact that, from the term original to the term fake, in between there are a number of intermediate categories such as copies and replicas. Replicas, despite having been executed by the same hand, have small differences that are sometimes difficult to recognize. Such works must therefore be studied expertly and meticulously: a careful and experienced eye cannot miss the discriminating element of quality. Copies, on the other hand, are easier to detect for an expert eye. In the past, however, in several cases, original works and replicas have been considered copies: this often happened because of the poor state of conservation (repainting, dirt, yellowed paint) of these works, a factor which contributed to their incorrect identification.

Often, in order to distinguish a replica or a copy from the original, it is necessary to use diagnostic-analytical technologies, for example, to detect any *pentimenti*: in this regard, without generalizing, it can be stated that if a painting has no *pentimenti*, it generally means that it is not an original [6-7].

In the art market, the buying and selling of forgeries, fakes and counterfeits is widespread and the corresponding economic returns are significant: according to experts, a very large percentage of art works on the market are, in reality, fakes.

Moreover, in the past, forgery and restoration often amounted to the same thing: restoration work carried out by forgers was either aimed at completely replacing the original or altering the entire work to such an extent that it was no longer possible to distinguish the coeval from the non-coeval [8].

The increasing number of forgeries and the problem of attribution therefore represents a major problem in the art market. Indeed, many misattributions are made without the intent to deceive, and are very often made to the detriment of the buyer and/or seller. These are just a few aspects that further emphasize the importance of a certain degree of scientificity in the valuation of art market sales.

Fakes and forgeries abound in libraries, archives, museums and private collections. From ancient Greece to the present-day, the debate on forgeries constitutes a fascinating (and, in some cases, painful) chapter of our civilisation.

The clash between forgers and critics has paradoxically resulted in better knowledge of our literary, artistic, religious and political history.

A data-driven approach to support attribution processes certainly represents an opportunity for the industry. Below are the main areas in which algorithms, classifiable as AI-based technological species, could support experts, thereby reducing human error:

- Stylistic analysis: use of stylistic trait recognition algorithms, such as *convolutional neural networks* (CNN) trained on datasets of artworks, to recognize and analyze artistic styles. These are a type of artificial intelligence algorithm inspired by the functioning of the human brain. They are widely used to analyze images and recognize complex visual patterns. CNNs are able to automatically identify relevant features in images, enabling tasks such as facial recognition, object classification and autonomous driving.
- Signature recognition: use of Optical Character Recognition (OCR) algorithms applied to artists' signatures on works of art, using techniques such as segmentation and character classification.
- Brushstroke analysis: use of image processing algorithms to extract and analyze the characteristics of brushstrokes, such as direction, length and density, using techniques such as the Hough transform or texture analysis. These are algorithms used to detect geometric shapes, such as lines and circles, in images. It uses a mathematical representation to identify the parameters of the desired shapes. It is widely used in computer vision for detecting and extracting geometric features from complex images.
- Analysis of painting techniques: use of image processing algorithms to analyze specific techniques used by artists, such as shading or the use of colour, by identifying patterns or applying machine learning models.
- Texture analysis: use of image analysis algorithms to recognize and compare textures in artworks, using techniques such as Fourier transform or Haralick features (analysis of image textures to describe their complexity and structures) for feature extraction.
- Historical context analysis: use of textual analysis algorithms to extract information from historical documents, such as letters or records, and to identify links between a work of art and a specific artist or historical period.
- Searching for similar works: use of content-based image search algorithms to compare a work of art with a large database of works, using visual characteristics or machine learning algorithms to find stylistic or technical similarities.
- Iconographic source analysis: use of image recognition algorithms to identify and compare iconographic sources used by artists, using techniques such as deep learning (an artificial intelligence technique that uses deep neural networks to automatically learn complex representations and solve complex problems) for object identification or pattern recognition.
- Analysis of corrections or *pentimenti*: use of image segmentation algorithms to identify and analyze the corrections or *pentimenti* present in the artwork, using techniques such as contour analysis or processing of regions of interest.

5. Terminology and objective and subjective evaluation

Let us look at the terminology to distinguish different degrees of certainty in the attribution of a work of art [9]. Below are several employed in the specific field of authentication and attribution.

- Authentic: the work of art is entirely from the indicated era or is by a specific author;
- original: the work of art is by a particular artist whose stylistic characteristics are quite evident;

- Replica: a re-edition of an original prototype made by the artist himself;
- copy: reproduction of a work executed by a different artist;
- attributed to: this indicates that the work was executed at the time of the artist in question and that he is the most probable author;
- signature of: the purpose of this indication is to guarantee attribution to the named artist, although the authenticity of this signature must be verified;
- school of: the author of the work is an artist gravitating in the environment of the artist mentioned directly or is a pupil;
- follower: an artist who uses certain stylistic traits that can be traced to a particular master;
- fake: consists in the total replacement of an artefact for speculative purposes;
- Reproduced: this refers to a work that is identical to the original and produced by digitalization.

To this brief outline must be added the specifically adopted legal terms used in the field of forgery.

At this point, one must ask: "What is and how is the methodology[1] of assessing the authenticity of an artefact in the art market carried out? To answer this question a short description of what happens at a national and international level is given.

Fundamentally, the valuation carried out by auction house experts is a subjective evaluation, based on an analysis of the historical, stylistic, aesthetic, iconographic and, therefore, visual elements of the artefact of artistic interest, without the support of appropriate diagnostic techniques which, respecting the uniqueness and non-renewability of the asset, are non-destructive and non-invasive. The investigations carried out by the experts of the auction houses are summarized in a condition report, a written record containing qualitative and not quantitative information about the artefact. For this subjective assessment, the experience of the expert is, of course, a crucial element.An objective evaluation, with regard to the attribution of a work of art, its authenticity, and the assessment of its state of conservation, is instead based on the use of diagnostic methodologies, also with reference to new technologies. To be complete, the study of a work of art must be conducted with the synergic contribution of both the diagnostician-conservator and the art historian.

6. The reconstruction and digital reproduction of works of art

For some years now, digital mediation is being used in the reconstruction and reproduction of works of art. By combining the use of sophisticated equipment and advanced technologies with craftsmanship, it has won the trust of many international museums in conducting operations of great historical and artistic significance [10].

Interest in the philological aspect of artistic activities takes the shape of collaboration with sociologists, historians, anthropologists and semiologists.

In this regard, mention is made of the digital reproduction of the painting on canvas *The Wedding Feast at Cana* by Paolo Veronese (Figure 2), which was brought to France by Napoleon's commissioners in September 1797 and is now housed in the Louvre. The painting was 'scanned' in 2007 by the skillful technician Adam Lowe: it was decidedly something completely 'new'. Not just a copy and probably an excellent one, but a painting identical to the original, not only of the same size, texture, and material, even including the aura that Walter Benjamin says a reproduction usually loses. Thus, through digitalization, it is possible to obtain an artefact identical to the original, in which

form, colours and even the 'materiality' of the same are absolute. Since it is a pictorial work by a great master and, therefore, an unrepeatable *unicum*, no matter how successful its reproduction may be, let us say that its copying is nevertheless questionable.

Figure 2. The Wedding Feast at Cana, Paolo Veronese

It follows that, to the questions posed above and consequent to the production of works of art with AI, there follow, even in the case of digital reproduction, certain questions of a more ethical rather than aesthetic nature that are the prerogative of a work of art. In particular:

- where has the principle of *unicum* gone?
- where is its unrepeatability?
- where is its inevitably high market value?

The easiest way to answer these interrogatives is to rely on a serious and scientific analysis. The reproduction of a masterpiece could be considered legitimate, as long as it is clearly indicated. That said, hypothesizing specific areas in which AI technologies could be employed in processes to faithfully recreate art works, let us look at some that were proposed directly by an AI when asked the question. The resulting list was then refined by experts in the field by framing it in the literature [11-20]:

- High-resolution digitalization: use of upscaling algorithms, i.e. processes to increase the quality of an image based on artificial intelligence and thus increase the resolution of digitized images of works of art, preserving their details and improving visual fidelity.
- Three-dimensional reconstruction: using computer vision and image processing

algorithms to reconstruct three-dimensional models of works of art, allowing the work to be viewed from different angles and perspectives.

- Virtual restoration: application of artificial intelligence algorithms to digitally restore damaged or degraded works of art, reconstructing missing details or repairing defects such as scratches and stains.
- Accurate colour and lighting: using machine learning algorithms to accurately determine the colours of the authentic work and reproduce the correct lighting for faithful representation.
- Colour thickness analysis: using image analysis algorithms to determine the thickness of the different layers of colour in a work of art, enabling accurate reproduction of the painting techniques of the authentic work.
- Reproduction of texture and materials: using artificial intelligence-based texture generation algorithms to faithfully reproduce the different textures and materials present in a work of art, such as the texture of the brushstrokes or that of the surface.
- Animation and virtual reality: use of animation and virtual reality algorithms to create interactive experiences that allow people to explore and interact with the artwork in a realistic way, recreating the form and context of the authentic work.
- Simulation of the artistic style: use of artificial intelligence-based image generation algorithms to simulate the artistic style of a specific artist or historical period, enabling new works to be faithfully reproduced in a specific style.
- Haptic reproduction: using haptic feedback and 3D modelling technologies to create physical reproductions of works of art, allowing users to experience the tactile sensation and size of the work under examination.
- Digital archiving and preservation: using data compression and archiving algorithms to create high-resolution digital archives of artworks, ensuring long-term preservation and accessibility for future generations.

7. Concluding remarks

A work of art is characterized by a set of values (cultural, historical, aesthetic, artistic, spiritual, symbolic, social, technical, economic, financial, mercantile, authenticity, identity, interdisciplinarity, internationalization), which concern different areas of investigation: historical-humanistic, philological-philosophical-social, technical-economic-managerial, legal-identity. This holistic value should help to determine the specific price of the artefact and thus establish its economic-financial-mercantile-market value. It is nevertheless true to say that the price is what you pay, the value is what you get.

Many different factors, albeit linked to conditions and situations that may be considered uncertain and unpredictable, can contribute to determining the price of a work of art, based, moreover, on a subjective and objective assessment of its authenticity and its legal profile - a fundamental point to refer to, as already emphasized. It is at this point in the discussion on artificial intelligence and the digital reproduction of a work of art that we arrive at our main question:

"As regards the described potential relating to AI and the heated debate between historians and technicians on the topic of authenticating a work of art on the basis of a subjective and objective evaluation, does the accumulation of digitalized cultural data, the elaboration of an open access system, intelligent agents and generative algorithms, have the power to eliminate any kind of stereotype and prejudice, and so further contribute to finding a decisive solution to the heated and enduring debate on

authenticating a work of art, and finally confirming a single shared scientific truth?" This has been the focus of this paper. It can undoubtedly be said that the technologies listed in this work are enabling ones, i.e. those that provide the means to improve human performance and capabilities to achieve set goals. Those listed are just some of the areas where artificial intelligence could make a contribution in complex challenges, as in the case of art work attribution. It is important to emphasize that human interpretation and expertise remain essential to reach definitive conclusions.

Picking up on the above, in the technological environment that is being shaped by digital technologies, can we still seriously believe in freedom?

In this respect, it is necessary to demonstrate that even in the age of digitalization, freedom and creativity are still the trump cards for creating a social organization that is superior to a centralized and controlled model. This constitutes a challenge involving very different levels: cultural, but also political, economic and scientific. Fundamentally, it is a matter of nurturing and increasing human intelligence in its entirety, both individual and collective, qualifying the idea of freedom inherited from the 20th century, despite the fact that artificial intelligence and the digital world are already radically changing the way we know the world today and how we interact with it. From this, it is clear that our ability to correctly deploy and develop these technologies is particularly important, demonstrating that highly digitized models are compatible with human capabilities and complement them or indeed are even better. We can succeed with massive and deliberated investment in training. Education is therefore just as strategic as research and infrastructure: there is no future without quality education and lifelong learning. But that is not all. Widespread intelligence, as pointed out earlier, can only grow in organizations that value creativity, responsibility and autonomy of judgement. After the season of radical individualism, which is still widespread, we need an intelligent kind of freedom that can be cultivated and cared for and be responsibly employed in relations with others and the environment. Businesses, moreover, will have to adapt to change, by integrating new skills centered on innovation, digital technologies and artificial intelligence, framing data and offering the views of outstanding professionals at national and international level. This, then, is how experts from international scenarios become a permanent platform for analyzing cultural relations between geopolitical and geo-economic dynamics projected towards a more stable and less conflictual future with a structural impact on access and growth strategies in emerging and mature markets.

Notes

[1] The term 'methodology' means the study of methods. The term 'method', on the other hand, refers to the set of actions required to perform a chemical analysis: sampling, sample preparation, measurement. The term 'technique' refers to an action requiring a specific instrumental means. The term 'technology' is a synonym for 'applied science' oriented towards practical, concrete objectives and is based on scientific foundations.

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Biographical notes

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Summary

The growing presence of artificial intelligence (AI) in the management of civil and social life as well as in economic and political organization has led to a debate on AI involved in various scientific, philosophical, legal and moral questions, including cultural ones. In this paper, after a brief presentation of the application of AI in art and culture, we focus on art production using AI and the digital reproduction of art which temporally precedes that of AI-generated art. The very idea of artistic beauty emanating from works

of art produced with AI is consequently questioned, giving rise to a new creativity that is to be added to the human creativity of an artist's products. Lastly, the possibility is raised that specific generative algorithms may contribute to the resolution of the topical debate on the issue of attribution and authentication of works of art.