GENERATIVE ART AND ARTIFICIAL INTELLIGENCE

Mauro Annunziato

Artist-Scientist
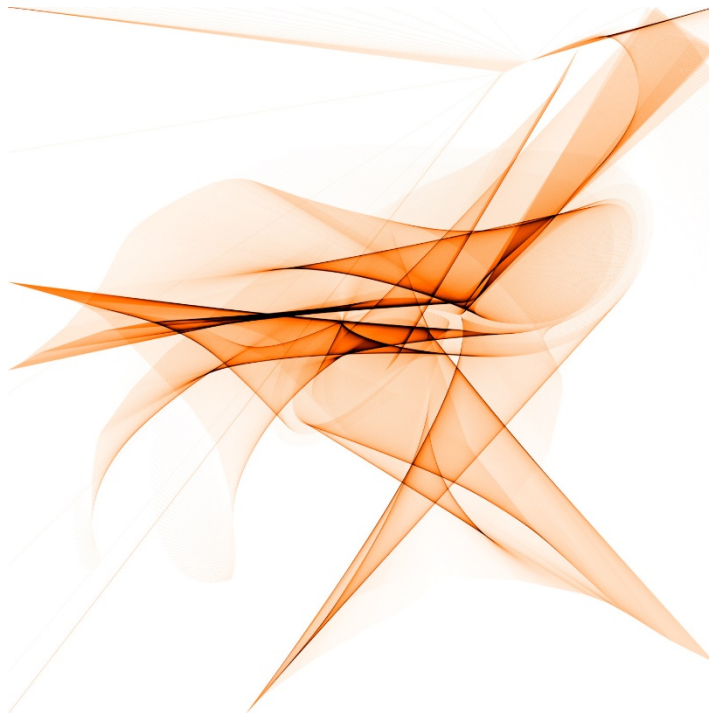www.mauroannunziato.com, mauro.annunziato@gmail.com

The relationship between art and technology has always been very strong. The meaning of the word technology itself comes from the Greek *techne*, technique, which means "art of knowing how to do something". Over time, the meaning of technology always identifies the use of advanced techniques, processes and technical-scientific knowledge for problem solving. In the art of the past, the chemistry of minerals, materials and colours was fundamental and could guide entire artistic currents or art/architectural works.

With the advent of digital technologies, art has found new and unexpected development. Not only for the ease of reproducing or correcting images or digital painting but also for the possibility of creating the image itself through a "programming code".

Generative art

Through this door, a cultural-scientific dimension entered the art: new paradigms from biology, genetic evolution and theory of complexity. Among all this are the learning systems of artificial intelligence.

Many experiments started in the field of the *generative art*. These arise rather in the graphic-mathematical field as visualization of dynamic mathematical systems (cellular automata, fractals, attractors...). Very often, as in the case of cellular automata (one of the best known examples was the game life by Conway - see in https://en.wikipedia.org/wiki/Conway%27s_Game_of_Life) or the chaotic attractors, these mathematical systems are able to reproduce over long time cycles always new and very complex forms.

Touching the Untangible (Mauro Annunziato, 2022, collection *The Garden of Attractors)*

When these techniques enter the artistic world, they generate great interest for their creativity and dynamism, but also perplexity for their replicability (often algorithms based on easily reproducible mathematical formulas) or their attribution to the artist who produced them.

Is the computer generating the artworks by itself or the artist who wrote the language code? This is a complex question. The history of the last 30 years has shown us that the artists can emerge from an indistinct mass of replicative experiences only when they find his own recognizable personal path and innovative ability. Today we generally recognized as the author of the work the artists who creates the digital work and code for his generation.

Starting from the 90s, an artistic movement of "Generative Art" started around an annual international festival organized by Celestino Soddu (Prof. Politecnico di Milano, precursor and animator). They defined the concepts underlying the idea of generative art (see the work of Philip Galanter - https://philipgalanter.com/downloads/ga2003_what_is_genart.pdf).

The term Generative Art refers to the concept of "Art that generates *art"*. Philip Galanter defines generative art as "any artistic practice in which artists applied systems such as natural language patterns, computer programs, machines, or other program innovations, as these systems have to a certain degree activated its own autonomous contribution to or even completed the work of art".

The situation becomes more complex when artists use the "random case" as a creative element as in the case of genetic art (see Eduardo Kac in https://www.ekac.org/gessert_council.html) which I will talk about in detail in the next chapter. In these works, the case plays a fundamental role in the creative process and gives the work itself a kind of creative autonomy and unpredictable behaviour. Often it represents the main beauty both in terms of creation of complexity and in terms of creation of "aesthetic bio-diversity".

It is not the first time that the "case" has been used as a creative artistic element. An evident example are the works of Alberto Burri and in particular the "Cretti" (black or white, made in the 70's) made by drying a clay compound, glue and color. Burri could'nt control the individual fracture of the "Cretti" but the control was obtained out on the base of a "meta-design" (or meta-design). Many artists, who use physical processes for their creations, actually pursue a meta-design and eventually intervene to orient the result (i.e the magnetic surfaces of Davide Boriani in '59 where a rotating magnet composed shapes in iron filings). Generative art moves in the same way, typically pursuing a meta-design and orienting its outcome from time to time. This process is very different from classical painting built as serial juxtaposition of brush strokes. In Generative art normally the artwork is the result of global interventions iterated in parallel procedure, overall work.
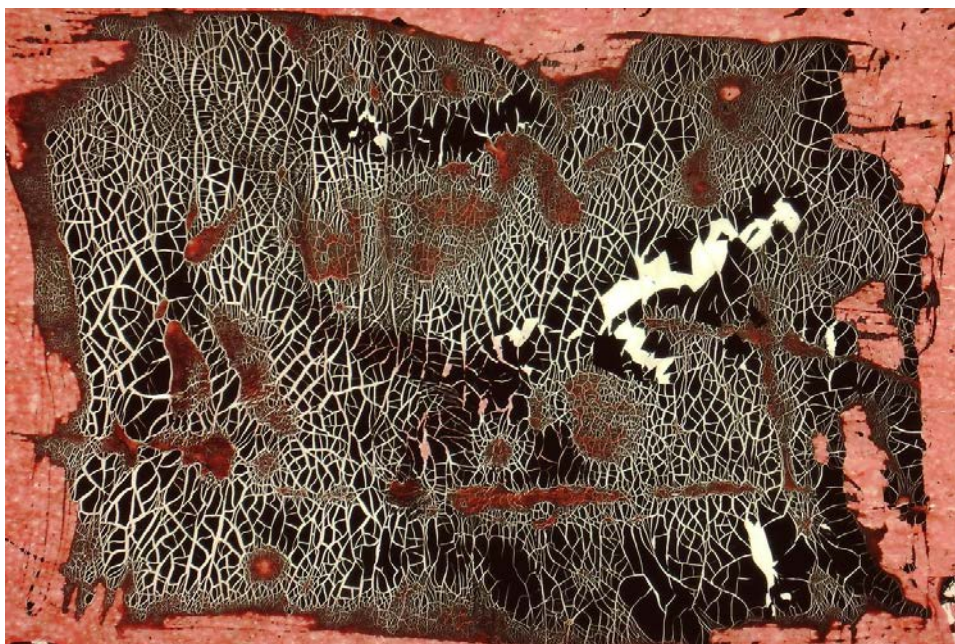
Fractures (Mauro Annunziato, 1993, collection *Kaos*)

Through the paradigm of Generative Art, with the entry of the case, chaos and autonomous generators, we can say that the artist becomes is the creator of a generative process and puts it into action. Sometimes this process occurs without necessarily determining the arrival point of the procedure itself. Paradoxically, the possibility that the work can regenerate infinitely without losing its aesthetic quality becomes the most fascinating aspect. In this case, we can distinguish the "creative dimensionality of the work". The work itself shows an autonomy (only) partially controlled by the author. The working method is based on meta-design, that is, the creation of a particular expressive style by introducing process parameters and random variables in order to generate variants. The creative process begins with a starting idea that corresponds to a prototype of the code and figurative elements iteratively modified to achieve an excellent aesthetic until arriving at the final design.

To put even more in crisis the authorship of the artwork, in the 90's started the research about interactive digital art (e.g.: Maurice Benayoun, Jeffrey Shaw, Roy Ascott, Studio Azzurro) in which the visitors interact through their movements in an interactive installation equipped with sensors (cameras, pressure sensors, proximity and contact sensors, light or sound,...). In this case, besides the author and the autonomy of the work, the visitor himself plays a fundamental role, determines the creative path in the hyperspace of parameters controlling the process through his own sensitivity. The artist becomes the one who creates a meta-generator able to bring out aesthetic biodiversity by playing on the autonomy of the work and the interactive action of visitors.

Parallel artistic experiences in the same years expanded the audience of interaction on visitors who could operate virtually from the internet (i.e. "The Tunnel under the Atlantic", 1995 by Maurice Benayoun) and creating urban works that evolved over time under co-creative impulses (i.e. "Vectorial Elevation" by Raphael Lozano Hemmer).

Between 2000 and 2010, many similar experiences occurred. The concept of author and authorship of the work has been much revised and hybridized leaving much more space to the idea of co-creation. In the same years, the first web 2.0 platforms with wiki approach were developed, That is, programs that get their value based on many small contributions of the people who interact with them (e.g.: wikipedia, google search engine, google earth....). If the web 2.0 has opened up a way of production of revolutionary value, it has however posed for the first time the problem of remuneration of these small contributions.

Evolutionary art and AI

In the same years, other elements emerge in the art panorama. In particular, two new strands have developed: genetic art and artworks based on artificial intelligence. They have often been classified as Evolutionary Art (see Metacreations: Art and Artificial Life, M Whitelaw, 2004, MIT Press).

These works have the capacity to evolve over time towards more complex open configurations. Genetic Art is based on the introduction of a mechanism of genetic mutations, reproduction and selection. Typically, the parameters that define the dynamics and aesthetics of the work are grouped in numerical sequences thought as a "DNA" subject to mutations in the replication phase.

Chaos Revenge (Mauro Annunziato, 1999, collection *Artificial Societies*)

The selection can be made with algorithms either by the artist himself or, finally, by visitors (directly in interactive installations or via the web). In these cases, the paradigm of "aesthetic selection" (Steven Rooke, "Galapagos" by Karl Sims (1997) - https://www.karlsims.com). When the context is composed of many evolutionary elements it is called artificial life or "Alife Art" (i.e. "Living Interface" of Christa Sommerer & Laurent Mignonneau, "Emerging Relationships" - Mauro Annunziato - 2000, https://www.youtube.com/watch?v=frwyw0NtGbk). The "living components" are mentioned as "creatures" or "autonomous agents". Other ways used on the metaphor of "memetics" (an evolutionary paradigm introduced by the philosopher Richard Dawkins in "The Selfish Gene" in 1976): the cultural evolution of a social context of a multitude of individuals exchanging "memes".

Although it is not a "scientific" simulations of the real world (which might be the purpose of scientists) the evocation of imaginary worlds as metaphors of real worlds is very interesting, perhaps also to grasp emotional meanings that escape the scientific approach. John Casti in 1997 defined these contexts as "Would-Be Worlds". In 2005 I defined this ability and this art form as Art of Emergence. ("Emergence and biodiversity of form: the aesthetics of the exchange between real and artificial life, M.
Annunziato, P. Pierucci, in Proc. of the II Italian Workshop of Artificial Life, Rome, 2-5 March 2005. Also in "Sistemi Intelligenti" (The Mill), Anno XVIII, n. 1, April 2006).

The second strand was based on the "learning capability" of artificial intelligence. In other words, the agent is equipped with a neural network which allows him to learn from experiences over time (possibly by visitors) and develop more complex and targeted behaviour to achieve certain objectives (e.g.: moving, swimming, eating, fighting, interacting with visitors, speaking or making sounds or melodies). See the pioneering work of Karl Sims "Evolved Creatures of 1994, https://www.youtube.com/watch?v=JBgG_VSP7f8).

*Emerging Relationships* (Interactive Artificial Life installation, Mauro Annunziato, 2000)

These experiments have shown remarkable evolutionary possibilities, often surprising for their mimicry of human intelligence. I believe that every artist who has worked in this field has tried to take these works to the limit of the possibilities of machines and asked themselves the fateful question: "Can artificial creatures (machines) develop a form of consciousness ?". The question is still open today. Science is not still able to give a wide recognized schema of "what consciousness is". So even if "conscious machines" will be possible in the future, we don't have today the computers, machines and algorithms to do so.

In this regard, John Searle in "The Mystery of Consciousness" (1997) gave and interesting answer. Searle observes that humans can correlate symbols with meanings while machines can only correlate symbols with other symbols (e.g., words, texts and images) but they have no access to their meanings. According to this position, the machines-creatures can evolve within the limits of adaptive behaviour that is very complex behaviour finalized to specific goal (for example, the survival of the creature itself) but without understanding the meaning of their actions.

This step is fundamental to understand what artificial intelligence really is. To clarify it I will briefly report my personal experience in the realization of an interactive installation (E-Sparks).

E-Sparks

E-Sparks (https://www.mauroannunziato.com/portfolios/interactive-installations/) is an installation I developed between the years 2000 and 2005 as an interactive installation in which a society of artificial creatures equipped with neural networks evolved through interaction with visitors. In the first experience, the visitor were able to release "food" into an artificial environment though his movements in the interactive space. Initially, the creatures have no form of knowledge. Only a "void" neural network. They ignore food and die after few life cycles. After a while, some creature start to take into account the presence of food in his processing (decision) of the movement. Approaching the food, they have a greater chance to eat, survive and give birth to children who inherited his own knowledge. After a few hours, almost all the creatures understand they have to eat to survive. Every time a visitor brought food, a competitive race emerge to survive. Over time, only the most effective creatures could survive in an increasingly competitive environment.
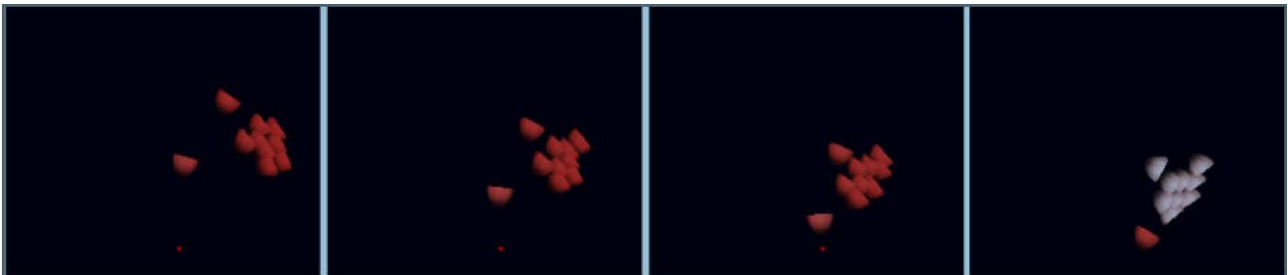
Competition between intelligent artificial creatures: learn to eat to survive!

The surprising consideration about that experience was that despite developing a spasmodic race to survive, the artificial creatures had no idea what they were doing. They had no idea about their lives or the meaning of the death. The underlying problem is that they do not have access to meanings, or emotions. The meaning is a long elaboration process (including emotions and abstraction) strongly connected to physical experiences. In order to feel a primordial emotion like "pain" you need a physical body. Today's machines, but perhaps we could better say the digital programs of today, although equipped with behaviour, are very far from any hypothesis of consciousness. Their "intelligent appearance" arises by a non-physical learning that led them to develop a survival instinct without a real connection with life and its meanings.

What we call "artificial intelligence" is something quite different from our intelligence. Human intelligence instead assumes emotions, feelings and meanings. Reasonably, we are simply projecting our mental patterns (humanization) as we often do with animals. So what is AI? My answer is that AI is (at least at this moment) a complex mirror that "emulates" learning experiences. If learning is based on people interacting, then AI is a reflection of their behaviour.

For this reason, the E-Sparks installation changed direction. The first exhibition was in Rome in 2005 at the "Forum of Traiano" in the walls of Ancient Rome. Visitors could speak to the creatures who memorized their sentences and repeated them to other visitors by correlating them to the responses that visitors gave to their solicitations. In this way they learn the ability to give sensible answers to visitors' sentences.

E-Sparks (Interactive Artificial Intelligence installation, Mauro Annunziato, 2005)

After many interactions (about 30,000 visitors and hundred thousand sentences exchanged), the artificial creatures become able to respond in tune to the solicitations, using human voices, playing with them with empathy. They could do so without understanding the meaning of the speeches that. It was clear that the AI I developed, was a mirror of the people who interacted with it. The visitors were very confused. They continuously had to decide if they were in front of intelligent talking creatures or in front of a mirror of unknown nature.

Generative AI in the art

It is now possible to address the last theme of this contribution. So far, I think it is clear that the relationship between art and AI is one of the many researches experienced by an artistic avant-garde strongly connected to the paradigm of complexity and digital technologies since begin of the new century (2000).

It is also clear that we are talking about something quite different from human intelligence. These environments succeed in emulating or reflecting the human material used in learning. They do not deal with meanings but only symbols without feeling emotions even when they give the sensation of doing so. It is also evident that they cannot invent concepts or generate behaviour not represented in the learning database. These keys are important to understand what is happening today with generative AI.

In 2014, Ian Goodfellow develops an innovative algorithm (GAN: Generative Adversal Network, https://proceedings.neurips.cc/paper_files/paper/2014/file/5ca3e9b122f61f8f06494c97b1afccf3-Paper.pdf) based over two competitive neural networks. One NN is engaged to generate images (learned in the Learning Database) and the other NN is engaged in judging whether those images can be considered "realistic". The two networks improve continuously as new learning cases arise. As learning DB, a large amount of texts and images are used. These schemes (others like AutoEncoder and Transformer have followed) have been very successful and are very effective in producing realistic images that respond to words supplied as input ("prompt").

These impressive results, surprise everyone and who does not know the process. Because the procedure have many business applications, a wide number of software platforms for generating images as be realized as Midjourney, Stable Diffusion and DALL-E (and now several others) which, by giving a series of words (prompt, from the name of the symbol ">" always used by programmers to get a keyboard input) generates an image. Most of the case, the image databases used are derived from the web without respect copyright rights.

Artists ("prompters") emerge who wish to explore this new way and use this tool to produce evocative images generated from the combination of specific concepts. These tools are still in the experimental phase and very often the result depends on the specific words used (synonyms or simply different prompt composition lead to different results). It should be clear that the resulting images are not photomontages of images contained in the database. For example, I can ask to generate an image of a "fishing boat in the port of Venice in the style of Van Gogh" and the generated image does not correspond to any Van Gogh painting. In essence, the style of Van Gogh is "copied" but the represented subject is connected to the imputed prompt.

There is a major difficulty for an artist using these tools. It is difficult to find a graphic style of its own as the system tends to derive it from the images in the database. There is a real risk of generating non-original works (aspect that may not be a problem for many business applications). It takes a lot of experimentation and above all a strong personality on the part of the artist to be able to produce original, recognizable and interesting works. Often it is a matter of exploiting the "bugs" of the system in a compositional sense (with the problem that the next version of the platform could give different results!).

In generative art and evolutionary art (including AI-based works) the artist is engaged in coding (programming) his own generation environment. The digital skills required are high (so risk is an elite form of art) but you have total control over the result.

In Generative AI, generating an image is quite simple (one hour is more than enough to learn and therefore lends itself to an easily accessible art) but being the control much less. It is very difficult to generate an original and interesting work.

The evolution of authorship

In the light of these considerations, the issue of authorship becomes even more complex and a debate emerged around the real attribution of a work of Generative AI.

In both the case of Generative Art and in those of Interactive or Evolutionary Art (including Artificial Intelligence techniques) the role of the artist is fundamental. The artist work on a meta-design entirely generated and coded by the artist rather than working on the single instance of the work. Therefore, there is no doubt about attribution unless you use algorithms extensively explored.

NeuroSociety (Interactive Artificial Life installation, Mauro Annunziato, 2024)

In the case of Generative AI, the artwork is a sort of co-creation by the artist, the programmers of the generating tool and all those who have produced the images contained in the training database. Where the DB is an important part of the web content, then the digital society itself participates in the construction of the work in a kind of collective creation.

This reasoning does not intend to detract from the contribution of the artist but it is necessary evaluate on a case-by-case basis in order to understand the path taken by the artist himself, the narrative of the work elaborated by the artist. Many of the conceptual works base their value not so much on the object itself but on its narration or contextualization (or better de-contextualization as in the case of Man Ray and pop art). Therefore, art based on Generative AI cannot be generally considered as a purely non-original technological artistic form: the work must be assessed in the context proposed by the artist.

Art, AI and society

Precisely as a mirror emulative of learning, a work of Generative AI based on collective co-creation can, through its limits, express the cultural contradictions present in the "collective digital culture". As such, it provides ideas for interesting experimental paths. In any case, the experiences that are developing in some cases show original creations.

There are many objections to the use of AI in art. The most important is the close connection with the business system that produced such platforms. In essence, an economic value taken away from a large number of people is distributed to a few multinational corporates. This kind of problem is typical when significant new technologies are injected over the market concentrating power and economy. One of the most interesting routes to mitigate this aspect is the request made by several artists' organizations (including the Artist Rights Alliance) to recognise an economic contribution to the artist if his or her image is used. A regulation of the subject (Ai Act - https://digital-strategy.ec.europa.eu/it/policies/regulatory-framework-ai) is proceeding in this direction at European level.

In any case, the collective imagination is dominated by fear of machines becoming conscious (or the fear of looking in the collective mirror?). Although the limits of consciousness can put us to shelter from imminent dystopian futures dominated by machines, yet we must say that we are already accepting the existence of machines who take autonomous critical decisions without a sophisticated ethics or machines that spy on us in every corner of our lives. The social damage they could cause could be very large.

In such a hot topic, AI-based artwork could play a very important role in highlighting its nature, roles, contradictions and dangers of the use of AI in social organization.

Mauro Annunziato, www.mauroannunziato.com, 11/03/25