Tracing Autonomy & Artistic Significance: An Alternative Framework for Analysing & Comparing Generative Art

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As result of the current generative art boom, many generative works are flooding the art and media sphere. However, meaningful analysis, comparison, and discussion of generative art have so far been complicated by two factors: 1) the commonly used definition of generative art is broadly defined, resulting in a large variety of works sharing the same heading, and 2) existing methods for classifying and comparing generative art only facilitate a descriptive analysis of the generative systems within an artwork, but neglect the role & contribution of those systems to the work as a whole. In this paper we propose an alternative framework for analysing generative art, to aid the understanding of what generative art includes, where 'the generative' aspect(s) in a work take(s) place, how the generative relates to other aspects in that work, and how this differs from the generative elements and aspects in other works. Two concepts are introduced: *autonomous ability* (AA) and *artistic significance* (AS), including a larger framework to analyse artworks along these concepts. The framework asks 1) what elements (generative and non-generative) the work consists of, 2) what the role of these elements is within the artwork, 3) how autonomous these elements are, and 4) how artistically significant the contribution of the element's role is in relation to the artwork as a whole. We apply the framework to a selection of four generative artworks to test its working, present the corresponding results, and reflect upon the framework.

Keywords: Generative Art, Generative Systems, Framework, Critical Analysis, Autonomous Systems, Generative Methods.

1. Introduction

Generative art is currently experiencing a significant boom. Developments in GAN, blockchain and NFT technology, but also the introduction of generative AI tools such as DALL-E, Midjourney, Stable Diffusion have pushed methods for creating, collecting, and trading computer generated art, giving extra momentum to the field of computational creativity and the related discussions about creativity, authorship and authenticity. Artworks generated through these technologies are flooding online portfolio platforms, but are also well represented at art & media festivals globally and even have entered traditional art auctions (Cohn 2018) and art competitions (Vincent 2022), demonstrating that generative art is a field and practice that is here to stay and continues to provide both an interesting scope of work and discussions. So, what exactly is generative art? Following the commonly accepted definition, introduced by Philip Galanter, generative art:

> … refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art. (Galanter 2003, 4)

Most will think of computer-generated art, such as the works of Manfred Mohr, Lillian Schwarz, Michael Hansmeyer, or Anna Ridler. However, as Galanter's definition proposes, generative art also includes art that is not computer generated, yet still produced by autonomous systems. We support this perspective and see Sol LeWitt's wall drawings, Alexander Calder's mobiles and forms of Islamic tiling as examples of generative art without the use of a computer, acknowledging the long history of generative art. These examples show that a wide variety of works can be considered generative art. Its broad definition allows for this: it not only includes many different types of generative artworks under the same heading (e.g., both generative computer and non-computer art), but also blurs the many differentiations that exist *between* generative artworks, such as style, discipline, or media. It's not surprising therefore, that in the past decades multiple methods by various researchers were formulated to classify, evaluate and compare generative art forms, resulting in multiple schools of thought. Although these entail useful descriptive frameworks, we notice that a critical analysis and comparison of the artworks through these frameworks is harder to obtain. There is a considerable focus on generative processes themselves but what falls short is the positioning of, and reflection on, the role of these processes in relation to the artwork as a whole. With this study, we aim to formulate an alternative perspective for analysing generative art, that could facilitate a critical understanding of what generative

art is, what 'the generative' comprises in an artwork, and how this can differ between generative artworks.

2. Review of Theoretical Framework

To illustrate the current discourse, we will shortly review the main existing frameworks on analysing generative art, being those of Galanter (2003; 2008; 2016), Boden & Edmonds (2009), and Dorin et al. (2012).

Galanter (2003; 2008) proposes to view generative art from a systems and complexity theory influenced paradigm. He states that systems (i.e. complex, dynamic systems that inhibit "a large number of small parts or components that interact with similar nearby parts and components" (Galanter 2003, 5), and proposes to classify these systems on a scale from ordered-disordered and simple-complex. We reckon the importance to look at systems, as their properties play a crucial role in generative art. However, we think it is limiting to solely focus on a system's inner workings without taking its output into account too. Moreover, we doubt if complexity as such is an interesting parameter for evaluating generative art, as it reveals little about what the regarding system *contributes* to the work. Galanter does identify problems regarding evaluating generative art which he augments with questions (2016) of which some we think are valuable to look into (such as the problem of locality: "is the art in the object, the system, code or something else?" (Galanter 2016, 171) or the problem of creativity: "Are generative systems creative?" (Galanter 2016, 172). These questions however are only asked after elaborating on his paradigm, and do not seem explicitly integrated in his framework. Moreover, an explanation of *how* these systems are applied in the artwork and what the generative properties of these complex systems attribute to the *artwork as a whole* is largely left untouched in Galanter's theory, which we consider crucial for achieving a critical understanding of the generative in art.

Boden & Edmonds (2009) introduced a list of eleven subcategories of computer art, ranging from "Ele-art" (involving electrical engineering and/or electronic technology), to "Evo-art" (evolved by processes of random variation and selective reproduction that affect the art-generating program itself) (Boden & Edmonds 2009, 37), and question for every category "whether the appropriate aesthetic criteria and locus of creativity are the same" (Boden & Edmonds 2009, 21). Compared to Galanter, we think that their view holds a broader notion of what constitutes the artwork, as they speak of an *art system* of which "the artist, the program, the technological installation (and its observable results), and the behaviour of the human audience" (Boden & Edmonds 2009, 40) are all part. We value this more inclusive notion of (locus of) creativity, but miss the possibility in their taxonomy for a critical look into the roles of all these parts. This

arguably makes Boden & Edmonds' classification more of a detailed, medium-specific description of the current computer art landscape, but it does not allow for a dissection or evaluation of the individual elements that are at play in generative art.

According to Dorin et al. (2012), generative art systems are constituted by four components: entities, processes, environmental interaction, and sensory outcomes, along which they propose to outline generative artworks in order to reveal the dynamic processes at play. Compared to Galanter and Boden & Edmonds, we think this method enables a more thorough view into the individual subjects or media used in the artwork *and* their underlying interrelations: a factor we consider characteristic for generative art and therefore essential to critically look at. Also, Dorin et al. take into account some level of external input (which they termed "environmental interaction") (Dorin et al. 2012) involved in the artwork as well as something that could translate to the artwork 'as such' (i.e. "sensory outcomes") (Dorin et al. 2012). Although we think this last component is still a fairly narrow conception of the artwork as a whole (as an artwork can include more than just sensory outcomes), we do think that, when analysing generative art, taking into account both external factors *and* the output of the system are valuable steps in understanding the complete picture. However, other than naming these components, Dorin et al's framework does not facilitate a critical examination of these, which renders it more of a descriptive tool, similar to Galanter's and Boden & Edmonds'.

In short, the above mentioned frameworks do contribute to a useful and necessary body of knowledge on generative art, especially for establishing a singular vocabulary for researching and discussing generative works. However, their descriptive approach does not allow for a more in-depth critical analysis of what the generative in a work *contains* and what it *contributes*. And although this might not be their ambition (Dorin et al. express their "desire for an analytical descriptive rather than a critical framework" (Dorin et al. 2012, 256) and Galanter poses considerations through meta-questions), in our view this leaves possible interesting and valuable questions unanswered. For example: what exactly is the 'generative' aspect in the work? Where in the artwork does this take place? How does this generative element relate to other elements involved in the work? Can we, for example, define different degrees of 'generativity' in or between artworks? And for that, can certain artworks be more generative than others, or in different aspects? We try to formulate an alternative way of looking that could cover this and facilitates a cross-comparison of these factors amongst generative artworks, by the following approach.

3. Approach and Methodology

When we closely interpret the definition of generative art as given by Galanter, it seems to imply that there are two types of 'degrees' at play within the artwork. First, if generative art involves a (partially) autonomous system of some sort, then this implies that there is a degree to which that system itself *is able to operate autonomously*. And second, if generative art is art that is (partially) produced by these systems, then this implies that there is a degree to which the system's output *is important for establishing or creating the artwork as a whole*. But what does this autonomous behaviour entail? How autonomous is this truly? Can we define multiple levels of autonomy in these systems across generative artworks? And if an autonomous system is involved, to what extend is the output of the generative system used in the artwork? What is its creative importance within the artwork? As these factors by definition seem to be important for generative art, we think it could be interesting to analyse generative art according to these. We thus introduce two concepts: *autonomous ability* and *artistic significance,* through which lens we propose to analyse generative art to find answers to the questions posed above and explore if we can come towards new insights about the generative in art.

3.1. Autonomous Ability

With the autonomous ability (AA) of an aspect in the artwork, we aim to examine *how independently this aspect can operate or execute its role without external help or input*. This could mean setting things into motion, performing a task, initiating something, but also creating or revealing something that is unpredictable, new, or surprising (i.e. things that could be defined as "emergent" behaviour or properties (Monro 2009; McCormack 2001), depending on the generative system itself. For example: where or when does it require support, assistance or input? If so, from whom or what? And is this supporting aspect then internal to the artwork or external, such as the artist, the audience or any other environmental factor? How autonomous is it able to operate if these supporting factors weren't there? Next to this practical execution, also the degree to which the aspect can make its own 'choices' independently are part of autonomous ability, as well as how much *creative freedom* the aspect has within these choices. For example, where does the decision making within the work take place? And how does this work? Is the output of the generative system in a way already predetermined? If so: to what degree, and by whom or what? What range of 'freedom' does the aspect have when creating its output? How much leeway or agency does the aspect have to navigate or transform the output space? Ultimately, can we define levels of independence, and subsequently degrees of autonomous ability?

3.2. Artistic Significance

With the artistic significance (AS) of an aspect in the artwork, we aim to examine *what its creative contribution to the artwork is* and *how artistically important this contribution is for the final work as a whole*. We reckon this might be hard to objectively determine, but we aim to achieve this with the following questions. What does the aspect contribute to the artwork? How does this contribution compare to the contribution of other aspects involved in the work? Could the artwork still be the artwork, if the aspect's contribution and its characteristics were not there? We would argue that deliberately distinguishing *output or performance* of the generative aspect from the *artwork as a whole* helps to more clearly formulate the concerning aspect's contribution to the work, and subsequently its artistic significance. For some works this might even be a necessity, in case the generative aspect is *not the only* aspect in the work. Therefore, in order to discern more relevant aspects in the work and their tasks, we feel the need to define two other factors for analysis, namely *elements* and their *roles*.

3.3. Elements

To define the autonomous ability and artistic significance of an aspect within a generative artwork, a good understanding of *what the actual artwork is* is required. What parts does the artwork consist of? And what part does the output or performance of the involved generative system take in this? Is this output or performance the artwork (i.e. does the output equal the work)? Or are more factors involved in constituting the overall work? We state that generative artworks often consist of more than just 'the generative', whether that being systems or processes. In fact, they can be a mix of both generative and non-generative aspects, or might even contain more non-generative elements than generative. For example, in Sol LeWitt's mural drawings, both the sets of written rules and instructions (generative), the draftsmen interpreting these (generative), as well as the site specific drawing surface with all its characteristics (non-generative) play important roles in how the resulting work will look like (Lovatt 2010, 2012). Moreover, their interrelations are relevant too, as the generative properties of the written rules are dependent on the non-generative properties of the surface, and vice versa. What we hope to illustrate here, is that it is difficult, and even unfavourable, to only take the generative aspects into account and ignore the non-generative when analysing generative artworks. Unfavourable, because it is imaginable that in a work the *non-generative* aspects have a crucial influence on the *generative* aspects, which in that case, might affect how we regard the autonomous ability of that generative aspect. Moreover, not only the generative aspects in a work can be from artistic importance for the artwork as a whole, but the non-generative aspects evidently as well. We thus state that isolating solely the

generative in an artwork falls short of a thorough analysis, would leave dependencies amongst aspects unseen, and eventually would skew the comparison of generative works fundamentally. Therefore, we propose to include both generative and non-generative aspects in the analysis, as well as their mutual dependencies and dynamics. We will call these the *elements* of the artwork in this study: the building blocks that constitute the artwork; its most important parts, that all together make the work 'the work'. There can be many or few elements involved in the work. To create more clarity, we define six element categories, being:

1. **Artwork elements:** the individual components or tools that are used in the artwork, both during its making process as well as in the final resulting work. These can be hardware, software, data, material, etc. and their possible output. Questions to distill elements under this category are: what individual parts are used in making this work? What generative system(s) are used? And what separate elements does this system itself consist of or are important to define? Next, the artwork might also include non-generative elements, as we discussed. What are these?

2. **Artist elements:** the maker(s), initiator(s), or architects of the work. What has been created and decided by the artist (and what not)? To define what level of autonomy or what level of artistic significance a certain element has, a good understanding of the role of the artist(s) is required. For example: is the artist's input required to let an element create output? Additionally, what role does the artist have in the final artwork or output? E.g. was there selection, modification or curation involved in the resulting work? If so, at what level?

3. **Performer elements:** the one(s) performing or executing the work. In the same manner as the artist element: is there a 'performer' present in the work that is from influence? Something that for example executes the work? Or let it 'become' the final resulting artwork? And if so: who or what is this?

4. **Audience elements:** the ones experiencing or witnessing the resulting work. What influence do they have on the work as such? Can they interact with or participate in the work? If so, what is their range of control: how and to what degree can they affect the work?

5. **Environmental elements:** external factors from the environment the resulting work is situated in. Is there any external input required or involved in the artwork? If so, what is it, and how does it affect the final work?

6. **Element interactions:** dissecting a work in the individual components involved might obscure how they work together. To mitigate

this, we describe their interactions, interdependencies and resulting behaviour as Element Interactions.

3.4. Roles

We have touched upon it already in some questions above, but we would like to highlight it explicitly. An element's autonomous ability and artistic significance is depending on *its specific role within that artwork*. Namely, a generative system involved in a work can by itself have strong autonomous qualities but if its output is filtered, restricted or a byproduct in the overall work than that influences its autonomy and thereby its artistic significance in relation to the artwork as a whole. Therefore, we argue it's important to examine each element's role within the context of that artwork. For example, what does the element do? What is its function or task(s) in the work? E.g. does it require interaction with other elements in the artwork and provide or receive input? Does it perform or execute something? Additionally, a work (or its output) doesn't have to completed by the artist. A work can be ongoing, ever changing or interactive. Does the audience, performer (if required) or environment have a role in the work? For example, is a generative musical composition fully completed when the artist has finished writing/making it? Or does it require certain executions by performers to become a final instance of the artwork (and does it allow for multiple different instances)? In other words: is the role of an element to create a *blueprint or score* of the work or to fully complete the artwork? We suggest that not the elements themselves, but the qualities and the contribution of their *roles*, should be analysed along the concepts of autonomous ability and artistic significance to get the most accurate and thorough understanding of where the generative in an artwork is situated. This requires to not only look at the internal elements of the artwork but also the roles of the other element categories: like the artist(s), performer(s), audience, environment, and element interactions. Therefore, we propose to first define all the elements present in the artwork, then evaluate what the roles of each element are, and only then analyse how autonomously these elements are able to perform these roles and how artistically significant their roles are for the final artwork as a whole.

In summary, the steps and questions for the analysis look like this:

1. What are the **generative and non-generative elements** involved in the artwork? This includes not only the material (e.g., hardware and software) the work consists of, but also the artist(s), performer(s), audience and environment of the work. Furthermore, both the making process and the resulting work are included in the analysis. What are the **roles of these individual elements** within the artwork? The role describes an element's functions and tasks. Does it generate, create, instantiate or determine something? Does it have emergent

properties? Does it require interaction with other elements in the artwork? Does it perform/execute something? Does it function as (or creates) the blueprint/score of the work? Does it complete the artwork, or create an instance of the artwork?

2. How **autonomously it is able to execute/perform this role?** I.e. can it operate/execute independently? Where or when is the artist or audience needed to let it create output? What levels of independence can we define and distinguish? And, to what extend does it have creative freedom in its role?

3. How **artistically significant is this role** for the content of the artwork as a whole? I.e. how important is the element's performance for creating the output? And how significant is that output and performance to the artwork as a whole? Could the artwork still be the artwork if the element's capacity/characteristics/input were not there?

Answering these questions carefully and consistently gives a thorough dissection of the generative artwork and what is at play. We hope it discloses what differences or similarities exist between the generative amongst separate artworks, and helps in making various dimensions of generativity in generative art explicit. For example, does the generative in an artwork lie on the level of the execution by the audience? How much generativity is held or performed by the artist self? Or, does the generativity exclusively lie on the level of the generative system? Making these differences explicit might, ultimately, aid comparison and evaluation of generative art.

Schematically, the framework looks like the matrix below:

Figure 1: Schematic overview of the proposed alternative framework.

	Artwork (AW) (its subjects, media, systems, individual parts, etc.)	Artist (AT) (the maker(s) or initiator(s) of the work)	Performer (PF) (the one(s) performing or executing the work)	Audience (AD) (the ones experiencing the work and participating/ interacting with it)	Environment (EV) (external input from the environment in which the work is situated)	Element Interactions (EI) (how elements relate to/ interact with each other)
ELEMENT						
ROLE(S) of the element in the artwork						
AUTONOMOUS ABILITY of the element to perform its role						
ARTISTIC SIGNIFICANCE of the element's role for the artwork						

4. Analysis and Comparison

To evaluate the framework, we tested it on a small, diverse selection of eight[1] generative artworks (ranging from 'traditional' to 'uncon-

1. The complete list of analysed works is: 1) *Mobile* (c. 1932) by Alexander Calder; 2) *Fidenza Collection* (2021) by Tyler Hobbs; 3) *Continuous Project - Altered Daily* (1970) by Yvonne Rainer; 4)

ventional', older to contemporary, and computer to non-computer examples of generative art) from different art disciplines. For the scope of this paper however, we chose to illustrate the model by means of four artworks: Alexander Calder's *Mobile* (c. 1932) (Fig. 2), Vera Molnár's *Structure de Quadrilatères* (1985) (Fig. 3), Mario Klingemann's *Memories of Passersby I* (2018) (Fig. 4), and Tyler Hobbs's *Fidenza Collection* (2021) (Fig. 5). In this section we will explain how we approached the analysis and what our insights are from comparing these analyses between the four artworks.
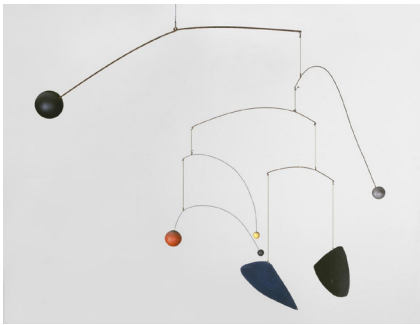
For each artwork, we filled in the matrix as introduced in Fig. 1. To support consistent comparison, for the third (AA) and fourth row (AS) we used a semi-quantitative measurement in the form of a six-step scale.[2] To keep the matrices concise and improve cross-referencing to cells, all cells were tagged with a short alphanumeric string corresponding to the element category abbreviation letters,[3] column number (starting from "1" for every element category, if more than one element under the same category is present) and row letter(s).[4] Once the matrices were completed, we traced 1) where in the artworks the generative is situated (by detecting in which cells of the row Roles the most generative concepts (e.g. "creating", "emerging", "inventing", "producing", etc.) are present. Elements *with* these concepts were defined as 'generative' (i.e. 'active', displayed in bold text in the matrices), whereas elements *without* these concepts were defined as 'non-generative' (i.e. 'passive', in regular text), 2) how the autonomous ability is distributed over the elements of the work (by evaluating the content of the /AA coded cells on their score), and 3) how the artistic significance is distributed over the elements (by evaluating the content of the /AS coded cells on their score). Lastly, to not obscure the boundaries between the *making process* of the work and the *work itself*, an extra visual distinction in the matrices was made between elements that *are part of the resulting work* (highlighted columns) and elements that *are not* (non-highlighted columns).[5] The completed matrices can be viewed in fig. 6, 7, 8, and 9.

4.1. Amount of Distinguishable Elements

When we compare the matrices with each other (meaning: between the four artworks), we find that first: the amount of distinguishable

Figure 2: *Mobile.* Kinetic sculpture. Image retrieved via Tate Gallery (2019). © Alexander Calder, Mobile, c. 1932, c/o Pictoright Amsterdam 2023.

Figure 3: *Structure de Quadrilatères.* Computer-generated graphic in ink on Calcomp plotter paper. Image retrieved via Senior (2019). © Vera Molnár, 1985, c/o Pictoright Amsterdam 2023.

Structure de Quadrilatères (1985) by Vera Molnár; 5) *Seven Experiments in Procedural Animation* (2018) by Karl Sims; 6) *Hot Pool* (2010) by Driessens & Verstappen; 7) *In C* (1964) by Terry Riley; 8) *Memories of Passersby I* (2018) by Mario Klingemann.

2. Being: 0) Not Applicable (N/A); 1) None; 2) Low; 3) Medium; 4) High; 5) Very High.

3. Artwork = AW; Audience = AD; Artwork = AT; Environment = EV; Performer = PF; Element Interactions = EI.

4. Element = E; Autonomous Ability = AA; Role(s) = R; Artistic Significance = AS; Format of the code tag thus becomes: [ElementCategoryLetters+ ColumnNumber/[RowLetter(s)]. E.g. EV2/AA = the second environmental element's autonomous ability.

5. As the highlighted element columns already make clear what is part of the resulting work, the Element Interactions column was not highlighted.

elements per artwork is considerably higher than we expected to define a priori. Apparently, when critically dissecting a work, more elements (both passive and active) emerge as essential. This could broaden the scope of what to take into account when analysing generative art, but moreover: requests for a broader conception of what could be seen as generative, autonomous or artistically significant within a generative artwork.

4.2. Distributed Generativity and Autonomy

Second, in all works the generative properties seem not confined to one individual element, but are distributed across multiple elements. For example, in Klingemann's work, the GAN models (AW3/R), the application (AW3/R), and the external output of successful samples (AW6/R) all hold generative properties. In Calder's Mobile and in Hobbs' *Fidenza*, also elements outside of the work play a generative role (for Calder the air current (EV/R), and for Hobbs the Art Blocks platform on the Ethereum blockchain (EV1/R)). Notably, the matrices make clear that in all four works the artists (AT/R) essentially have the most generative roles. This signals that more elements than the ones involved in — what are traditionally considered — "the generative systems" (such as algorithms, computers, set of natural language rules, etc.) can hold generative properties and can have an essential role for the content of the work. Furthermore, we see that the interdependencies between the 'traditional systems' and external elements in the works become visible in the column Element Interactions of the matrices. E.g. in both *Memories of Passersby* and *Fidenza*, we observe that the most generative processes take place at the level of the interactions of the elements (EI/R). This indicates that individually, many elements possess some degree of generative behaviour or properties, but that this range can be significantly enhanced, facilitated or kickstarted, in combination with the behaviour or properties of other elements: of which some might not even be internally part of the resulting work itself (i.e., 'Artwork' elements), but external (such as 'Environmental' or 'Audience' elements). This shows that the actual generative "system" of the work often encompasses more than solely the 'main' generative Artwork elements, and results from the greater whole of all its generative elements. Moreover, when comparing the autonomous ability of the generative elements across the artworks, we see a similar phenomenon: individually the generative elements have a lower degree[6] of AA then a priori expected, mostly due to their dependency on other elements in order to operate autonomously. But when viewed in context of their interactions, it appears that they collectively hold a very
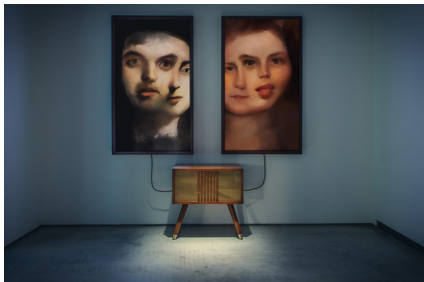

Figure 4: *Memories of Passersby*. Installation made with GANs (AI). Image retrieved via ONKAOS (n.d). © Mario Klingemann, Memories of Passersby I — Companion Version, 2018. Courtesy of ONKAOS.
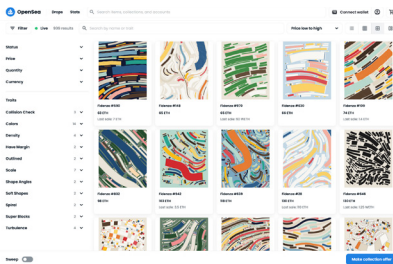

Figure 5: *Fidenza Collection*. Set of 999 algorithmically generated digital images. Image retrieved via OpenSea (n.d.). © Tyler Hobbs, Fidenza Collection, 2021.

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6. NB: the terms "low(er)" and "high(er)" as used in the text for comparison and discussion of the analyses results are different from the values "Low" and "High" used in the matrices. "Low(er)" in the text refers to the lower part of the six-step scale in the matrices (N/A - None - Low - Medium). "High(er)" in the text refers to the upper part of this six-step scale (High - Very High).

high degree of AA. E.g. in *Fidenza*, where the artist (AT/E), the script (AW1/E), the on-chain art platform (i.e. an 'Environment' element) (EV1/E) as a system (EI/AA) together are responsible for much more creative choices in the whole process, and carry significantly more autonomy than individually.

4.3. Deviated AA and AS

Third, the matrices show that the degrees of AA and AS not always align within elements. Meaning: not all elements that scored high in AA in an artwork, also scored high in AS, or vice versa. E.g. the application (AW2/E) and the external output of successful samples (AW6/E) in *Memories of Passersby*, or the program (AW1/E) or computer monitor (AW1/E) in *Structure de Quadrilatères* (both low AA, but high AS), or the on-chain art platform (AD1/E) in *Fidenza* (high AA, medium AS). This finding seems to contradict what is generally (implicitly) assumed in most studies into generative art, namely that when an autonomous element is used for creating the work, this element by definition also is important for the work as a whole, and the other way around. From the perspective of this framework, it appears that the degrees of AA and AS can diverge across individual elements involved in the artwork. However, one element that structurally does show alignment in AA & AS (i.e. both high) in the analyses is the 'Artist' (AT/E). This seems to indicate that, despite the general conception that in generative art a large part of control is attributed to a system or machine, the artist still plays a significant role in making the decisions (AT/AA) in the analysed works, that are — compared to decisions of other autonomous elements — highly important for the artwork as a whole (AT/AS). In the matrices, this becomes most evident in row /R, where the amount of crafting, developing, testing, and altering required by the artist in order for the machine or system to generate the envisioned output is listed. E.g. Calder's methodological experimentation with the physics of the mobile's hardware (AW/E) in combination with the air current (EV/E) to ensure interesting compositions, or Hobbs' extensive iterative process of designing, testing, tweaking an existing algorithm (Hobbs n.d.) in order to create a script producing coherent quality output over the full series of 999 at-random instances. As example, the designed properties of the *Fidenza* algorithm are particularly important for the content of the artwork, which makes the artist's role more artistically significant for the work than for example the role of the on-chain platform (EV1/AS) or the minting collectors (AD1/AS).

Additionally, the matrices also make explicit how the artist (AT/R) executes significant steps of selection, moderation, and curation of the in- or output of what can be regarded as the generative system, before the work becomes the final work. E.g. Molnár not only iteratively altered the code of her program (input) (AW1/E) based on the outcome visible in real-time on the monitor (output) (AW4/E) (a

process she termed "conversational method" (Molnar 1975), which was only enabled after the introduction of computer monitors), but subsequently also selected one particular instance of this program as fit for printing and exhibiting (and thus discarded the other outcomes). These form profound interventions, affecting the resulting artwork and its experience. This emphasises that although generative art involves "independent systems", on various levels the 'hand' of the artist is still very present.

Lastly, a finding that taps into this: over the course of time, some artworks have been generally renowned as undisputed examples of generative art, such as Molnár's. Often, critics tend to attribute a degree of autonomy in these works to the computer, mostly because of its ability to incorporate "randomness" (Guillermet 2020). With that, Molnár's aforementioned conversational method is often mentioned as an instinctive approach "that enables greater receptiveness to the unpredictable" (Rigamonti di Cutò 2018) which would prevent "premeditation" of the work. However, analysing Molnar's work through our framework suggests that one could also interpret Molnár's work as the opposite *because* of this conversational method, as the matrices disclose how much curation and iteration of the "random output" is present: the work is generated using an algorithm but the *behaviour* of the algorithm (including the used amount of randomness) is programmed by the artist instead of autonomously generated. In this case, one could arguably question how 'unpredictable' a generated work is, if the outcomes of the generating machine are heavily controlled, reviewed and curated in the process by the artist self. The matrices show that in other approaches curation and control takes place on a different level, such as in Hobbs' where controlled randomness is still at play (Hobbs n.d.), but who's method does allow a large range of different, 'unknown' output that can be generated/ produced based on the randomly generated seeds. These different approaches could suggest for a more critical perspective on how 'generative' and 'autonomous' the involved elements in generative art actually are.

Mobile (c. 1932), Alexander Calder

ELEMENT	Artwork (AW) (its subjects, media, systems, individual parts, etc.)	Artist (AT) (the maker(s) or initiator(s) of the work)	Performer (PF) (the one(s) performing or executing the work)	Audience (AD) (the ones experiencing the work and participating/interacting with it)	Environment (EV) (external input from the environment in which the work is situated)	Element Interactions (EI) (how elements relate to/interact with each other)
ELEMENT	AW/E. Steel wire, metal panels, wooden spheres, string	AT/E. Alexander Calder	N/A (not present/no explicit role in the work; therefore not applicable)	AD/E. The audience walking around the work	EV/E. The air current in the room where the work is presented	EI/E. The components of the mobile (AW/E) move by the changing air current (EV/E) present in the room.
ROLE(S) of the element in the artwork	AW/R. To generate movement and subsequently different compositions.	AT/E. Composing the mobile: choosing composition and balance between the individual elements of AW/E. Designing the "system" of mobile, air current, movement all together, and with that defining the "grammar" of the sculpture.	N/A	AD/R. To observe the work, and by standing and walking around it, add to the air current EV/E that causes AW/E to move and take on compositions.	EV/R. To initiate the process of AW/E generating movement. To displace the attached elements of AW/E relative to each other, so the work changes composition and perspective continuously	EI/R. The whole of mobile, audience, environment and their interaction forms the generative system, and it is there to form a closed, self maintaining loop.
AUTONOMOUS ABILITY of the element to perform its role	AW/AA. High: requires EV/E to generate movement, and its range of behaviour is dictated by the design choices of AT/E (by which the shapes and surfaces to catch wind are determined). However, its design still inhibits a large output space with a wide variety of possible movements and thus possible compositions that AW/E can autonomously take on.	AT/AA. High: holds significant agency in making creative choices for the grammar of the mobile. However, is depending on the physics of EV/E in combination with AW/E, to eventually create a composition-space that is interesting to experience for AD/E. For this, AT/E needs to experiment extensively to understand interaction of AW/E with AD/E and EV/E. Moreover, in the resulting work AT/E has no further influence, as this all depends on AW/E and EV/E.	N/A	AD/AA. Medium: can choose how to position themselves in space related to AW/E to observe different compositions, and with that might influence EV/E (e.g. by passing direction, speed).	EV/AA. High: the natural air current is specific to the environment needs no input or support from anything else, which makes this element autonomous.	EI/AA. Very high: once the mobile is hanging, the system is able to work independently and infinitely, and with that is able to generate new compositions of the work indefinitely.
ARTISTIC SIGNIFICANCE of the element's role for the artwork	AW/AS. Very high: movement is a key factor in this kinetic work. Therefore, AW/E is very important for both functionally catching EV/E in order to generate this movement, as for the continuous visual compositions of the sculpture, which makes AT/E highly artistic significant.	AT/AS. High: the artistic choices of AT/E in designing AW/E and experimenting how balance is formed influence the output space of possible compositions of the mobile, which is a priori determined with AW/E as this is a priori determined by AT/E through AW/E.	N/A	AD/AS. Low: significant to lesser extent for subtly contributing to EV/E. However, cannot influence nor add to the range of motion and thus compositions possible with AW/E, as this is a priori determined by AT/E through AW/E.	EV/AS. Very high: The air current initiates the generation of movement by the mobile, which is a very important factor of the work.	EI/AS. Very high: the interaction of the artwork elements with its environment is key to the work: it is what the sculpture is about. Therefore, the dynamics between all the elements is very artistically significant for experiencing the resulting work.

Figure 7: Matrix with analysis for *Structure de Quadrilatères* (1985)

Structure de Quadrilatères (1985), Vera Molnár

Category	ELEMENT	ROLE(S) of the element in the artwork	AUTONOMOUS ABILITY of the element to perform its role	ARTISTIC SIGNIFICANCE of the element's role for the artwork
Artwork (AW) *(its subjects, media, systems, individual parts, etc.)*	AW1/E. The program containing the drawing algorithm, designed by AT/E	AW1/R. To generate AW2/E, through AW3/E. Contains the rules and parameters designed by AT/E, through which AW3/E writes the 'composition' of the work i.e. lines and squares. Is an instance of AW1/E, and of the blueprint (AW1/E) that together make up the 'grammar' of the work. In short: to function as a blueprint of the work, is iterated on through adapting AW1/E by AT/E.	AW1/AA. Medium: depends on AT/E for its contents, and on AW3/E for its execution. But also: inhibits less room for creative 'freedom' or randomness as the code is relatively deterministic: it's designed to mimic the mental picture of the image by AT/E.	AW1/AS. Very high: it contains the 'grammar' of the work (i.e. the constraints of working with lines, squares, density, etc) that dictates what AW3/E should execute and are thus what to create as AW2/E.
	AW2/E. The output of AW1/E, executed by AW3/E.	AW2/R. Is the visual output of AW1/E, and the 'composition' of the work: an instance (AW2/E) of the blueprint (AW1/E)	AW2/AA. Medium: the output of AW1/E, changing in form with every iteration by AT/E. However, it does not have the ability to transform itself: it is created rather than creating.	AW2/AS. Medium: the iterative process to get from the 1st instance to the final one (which AT/E selects to become AW6/E) is artistically important for this work. However, because of this curation, most individual instances of AW2/E are discarded in the process, and are thus not significant for the final version of AW6/E.
	AW3/E. The computer	AW3/R. To execute AW1/E, and produce AW2/E. With this, AW3/E, a real-time output device via which AT/E can view AW2/E.	AW3/AA. None: can arguably execute AW1/E independently. However, has limited range of 'choice' as it effectively 'follows' instructions of AW1/E.	AW3/AS. Medium: is a crucial tool for materialising AT/E's 'ideas' (i.e. calculating the permutations of AW1/E designed by AT/E), and therefore also important for this work.
	AW4/E. The computer monitor (CRT screen)	AW4/R. To function as a real-time output device via which AT/E can view AW2/E.	AW4/AA. None: it has no other option than to show AW2/E (in its exact form)	AW4/AS. High: compared to mainframe computers without screens, the real-time feedback provided by AW4/E allows AT/E to interact and iterate immediately on AW1/E, which AT/E designed by AT/E. This iterative AW3/E for the iterative process of EI/E.
	AW5/E. The plotter	AW5/R. To print AW6/E.	AW5/AA. None: cannot operate AW5/R without being controlled by AW3/E, and has no creative freedom in what to print.	AW5/AS. Low: is important for physically producing AW6/E. But AW2/E (the 'end product') in physical form, and what is presented by AT/E as "the artwork".
	AW6/E. The physical black & white print with lines and squares	AW6/R. To function as the physical output of AW2/E, the final iteration of AW2/E.	AW6/AA. N/A (is a passive factor, that is created)	AW6/AS. High: is the final, curated output of AW2/E (the 'end product') in physical form, and presented by AT/E as "the artwork".
Artist (AT) *(the maker(s) or initiator(s) of the work)*	AT/E. Vera Molnár	AT/R. To design AW1/E. To iterate on the design of AW1/E after seeing AW2/E via AW4/E. To select the final version of AW2/E to be printed as AW6/E.	AT/AA. High: holds great creative freedom in many stages of the work: inventing AW1/E, iteratively altering AW1/E (i.e. 'conversational method') & curating AW2/E for AW6/E. However, relies for her conversational method on the AW3/E compositions AW1/E.	AT/AS. Very high: the decisions by AT/E significantly affect what AW6/E results in. Moreover, the curation by AT/E that is involved in this method means a larger artistic significant role of AT/E in the artwork as a whole.
Performer (PF) *(the one(s) performing or executing the work)*	N/A (not present/no explicit role in the work; therefore not applicable)	N/A	N/A	N/A
Audience (AD) *(the ones experiencing the work and participating/interacting with it)*	N/A (not present/no explicit role in the work; therefore not applicable)	N/A	N/A	N/A
Environment (EV) *(external input from the environment in which the work is situated)*	N/A (not present/no explicit role in the work; therefore not applicable)	N/A	N/A	N/A
Element Interactions (EI) *(how elements relate to/interact with each other)*	EI/E. The computer "draws" the "mental image" that the program contains, and is iteratively given new permutations by the artist for generating the next instance.	EI/R. To facilitate a dialogue between AT/E and AW3/E, which ultimately results in generating AW6/E.	EI/AA. Medium: once the infrastructure of EI/E is established, EI/R can flow independently. However, AT/E has such a decisive role in initiating, maintaining, and operating EI/R, that it diminishes the AA of EI/E as a whole.	EI/AS. Very high: the interaction between AT/E, AW1/E, AW3/E & AW4/E dictates what AW2/E and thus AW6/E as final artwork looks like, making EI/R very artistically significant for the artwork as a whole.

Figure 8: Matrix with analysis for *Memories of Passersby I* (2018)

Memories of Passersby I - Companion Version (2018), Mario Klingemann

ELEMENT	Artwork (AW) (its subjects, media, systems, individual parts, etc.)							Artist (AT) (the maker(s) or initiator(s) of the work)	Performer (PF) (the one(s) performing the work and or executing the work)	Audience (AD) (the ones experiencing the work and participating/ interacting with it)	Environment (EV) (external input from the environment in which the work is situated)	Element Interactions (EI) (how elements relate to/interact with each other)
ELEMENT	AW1/E: Training data (images of paintings)	AW2/E. Application containing learning conditions, developed by AT/E	AW3/E. GAN models, developed by AT/E and trained on AW1/E through AW2/E.	AW4/E. Computer	AW5/E. INTERNAL OUTPUT: – virtually generated samples, discriminated by itself	AW6/E. EXTERNAL OUTPUT: – visually generated samples, presented on AW7/E	AW7/E. Physical objects of the installation: two 65" 4k framed screens, wooden console housing the computer and other hardware, chairs	AT/E, Mario Klingemann	N/A (not present/no explicit role in the work; therefore not applicable)	N/A (not present/no explicit role in the work; therefore not applicable)	EV/E. The room AW6+g/E are exhibited in, and its properties (lighting, size, acoustics)	EI/E. Based on what it has received as input, the GAN models "learns" itself to produce its own "paintings", which are presented in real-time
ROLE(S) of the element in the artwork	AW1/R. Is the dataset of digital images (concerning 17th–19th century Western-European paintings) on which AW3/E is trained. Is collected, curated, and formatted by AT/E.	AW2/R. Instructs AW3/E with its learning conditions; contains algorithms indicating how to process AW1/E, iteratively fine-tunes its training and subsequently its method of generating. Contains the blueprint for the internal feedback loop of generation between AW3/E, AW5/E, and AW6/E	AW3/R. Generates AW5/E, based on its training on AW2/E. Executes method of generating AW5/E with discrimination. If discrimination is successful.	AW4/R. Tool for AT/E to develop AW2/E and AW3/E with. Executes AW2/E, which is virtually presented to AW3/E for discrimination, after which a selection of AW5/E then becomes AW6/E.	AW5/R. Set of images of fake portraits generated by AW3/E based on the AW5/E samples that successfully passed the discrimination by AW3/E. Visually presented as a stream of morphing portraits on screens of AW7/E.	AW6/R. Real time generated images of the AW5/E samples that successfully passed the discrimination by AW3/E, and presented to the audience as a stream of morphing portraits on screens of AW7/E.	AW7/R. To function as both practical (house & format AW1/E. To the hardware of AW/E) and decorative elements that enhance the experience of AW6+g/E to AD/E.	AT/R. To collect, curate & format AW1/E. To design and develop AW2/E, to select and alter AW3E.	N/A	N/A	EV/R. To establish the ambiance in which AW7/E is exhibited, that ultimately adds to the experience of AW7+h/E for AD/E.	EI/R. To form a self-operating and self-maintaining system with internal feedback loop, that is able to generate output indefinitely.
AUTONOMOUS ABILITY of the element to perform its role	AW1/AA. N/A (AW1/E is a passive element, that does not contain explicit generative properties.	AW2/AA. Medium: has autonomous capacity for training AW3/E. However, depends on AT/E for its design, and thus also what its content dictates.	AW3/AA. Very high: is able to generate, select, and adjust output independently and continuously, due to internal structure of generation and discrimination. Outputs in essence "follows the instructions provided by AW2/E.	AW4/AA. Low: can arguably operate autonomously. Concerning freedom of choice; however, it has limited capabilities as it is a passive element, that does not contain explicit generative properties.	AW5/AA. N/A (AW5/E is a passive element, that does not contain explicit generative properties.	AW6/AA. Low: is able to generate new visualisations continuously, but itself inhibits no creative "choices" in which images from AW5/E to include, as this is determined by AW6/E.	AW7/AA. N/A (AW7/E is a passive element, that does not contain explicit generative properties.	AT/AA. High: AT/E is very autonomous and holds a lot of creative agency in performing AT/R. However, AT/E relinquishes significant control over what samples are created (AW5/E) and selected for AW6/E, to AW3/E.	N/A	N/A	EV/AA. Medium: however the properties of EV/E could influence how AD/E experiences AW6+AW7/E, they are a prior decided upon and many creative choices fixed by AT/E (darkened, empty, silenced) to carry out AT/E's vision of how work are made "within" or by the collective elements that constitute the collective system.	EI/AA. Very high: the system of the relevant elements all together is part of the concept of the work: the idea that a system like this can autonomously operate in its architecture, and generate many creative choices for the content of the work are made "within" or by the collective elements that constitute the collective system.
ARTISTIC SIGNIFICANCE of the element's role for the artwork	AW1/AS. High: the specific visual properties (i.e. colour palette, contrast, composition, figurative representation) inhibited by these images, will inevitably influence the content of AW5/E, making AW1/E some artistic significance for the curation of output, which arguably makes AW1/E artistically important for the content of the work.	AW2/AS. High: because it dictates how and what AW3/E "learns", it indirectly influences the output of generation AW5/E and thus AW6/E. Therefore, it has some artistic degree of internal significance for the content of output, which arguably makes AW2/E artistically important for the content of the work.	AW3/AS. High: what the basis for further decisions and outcomes along the work. However, its role is not important as the content of AW6/E for the artwork as a whole.	AW4/AS. Medium: without its properties, this work could be materialised, effectively making AW4/E a productional requirement for the work. However, its role is not important as the content of AW6/E for the artwork as a whole.	AW5/AS. Medium: might contain samples that are selected for AW6/E. But might also contain samples that are discarded by AW3/ work. Moreover, its content forms the input for the feedback loop of EI/E; making it as important as the content of AW6/E for the artwork as a whole.	AW6/AS. Very high: is the main experienceable component of the work, and as such can enhance the experience of it. However, are not as important as the content of AW6/E, making it artistically significant to the work as a whole.	AW7/AS. Medium: are important for the full experience of the work, and as such can enhance the experience of the work. However, are not important as the content of AW6/E for the artwork as a whole.	AT/AS. High: curating AW1/E determines the visual output space of AW7/E, setting parameters in AW2/E (which form a discrimination guideline for AW3/E) enforces a certain aesthetic of AW5/E. These are important for the content of AW5/E. However, due to the complexity of the internal feedback loop (EI/EI), AT/E can hardly foresee every result of its design choices processed in AW2/E, which diminishes the AS of this element.	N/A	N/A	EV/AS. Medium: the properties of EV/E can certainly enhance the experience of AW. But since these are largely directed by AT/E, and not suppose to change over time, these are from lesser AS for AW than other elements.	EI/AS. Very high: the self-maintaining system is an important part of the concept of the work: the idea that a system like this can autonomously operate and generate unpredicted outcomes (and which has learned itself how to do so) is an important factor for the experience of the work. Therefore, EI/E is artistically significant part for AW as a whole.

Figure 9: Fig. 9. Matrix with analysis for *Fidenza Collection* (2021)

Fidenza Collection (2021), Tyler Hobbs

ELEMENT	Artwork (AW) *(its subjects, media, systems, individual parts, etc.)*					Artist (AT) *(the maker(s) or initiator(s) of the work)*	Performer (PF) *(the one(s) performing or executing the work)*	Audience (AO) *(the ones experiencing the work and participating/ interacting with it)*	Environment (EV) *(external input from the environment in which the work is situated)*	Element Interactions (EI) *(how elements relate to/interact with each other)*
ELEMENT	AW1/E: The script containing the algorithm with different parameters (i.e. scale, shape, colour, margin, turbulence, etc.), selected and designed by AT/E. Uploaded by AT/E to EV1/E.	AW2/E: Computer	AW3/E: Collection of 999 digital images (JPEGs), each a unique instance generated by the script (AW1/E). Exist as NFTs on EV1+0/E.	AW4/E: The printer	AW5/E: The physical prints of AW3/E.	AT/E: Tyler Hobbs	N/A (not present/no explicit role in the work; therefore not applicable)	AO1/E: Collector minting a Fidenza NFT via EV1/E. AO2/E: Visitors of EV1+0/E witnessing AW3/E or people witnessing or owning AW5/E.	EV1/E: Art Blocks, a platform hosting generative art and NFT collections on the Ethereum blockchain. EV2/E: Secondary NFT marketplaces, such as OpenSea, Rarible, Foundation, etc.	EI/E: The audience is able to instantiate the generation of a work, through the blockchain technology, which outcome is a priori unknown to both the audience and the artist.
ROLE(S) of the element in the artwork	AW1/R: To generate AW3/E through EV1/E: Functions as a blueprint for AW3/E; provides the main parameters that can be altered; input provided by EV1/E, in order to generate the instances of AW3/E.	AW2/R: Tool for AT/E to develop and test AW1/E, with, prior to uploading it to EV1/E. Executes algorithm (AW1/E), but to be wrapped as NFT and directly transferred via EV1/E to AO1/E. Possibly resold by AO1/E to AO2/E via EV2/E.	AW3/R: Are the individual instances of AW1/E; the visual output of a specific iteration of the algorithm (AW1/E). To be representation of AW3/E directly transferred via AO1/E or AO2/E	AW4/R: To print AW1/E;	AW5/R: To function as the physical, high quality representation of AW3/E, optionally ordered by AO1/E or AO2/E	AT/R: To design AW1/E, to select an existing algorithm and experiment extensively with its possibilities, to test what range for every parameter provide interesting outcomes for AW3/E, and adjust the algorithm to that. In short: to design the blueprint of the work.	N/A	AO1/R: To mint (i.e. purchased) an instance (AW3/E) of AW1/E via EV1/E. Received both the minted image (AW3/E) and the corresponding NFT in their NFT wallet. Can decide to offer AW3/E for auction to AO2/E via EV2/E.	EV1/R: To facilitate the infrastructure for minting AW3/E and generating corresponding NFTs, Generates a random seed during minting the AW3/E. Stores AW3/E on chain. EV2/R: To showcase the collection to AO2/E, and for the resale of AW3/E	EI/R: To establish an interesting method of generating art: creating (AW3/E) by the technical infrastructure (EV1/E), without any possibility of curation afterwards.
AUTONOMOUS ABILITY of the element to perform its role	AW1/AA. High: requires EV1/E's input before it can generate AW3/E. Contains a relative 'simple' algorithm that even inhibits controlled randomness (as AT/E predetermines ranges for every parameter). However, still inhibits a vast output space for creative output.	AW2/AA. Low: can arguably operate autonomously. Concerning freedom of 'choice', however, it has limited capabilities as it in essence 'follows' the instructions provided by AW1/E.	AW3/AA. N/A: AW3/E is a passive element	AW4/AA. None: cannot operate AW4/R without being controlled by AW2/E, and has no creative freedom in what to print.	AW5/AA. N/A: AW5/E is a passive element	AT/AA. High: does not have any control over the process of AW3/E generation (through minting), a vital step in EI/E. However, this is the only action AO1/E can take for generating AW (i.e AO1/E is by design of AT/E not autonomously able to influence what parameters will permutate in AW1/E.	N/A	AO1/AA. Medium: has the agency to initiate the generation of AW3/E (through minting) since it has no influence on the contents of the permutations in any way, and thus cannot affect the resulting work as such.	EV1/AA. High: depends on AW1/E and its technical properties & the notion that AW3/E is a coherent, limited series of work (which does, making it integral part of the work. Yet, it does not determine the content of the work, making EV1/E less artistically significant than AW1/E. EV2/AA. N/A: EV2/E is a passive element	EI/AA. High: The system of EI/E is able to operate independently, and inherently contains the properties to decide on the visual characteristics of the work.
ARTISTIC SIGNIFICANCE of the element's role for the artwork	AW1/AS. Very high: the unity in variety makes AW3/E an interesting set. So although every instance of AW3/E is constructed within the same constraints, and thus all have the same 'grammar', the visual output is the core artistic concept of the work, and thus significant difference across the outcomes that AW1/E is able to generate.	AW2/AS. Medium: without the properties of the computer, this work could be materialised. This makes AW2/E a productional requirement for the work. However, its properties are not important for the content of the work, and AO2/E view and purchase as 'the artwork'.	AW3/AS. High: it is the visual output of the algorithm (i.e. the 'end product'), and the element AO1/E and AO2/E view and purchase as 'the artwork'.	AW4/AS. Low: is important for physically producing and thus experiencing AW4/E. But AO1+b/E view and purchase as a form of 'the artwork'. Yet, although a nice addition, printing AW3/E is not the main artistic concept of this artwork (whereas AW3/E is: generating and storing art on chain).	AW5/AS. Medium: is the visual output of the algorithm (the 'end product') in physical form, and the element AO1+b/E view and purchase as a form of 'the artwork.' Yet, although a nice addition, printing AW3/E is not the main artistic concept of this artwork, making the role of AW5/E less artistically significant for the work as a whole.	AT/AS. Very high: both the 'grammar' of the script containing the rules with which AW1/E can generate AW3/E, as well as the resulting grammar present in AW3/E are key to the process of EI/E, making the role of AW3/E very artistically significant for the work as a whole.	N/A	AO1/AS. Low: other than initialising the generation of an instance of the work, AO1/E is not artistically significant for AW3/E, since it has no influence on the contents of the permutations in any way, and thus cannot affect the resulting work as such.	EV1/AS. Medium: its role is important for creating visibility for the full collection (AW3/E), and thus for establishing the notion that AW3/E is a coherent, limited series of work (which adds to the idea/ mystery of 'what is part of the work. Yet, it does not determine the actual content of the work, making EV1/E less important from any importance. EV2/AS. Medium: its role is important for creating visibility for the full collection (AW3/E), and thus the role of EV2/E contributes to the idea of an algorithm and the blockchain technology being able to generate coherent series of images. This element of surprise as well as outsourcing of control EV2/E'), but for generating the actual content of the work, it is not from any importance.	EI/AS. Very high: although the concept is simple, the role of EI/E contributes to the idea of an algorithm and the blockchain technology being able to generate unpredicted, unique yet coherent series of images. This element of surprise as well as outsourcing of control is an important artistic element to this artwork as a whole.

5. Discussion and Limitations

Having analysed a few artworks with this framework, we can discuss the first findings on its working and its results. First we observe that, when completed, the matrices tend to make clear where the *generative gravity* within an artwork is located, that is within the presented artwork itself (i.e. 'closed': at the left side of the matrix, under column AW), or outside of the artwork (i.e. 'open': at the right side of the matrix, under columns AT - PF - AD - EV - EI). This visual aid might be valuable for obtaining a quick, basic understanding of a generative work. Second, columns AW (Artwork) and EI (Element Interactions) seem to disclose that generative art exist in roughly two forms: works that are generat*ed* (i.e. works that are created with or through generative methods, but of which the resulting work is not generative themselves) or works that are generat*ing* (i.e. resulting works that are generative themselves). The first form consists of final work or 'end products' that are 'finished', do not require any further input and are not evolving over time (e.g., the works of Molnár and Hobbs). Works of the second form, however, are not 'finished', do require certain input in order to 'work' and are evolving over time, (e.g., the work of Calder and Klingemann (ONKAOS 2018)). We think this is an important distinction to make and could function as an extra classifier for analysing and comparing generative artworks.

Lastly, we found that the framework exposes how generative art artists are not specifically interested in letting a machine or system produce something autonomously, but more *in creating something in collaboration with it*. They use generative methods as a way to establish a *dialogue* between them and 'the system', that adds a sense of serendipity, unexpectedness and (controlled) 'out-of-control-ness' that makes generative art both interesting to make and experience e.g. Molnár's conversational method, Hobbs' and Calder's structural grammar that generates surprising compositions in combination with other system elements. This, together with the argument for an adjusted notion of the AA of those systems, might shift the discourse around generative art from art created *by* the machine, to co-creating art *with* the machine.

Needless to say, this framework is not conclusive in every aspect. To an extend it has fixed guidelines on how to analyse and interpret generative artworks, but in theory multiple readings of elements, roles, AA or AS are still possible. We tried to obviate this as best as possible, by articulately defining what we consider under every concept and element category, and what to fill in where in the matrices. However, we realise that some ambiguity in interpretation of these questions might exist: per artwork, but also per analyser. For example, for *Fidenza*, we listed the on-chain Art Blocks platform as an environmental element (EV1/E), as the work technically is presented there, whereas one arguably could also consider it an Art-

work element. Additionally, we chose not to include the computer monitor as element in the analysis for Klingemann and Hobbs, but we did for Molnár since we considered that in context of Molnár's work the monitor was from greater importance to the work as such.[7] Other well-argued choices for elements and placements, however, are just as valid for analysis. This touches on a challenge we encountered ourselves: how to deal with the tools used for making the work? How to interpret their AA and AS? E.g. the computer: essentially a tool that 'follows' instructions provided by a program to generate output. Framed by the question: "what does its role contribute to the artistic content of the work?", we considered its AA and AS therefore low (see AW4/AS in Klingemann's, and AW2/AS in Hobbs). However, we reckon one could also interpret its AS as high based on a different reasoning (e.g. in case of Molnár: "using computers as tools for artistic expression was novel at that time, and therefore the idea of this element being able to generate something artistically is more important to the work" or "the computer enables a certain *vision on or inspiration for* producing art in general, which in itself is artistically significant (to the work)"). We realise this might diminish the effective conclusiveness of the framework, and therefore suggest to assess this in future research, while ensuring its flexibility. Analysing generative artworks through this framework proved to be an iterative process of adding, deleting, and shifting elements across the matrix, going back-and-forth between all elements for understanding and defining their roles, AA, and AS. This in itself already illustrates the intricate, multifaceted aspects of generative art. Concerning representation, we aimed to test the framework on works from multiple art disciplines. However, due to the scope of the research, examples from literature, design and architecture were not included in the analyses, nor were works outside of the Western art canon. We are aware that this affects the results, and therefore suggest for future research to include works from outside these frames, in order to facilitate more comprehensive comparisons and conclusions with the framework.

6. Conclusion

We developed this framework from the need for a more in-depth, critical method for analysis of generative art, that honours its diversity and allows for an understanding of the generative beyond solely the denotation of the 'system' or its processes. Important notions were previously coined by Galanter, Boden & Edmonds, and Dorin et al., which established a useful ground. From this, we aimed to make the next step and approach the generative in relation to the work as a whole including all involved external elements and their interactions. Therefore, we pushed dissecting generative art further

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7. Due to the facilitating role the monitor directly played for Molnár's specific way of making generative art (i.e. her "conversational method" (Molnar 1975)), resulting in this specific work.

by deliberately defining more element categories (e.g. 'Artist', 'Performer', 'Audience', etc.) in our framework in order to make their impact within the work explicit. We took Galanter's definition of generative art quite literally, and proposed to analyse generative art through the lens of autonomous ability and artistic significance, to see what it would reveal about the generative within and between artworks. We noticed that by being very meticulous and explicit in this, details on what plays an important role in the work, what is generative and on what level this takes place in the artwork come to the surface. The most notable findings are that significantly more elements then generally accredited for, together constitute the 'system' in a generative work. Also, more elements than the generative can (either) be autonomous and artistically significant for the work as such but correspondingly: not all generative elements by definition are autonomous nor artistically significant. In that fashion, the degree of autonomous generativity of some generative works could be questioned, and lastly: a lot of autonomy and artistic significance within the artworks is located at the level of the artist. Perhaps these findings challenge some general assumptions of generative art (e.g. that something "generative" is unquestionably autonomous, and that something "autonomous" by definition is artistically important for a work). We reckon this way of thinking about generative art certainly adds to the idea of "creative machines" and "art autonomously made by systems", which unmistakably speaks to our collective imagination and hype sensitivity. However, analysis through our framework discloses that even system-generated work contains a considerable degree of control and direction held by other elements — especially the artist self, which might nuance our general view on how much control the artist actually relinquishes to an autonomous system, and might adjust our conception of how "autonomous" those systems truly are.

We hope this framework provides an interesting alternative perspective on generative art. We think it can be a meaningful tool for analysing and comparing artworks, and help in obtaining a more critical understanding of generative art. We consider the framework valuable for art critics, researchers, and curators, but also for makers of generative art themselves, as it might reveal opportunities for applying generative methods or elements at different categories or in different modes. Needless to say, the field of generative art evolves rapidly and turbulently, which provides both a challenge for the framework and interesting conditions for its application and relevance. We are therefore curious what it can contribute in light of these rapid developments in generative AI, the proliferation of generative art production, and corresponding public discussions about creativity, authorship and authenticity.

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