Automating Art: A Case-Study of Cellular Automata in Generative Multimedia Art

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ABSTRACT

This paper aims to furnish an overview of Life, a real-time generative multimedia artwork based on a custom version of the Game of Life algorithm developed by mathematician John H. Conway. Life deals with generative art, cellular automata, and the concepts of visualisation and sonification. The explanation of the artwork itself is preceded by an overview of the relevant surrounding contexts, aimed in particular to familiarise with the concepts of generative art and cellular automata.

Keywords: generative art; cellular automata; software design; sound art; multimedia.

Demo of the artwork:
https://www.enricodorigatti.com/wp-content/uploads/2022/01/Life.mp4

1. INTRODUCTION

Life is a multimedia, real-time generative artwork realised in 2018 and based on a custom version of the famous the *Game of Life* algorithm developed by John H. Conway. As a software, *Life* can be executed on a wide range of devices (from desktop to mobile ones), and once started, it can run potentially forever, or until the user presses the 'Escape' key. On the hardware side, *Life* requires basic video and audio playback, and offers the possibility to set the graphic quality in order to fit the computational power of portable or old devices as well.

The paper is organised as follows: after an introduction to the topic of generative art, an overview of cellular automata is proposed, with a specific focus on the *Game of Life*. In the fourth section, *Life* is discussed and its algorithm, the visual output, and the auditive one, are explained. Lastly, *Life* is contextualised drawing from two frameworks for the classification of generative artworks. This last section explains processes and mechanics at whose ground there are artistic choices, particularly to make it easier to understand what one sees and hears when running the software.

2. GENERATIVE ART

Although examples of generative art precede the advent of the computers [1, 2], the use of this lemma «[…] has now converged on work that has been produced by the activation of a set of rules *and* where the artist lets a computer system take over at least some of the decision-making […]» [1]. Nevertheless, what is important in this form of artistic expression is not the media used, rather than the set of rules employed by the artist to realise the final artwork: «Rules are at the heart of this type of art.» [1], and «Generative art enables the artist to concentrate on the underlying rules themselves: the structures that define the artwork, as against the surface.» [1]. However, with the advent of technology, it is not rare for generative art to be realised through and associated to, by the collective imagination, the work of an IT system instructed in a specific way. In these cases, the set of rules is not directly employed, translated practically by the artist—examples this way are the numerous music composition dice games, of which the one for composing infinite waltzes attributed to W. A. Mozart is probably the most known [3, 4]—, but rather mediated, elaborated and executed by a machine—that is, for example, a computer: «The evolution of the electronic computer transferred algorithmic composition to the digital domain, bringing a wealth of new possibilities and allowing the machine to be a part of the process.» [5].

2.1 Two Frameworks for Generative Art

Nevertheless, this binary classification assuming generative artworks realised through rules applied by humans on the one side, and machines executing them on the other, is way too simplistic. Indeed, generative art is branched into many subcategories and offers different possibilities in terms of classification, depending on the perspective and objective of the focus.

One valuable framework, proposed by Boden and Edmonds, explains 11 possible categories for generative art based on the medium employed [1]. Such taxonomy clearly shows that generative art is a much deeper phenomenon than the definition may suggest, although the authors acknowledge that it admits some overlapping and borderline cases [1].

The second framework, proposed by Dorin and colleagues, unlike the former, focuses on the actors, processes employed, and output produced, originating a more detailed and deeper analysis of the artwork evaluated, which is split into four elements: 1) *Entities*—the (unary and indivisible) subjects upon which a generative artwork's processes work; 2) *Processes*—mechanisms of change occurring within a generative system (include initialisation and, possibly, termination procedures; 3) *Environmental interaction*—the input the artwork may collect, through sensors, from the surrounding environment; 4) *Sensory outcomes*—the aspects of a generative work which can be experienced [2]. It can be said that while the framework proposed by Boden and Edmonds aims to fit an artwork in a specific context and artistic current, the one proposed by Dorin et al. is keen on furnishing a deeper explanation of the artwork itself. It comes clear that, while used in conjunction, they can furnish a valuable description and contextualisation of a specific artwork. Later on, *Life* will be analysed from both these perspectives.

2.2 The Nine Problems of Generative Art

An interesting characteristic of generative art created through the work of computers, though, is that it comes along with some problems. Such nine problems, listed by Galanter [6], are not of mathematical conception, requiring a solution; rather, they are questions that should be taken into account when creating, analysing, or just enjoying a generative artwork. «These are not problems requiring single correct solutions. Rather, these are problems that invite consideration by the artist when creating generative art; that theorists will want to consider in their analysis; and that well-informed audience members will want to ponder. These are problems that encourage multiple possibilities and opportunities.» [6]. Amongst all the others, the first problem seems to be of particular interest in the specific case of *Life*, as the artwork is entirely and continuously generated by an autonomous system. «Regarding generative art, the problem of authorship asks, "How do traditional views of authorship shift regarding credit, expression, and provenance?" When first encountering digital generative art, a novice will frequently ask "Who is the artist, the human or the computer?"» [6]. The author continues arguing that, while it is not uncommon that many will answer 'the human' (the programmer) to this question, there is not a unique, standardised solution.

2.3 An Answer Drawing from Interactive Art

Although a deeper analysis and reasoning around this problem is beyond the scope of this paper, answering Galanter's call to think upon it, an answer will be proposed. Drawing from the context of interactive art, it can be noticed that the question is very close to the «Where is the art?» [7] one arising there. Indeed, more than as 'artwork', an interactive installation can be described as an 'art system'—a lemma describing the installation, the audience as spectators, and the audience as performers [8]. In addition, there is to register a shift in the position of the artist, as «[…] the role of the artist is not so much to craft the artwork, but rather to specify and modify the constraints and rules used to govern the relationship between audience and artwork as it takes place in the world.» [8]. What is clear is that the artwork exists and takes place only when all of these agents exist and cooperate in synergy: «An artist does not make a final, completed piece of art, instead produces an area of activity for the receivers, whose interactive actions bring to life an artwork-event.» [9], and «[…] art only "happens" when someone interacts with the system. In some cases, the process of interaction is the art. In others, there is a clear *product* of interaction such as music performance or an image.» [7]. Interactive art, therefore, does not exist without a system capable of creating art through interaction; in turn, the system, regardless of its functioning, needs an artist who creates it and, and an audience interacting with it: and only now art takes place. Additionally, there is also the need for a public enjoying the outcome. What comes clear is that the same holistic approach can be employed to formulate an answer to the first problem proposed by Galanter [6]. Who is the artist when it comes to generative artworks realised through a machine? Following the reasoning proposed, not the artist nor the computer, yet both of them. The artist does not make the artwork, as they write code or, more generally, instructs the machine on how to behave. At the same time, the machine does not express itself through art; it rather interprets and executes the instructions received—even when it comes to AI there is an fundamental substrate consisting in the work of the programmers and scientists. Nor the artist nor the computer is the actual 'artist' in the sense a painter or a composer, traditionally, is. At the same time, however, their interaction—the sum of their work—makes it possible for the artwork to appear and to be enjoyed.

3. CELLULAR AUTOMATA

P Cellular automata are models of self-reproducing organisms, formerly proposed by John von Neumann. A simple explanation of what basic cellular automata are is proposed by Sarkar [10], who describes them as systems composed of the following elements: virtual living beings (cells), a set of possible states in which they can be; an environment—both finite or infinite, from one to *n* dimensions—; and a set of rules (conditions) determining over time the state of the cells. Additionally, time must be considered as a discrete function. The functioning of the system is simple. While at instant zero cellular automata are in some initial configuration, at every subsequent time step, there is a change in the state of all the cells. Such changes are determined autonomously for all the organisms, without the need of any input, by the rules decided a priori, which calculates the subsequent state of each cell based on its and its neighbours' current state.

Over time, cellular automata has evolved in many different ways, adapted and bent to the most various scopes and contexts, and nowadays are still employed and studied: «[…] physicists and biologists began to study cellular automata for the purpose of modelling in their respective domains. In the present era, cellular automata are being studied from many widely different angles, and the relationship of these structures to existing problems are being constantly sought and discovered.» [10]. However, for the scope of this paper, it is not necessary to explore and assimilate all the theory underneath this topic; indeed, knowing the basics of what cellular automata are, is sufficient for understanding the sections to follow.

3.1 The Game of Life

The *Game of Life* is a particular type of cellular automata, originally proposed by mathematician John H. Conway. Accordingly to Sarkar, it was designed to study the behaviour of a population through the application of a simple set of rules that were «[…] based on the principle that the growth or decay of the population should not be easily predictable.» [10]. These four rules, which determines the changes in the state of a cell, are summarised in the following table [10, 11]:

State	Neighbours	Result	Condition
1	0 to 1	0	Loneliness
1	2 to 3	1	Survival
1	4+	0	Overcrowding
0	3	1	Birth

Table 1. Rules in *Game of Life*.

Much research has been done, and is still pursued nowadays, on the *Game of Life*, leading to discovering particular configurations. Such configurations, behaving cyclically, are essentially patterns repeating forever a finite set of steps. Usually coming along with a name, some of them are the ‘clock’, the ‘pulsar’, and the ‘blinker’ [11]; other patterns, ‘fire’ masses of cells, and are therefore called ‘guns’, such as the ‘glider gun’ [10]. But the taxonomy includes other types of configurations, which are grouped based on their behaviour.

The *Game of Life* has become a widely popularised topic, with plenty of resources available. There is even a *LifeWiki* [12] which is dedicated «[…] to not only catalogue everything that is known about Conway’s Game of Life, but also keep up-to-date as advances are made with the game and new important patterns are found.» [13]. Lastly, Google offers an on-screen real-time simulation when querying ‘game of life’ in their web browser Chrome[1]

3.2 Cellular Automata and the Game of Life in Art

Arts, especially visual and sonic ones, have not been exempt from being attracted by the fascination of cellular automata in general, and the *Game of Life* in particular, interacting with and employing these systems in different ways. The following, non-exhaustive list is an brief overview of some resources making an artistic usage of cellular automata. The open-source program *Golly* has been developed «[…] for exploring Conway’s Game of Life and many other types of cellular automata.» [14]. Although this software has been primarily conceived as a simulation, it is capable of generating interesting designs, images, and geometrical patterns. Another example comes from Derivative, the developer of *Touchdesigner*, the visual programming environment especially suited for creating visuals, videomappings, and installations. In 2019 they organised in Montréal a workshop held by Simon A. Adams. On this occasion, the artist explained how to create real-time generative visuals using cellular automata [15]. Regarding the musical side, notable is the example furnished by the composer and mathematician Giovanni Albini, who created *Cellula – the Conway’s Game of Life Visual Synth* [16]. As the name suggests, this program distributed in the Virtual Studio Technology Instrument (VSTi) format makes the evolution of the *Game of Life* algorithm in charge of controlling the value of the parameters of the instrument itself. Similar, but distributed as an ensemble for Native Instruments’ *Reaktor*, is *Newscool* [17]. Designed by Ali Jamieson, it allows employing the *Game of Life* as a sequencer. A broad overview of the many artistic usages of cellular automata in the musical and sonic domain is provided in [5]. Although nowadays it may result outdated, as the article was published in 2005, it still provides a panoramic view of this topic. Lastly, from a more experimental and research-oriented standpoint, there is to acknowledge the work of Eduardo R. Miranda related to the exploration of the linkage occurring between music and cellular automata which, however, besides fostering the exploration of unconventional computing techniques for music [18], produces usable software as well, such as the Chaosynth instrument for Csound [19, 20].

4. LIFE

Life is a generative multimedia artwork based on a custom three-dimensional version of the *Game of Life* algorithm. It was designed to generate both visuals and audio based on the evolutionary state of the community of cells populating the environment, which is a finite matrix with a side of max. 12 cells. Such a shape of the ecosystem, however, imposes adapting the original rules to the new context. This means having rules allowing the community to evolve in an environment different from the two-dimensional original one, avoiding extinction due to overpopulation or loneliness. What is important to point out, therefore, is that this is the meaning of ‘custom’ when describing the algorithm of *Life*—a version adapted to fit a specific scenario.

[1]https://www.google.com/search?q=game+of+life&rlz=1C1VDKB_itIT992IT992&oq=game+of+life&aqs=chrome..69i57j35i39j46i512j0i512l7.3204j0j7&sourceid=chrome&ie=UTF-8. Query performed on the 13th of May 2022 in Google Chrome web browser.

4.1 The Algorithm

The translation of the *Game of Life* in a three-dimensional simulation is not a novelty. For example, strategies for this are discussed in [11], while CAMUS software, designed by Miranda [5, 20], implements it for compositional tasks. However, for *Life*, the trial and error approach was used as part of the design and implementation process as a means of encouraging flexible exploration of the different possibilities and alternatives. Indeed, while all of the four possible evolutions formalised by Conway—birth, survival, death by loneliness, and death by overpopulation—were incorporated, the conditions triggering them were adapted to this particular scenario. This was the first obstacle, and its solution allowed for the population of cells to not extinguish due to overpopulation in a very short time. After tweaking for the first time Conway's conditions in terms of thresholds (i.e. the number of organisms needed to influence the evolution of a cell), however, the opposite problem occurred. Conditions for reproduction were deemed to be too strict. While, on the one side, there were too few cases in which the cells were able to give birth to another one, on the other, there was an unsustainable rate of deaths due to loneliness. Another round of improvements and tweaks allowed for balancing the rate of births, the rate of deaths, and the survival rate. However, this time improvements were not limited to the thresholds. Indeed, new features, which are described below, were added to the algorithm.

4.1.1 Distance

The evolution of a cell is no more determined only by the number of near (direct) neighbours; instead, the algorithm also takes into account cells that are one cell away from the tested one, although weighing them differently in the count.

4.1.2 No-Borders Environment

Although the environment is a cube, internally, it behaves like a structure folded on itself. To better explain, the algorithm interprets the opposite faces on each one of the three axes as adjacent and, therefore, cells on faces zero and 11 are neighbours of each other.

4.1.3 Initial State

Originally the initial disposition of the living cells was determined by a function placing them randomly over a limited space compared to the total available within the matrix. However, further experiments proved the low efficacy of this method. This improvement, therefore, consisted in increasing the number of cells alive at instant zero while, at the same time, allowing their displacement over the whole area available. This resulted in living cells covering the environment more evenly, thus allowing more interactions and fewer cases of sudden extinction.

4.1.4 Illness

Like every living being, cells in *Life* are affected by sickness as well. These situations happen randomly, and negatively affect the evolution of the cell: it does not matter whether the number of neighbours would allow a cell to survive or even give birth to another one: should such an occurrence happen, the cell would die.

4.1.5 Seniority

This is probably the more branched and complex improvement to the system, which, incidentally, required a massive reorganisation of the code and structure of the algorithm. In this context, seniority applies to the number of epochs that the cell has survived in the environment, a characteristic that imitates the ageing of every living being. For clarification purposes, 'epoch' refers to the time passing between two checks on the same cell. Firstly, after a certain number of epochs, should the cell still be alive, it dies of old age. Additionally, the probability of getting sick increases, thus lowering the possibility for an old cell to survive incoming epochs. This system affects several of the previously mentioned mechanics. Most notably, it acts on the function governing the reproduction of the cells and on the one regarding their survival. On the one hand, concerning the former, it means that even when proximity is respected, after some survived epochs, a cell stops counting towards the number of cells needed to give birth to another one. Implicitly, this means disturbing the fourth condition (birth) of another cell as the old one, for this purpose, counts as dead. On the other hand, concerning the latter, after a certain amount of epochs, a cell needs to be surrounded by an increased amount of living ones to survive, otherwise, it dies. Practically, this translates into an increase of the threshold for condition one (death of loneliness), and in a consequent tightening of the number of cells required for condition two (survival).

4.1.6 Observations

Throughout the development process several observations were made. Firstly, regarding the ageing mechanism, in this three-dimensional situation, cells have a higher number of possible neighbours than in the original two-dimensional *Game of Life*; therefore, the tweaks applied the thresholds determining the evolution of the cells are (proved to be) sustainable, ensuring that the simulation does not terminate. Indeed, the thresholds employed in the final version of the software were determined after a conspicuous amount of sessions involving tests, observations, and fine-tuning. Such tests, additionally, allowed to suppose that *Life* could potentially run forever. The software, indeed, is designed to stop and self-quit, should the population of cells extinguish. However, the last and most intensive test session lasted 168 hours—an entire week with a machine running the artwork—and, once ended, *Life* was still being executed. Although longer test sessions could be useful to confirm or refute this statement, from a practical standpoint, they are hardly feasible. In addition, it is unlikely that the software will be run for such long timespans, and tests, therefore, were more focused on reduced intervals lasting up to 48 hours. What is important to point out is that no problem was registered.

Additionally, there is to notice that the strategy concerning the ageing system—as well as the one of enlarging the neighbourhood—are mechanisms considered in [11] as well.

Lastly, Boden and Edmonds registered that «[…] the label 'generative art', as used in the community concerned, has acquired biological overtones.» [1]. Although they do not seem to completely agree with (over-)incorporating biological meaning in the context of generative art, it is a matter of fact that generative artworks based on cellular automata create, incidentally, very simplified simulations of homogeneous communities of biological living beings. After all, to virtually create and study such simple communities was the objective pursued by Conway, leading to the creation of his famous algorithm [10]. In *Life*, although all the variables occurring in real life can not be taken into account—besides being way beyond the scope—, some key points concerning biological living beings are considered and incorporated. As previously illustrated, some examples include the simulation of the life-cycle, the concept of community, and the need for a sufficient amount of space (i.e. natural resources) to survive and reproduce.

4.2 Multimedia Output

Much has been said about the algorithm governing *Life*; its output, on the contrary, has not been described yet. As *Life* is a generative work, the algorithm determines both the visuals and the sounds produced. To a certain extent, it is correct to say that the multimedia output furnishes both visualisation and sonification [21] of the algorithm running underneath. The concept of audiovisualisation, therefore, can be used in place, as it refers to the «Simultaneous sonification and visualisation of the same data source [...]» [22]. The limit of categorising *Life* as an artwork of audiovisualisation, however, lies in that, first and foremost, it is an artistic work. Therefore, while both visuals and sounds are actually based on the state of the population of cells within the matrix, before being outputted, they pass through an intermediate layer, responsible for applying filters, effects, randomness, and other artefacts to enhance the artistic side of the work. Many of these modifications are determined or controlled, in total or partially, by data furnished by the algorithm as well; however, their application breaks the direct connection between the multimedia output and the algorithm itself, thus rendering the audiovisualisation more difficult to understand.

4.2.1 Visuals – Main Elements

Visuals are composed of two main elements: a representation of the cells within the matrix and a particle system. Regarding the former, alive cells are represented by a sphere floating in space, performing oscillations whose speed is determined by the age of the cell and by the number of neighbours. Changes in the state of the cells are represented as well through fade-in (new ones) and fade-out (dying ones). Lastly, the colour of the cells is determined by their age, shifting towards red as it increases. Regarding the latter—the particle system—, instead, the algorithm controls the following parameters: colour, speed and rate of the particles, and noise affecting their trajectory. However, data are not directly mapped to these parameters; indeed, they do not act over the whole range of a parameter, but rather only on a fraction of the total excursion possible. This limitation has been implemented to avoid extreme cases with parameters turned all the way up or down. Allowing for a 'safe pad' in both directions guarantees the smoothness of the experience for the audience, avoiding abrupt changes in the visual flow.

4.2.2 Visuals – Further Elements

Besides the main visual elements described, there are also secondary ones, namely the camera movements and the vignette obstructing the Field Of View (FOV). Both of them, however, have a sole aesthetic and artistic role, and their behaviour is primarily random-based. The camera is characterised by changing its position in space from time to time—although it always faces the matrix. The random-based behaviour lies in that the coordinates of each new position are selected each time randomly. Concerning the vignette, instead, the random-based behaviour is related to the centre and radius of the section of the screen left uncovered. However, although primarily random-based, both the camera and the vignette are influenced as well, partially, by the algorithm. More specifically, they are linked to the same parameter, namely the number of total alive cells within the ecosystem.

4.2.3 Visuals – Filters

As previously mentioned, filters and effects are applied to both the visuals and the sounds. While they allow for a richer artistic experience, at the same time, they diminish the understandability of the connection between the data and the multimedia outcome. Visuals are primarily affected by a filter that distorts, replaces and exaggerates the colours of the images. Although it creates vivid visuals, as a downside, it negatively impacts the colour-coded ageing of the cells, preventing, de facto, its understandability. However, despite that, it is still possible to notice the diversity amongst the cells, as they are coloured differently. Secondarily, visuals are affected by a lo-fi filter, which pixelates the images, degrading their quality. This effect, however, appears only when the camera translates from a position to another one. And while most of the time it disappears after a short while, very few times, due to certain internal conditions happening, it remains until the successive camera movement. Despite this, its overall contribution remains marginal.

4.2.4 Audio – Main Elements

Audio is generated through additive and FM synthesis [23] engines, which are fed by sinusoidal oscillators. All these systems have been coded specifically for this context. *Life* provides every plane on every axis with an oscillator, for a total of 36 sources. Each axis owns a range of frequencies for its oscillators to employ, and each oscillator has its frequency determined by the number of alive cells in the plane it represents. As data change the frequencies of the oscillators, 'playing' the sounds, it can be said that *Life* employs a sonification technique known as parameter-mapping sonification [24].

4.2.5 Audio – Further Elements

There is another element contributing towards the generation of the audible output of *Life*, which is a set of Low-Frequency Oscillators (LFO). 12 LFOs are available, whose frequencies are decided through processes involving the total number of alive cells in the three planes (x, y, z) of the corresponding index. The process determining which LFOs are employed is the same governing the employment of the audio synthesis engines. Once selected, an LFO can be applied either to control the panning of a synthesis engine or as a tremolo effect.

4.2.6 Audio – Filters

However, as for what happens for the visuals, some artistic choices break the direct relationship occurring between the algorithm and the audible output. Regarding the main sound elements, each synthesis process chooses its oscillators randomly amongst the 36 available, combining them accordingly to the type of synthesis. Additionally, FM synthesis engines have their modulation indexes based on an elaboration of the number of total alive cells within the matrix. Lastly, there is to notice that there are many additive and FM synthesis engines available to play sound. However, not all of them are employed simultaneously, as the ones playing are randomly chosen within this pool.

The audible output, therefore, alike for what happens with the visuals, although based on the data coming from the algorithm loses a lot of its connection with the data themselves due to them being rearranged and merged with random values. While this involved artistic choices, it is also a matter of technical and practical ones. Indeed, some early experimentations were performed to obtain a clearer sonification, but many problems arose. For example, to maintain the original idea to make audible all the 36 planes of the matrix, there was a lack of an audio synthesis technique providing a set of (main) controls great enough to allow a clear 1:1 plane-to-control mapping for all the planes. Such controls, indeed, needed to generate substantial and clearly perceptible modifications to the sound resulting. And, in the case of assigning one oscillator to each plane, such a number of sound sources resulted difficult to use simultaneously in a single additive synthesis process while maintaining the result balanced and intelligible. This problem affected both the spatial disposition of the sounds, and the distribution and loudness of the frequencies to avoid masking effects [26]. All that considered, the solution adopted and described resulted to be a good compromise in terms of artistic vision, design of the audiovisualisation, and constraints [25].

4.3 Contextualising Life

Previously, the frameworks for classifying generative artworks proposed by Boden and Edmonds, and Dorin et al., have been overviewed. Considering the former [1], *Life* fits into the CG-art category, which, standing for computer-generated art, includes cellular automata. Artworks related to this category share, as the main characteristic, to be generated by a computer program. The authors, however propose, in their article, two slightly different definitions for CG-art, differing in that the second one is a little more inclusive. Indeed, while at first they state that «A very strict definition of CG-art would insist that *(df.) the artwork results from some computer program being left to run by itself, with zero interference from the human artist*.» [1], lately, they add: «We therefore prefer to define CG-art less tidily, as art wherein *(df.) the artwork results from some computer program being left to run by itself, with minimal or zero interference from a human being*.» [1]. However, as *Life* does not require any external interference for its correct functioning, the first, stricter definition of CG-art can be applied, as it perfectly fits it.

Concerning the second framework [2], the description of *Life* through the parameters proposed by the authors results in the following schema, which is particularly useful in breaking up and summarising the whole artwork by employing the main elements explained in the previous paragraphs:

- *entities*: virtual organisms (cells);
- *processes*: entities evolve respecting a set of rules; unpredictable (random) events;
  - *initialisation*: software execution;
  - *termination*: none; death of all the entities; user stops the software;
- *environmental interaction*: none;
- *sensory outcomes*: visual elements and sounds.

5. CONCLUSIONS

By overviewing the relevant surrounding context and by analysing 1) the internal algorithm and its functioning, 2) the elements composing the multimedia output and the artistic choices operated, and 3) its contextualisation through the lenses of two frameworks developed for organising generative art, a broad presentation of *Life* has been provided.

The artwork, although based on Conway's the *Game of Life*, introduces substantial modifications and new features to adapt the original algorithm to its context and necessities. Similarly, while audiovisualisation techniques are employed, these have been bent, creatively used and integrated to, at the same time, overcome technical difficulties and create a specific artistic and aesthetic experience. The result is a multimedia stream which, although based on data coming from the algorithm, 'betrays' them, favouring in each of the two media it is composed of—audio and video—the artistic experience rather than the actual and precise representation of all the parameters of the community of virtual cells. This informed decision, while valorising one aspect of the artwork, inevitably has the downside of rendering hazier and opaquer the other—specifically, the adherence of the audiovisualisation with the data themselves. Nevertheless, in this case, the aesthetic result was considered more important than the precise representation of the data through audio and video.

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