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# The Machines Wave Back

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## ABSTRACT

This paper examines notions of autonomy and agency in the context of understanding artist and rules system relationships within an Autonomous Art System (AAS). The concept of Create / Read / Update / Delete is borrowed from computer engineering as a metaphor for a role-based (rather than medium-based) framework for classifying AASs and, combined with the discussion of autonomy and agency, forms the basis for a new taxonomic system of Autonomous Art Systems for analysis, categorization and comparison.

> "A chipped pebble is almost part of the hand it never leaves. A thrown spear declares a sort of independence the moment it is released."
>
> – Isaac Asimov, "The machine and the robot" in Robot Visions

> "The machines aren't very smart yet, but we're teaching them this stuff all the time. We're giving them eyes and ears and we're giving them access to our world. We're sharing our social spaces with them increasingly. They increasingly live like the render ghosts, on the borders of our world, and they're starting to share it with (us).
>
> – James Bridle, "Waving at the Machines"

## INTRODUCTION

The purpose of this paper is to propose a way to describe degrees of autonomy and agency in Autonomous Art Systems (hereafter, AAS) to aid in analysis, categorization and comparison of such systems, and to consider their boundary conditions in an art-making context. Along the way, I will tell a few stories, share some observations, and shamelessly poach terms and concepts across a range of unrelated disciplines. The broad goals of this investigation are to develop and present a new way to frame discussions of autonomous art systems, to complicate generally accepted notions of artist-AAS relationships and to a propose a new model of taxonomy for AAS.

The true challenges of this last goal, have become clearer through research. On one hand, a cross-disciplinary review of literature has exposed that, although the urge to create a descriptive or generative taxonomy of AAS seems strong, the expression of this tendency results in many schemes that break either too nebulous to be actionable, or so formally and/or disciplinarily tight as to be of limited interest to artists who are not also so inclined. [1] [2] [3] [4] This gap seemed to present an

opportunity to move forward. On the other, in terms of surveying existing work, it became apparent that artists have myriad approaches to documenting and communicating their processes in general (and perhaps AAS practices in particular) from complete opacity to illustrated step-by-step how-to and source code repositories, and from earnest interrogations of process to wild confabulations after the fact. This range of approaches presents an obstacle to generalizable classification through examination of existing work, and the situation is sometimes exacerbated by curators who lack experience with, or scholarship in, AAS. [5] None of this precludes saying something that I hope some will find useful, even if that something is headier and not as deeply engaged with the grain of actual practice as I might have wished.

## SITUATING AUTONOMY

The English word 'autonomy' derives from the Greek αὐτονομία (autonomía) in turn, from autonomos, meaning something like "having its own laws." The current, commonly understood, meaning points to someone (or something) having the capacity to make independent decisions, without outside involvement or control, about their own actions. This general way of understanding of autonomy—as a capacity—leads easily to notions of degrees of (if not of kinds of) autonomy, such as semiautonomous cars or semiautonomous geopolitical regions.

In an early (1978) sketch of autonomous systems in the context of remotely-operated undersea vehicles, Thomas B. Sheridan and William L. Verplank, developed a ten-point model of human-machine collaboration based on degrees of machine autonomy. The text of the manually-typed, hand-annotated and much-mimeographed chart, LEVELS OF AUTOMATION IN MAN-COMPUTER DECISION-MAKING, reads as follows:

1. human does the whole job up to the point of turning it over to the computer to implement.
2. computer helps by determining the options
3. computer helps determine options and suggests one, which human need not follow.
4. computer selects action and human may or may not do it.
5. computer selects action and implements it if human approves
6. computer selects action, informs human in plenty of time to stop it.
7. computer does whole job and necessarily tells human what it did.
8. computer does whole job and tells human what it did only if human explicitly asks.
9. computer does whole job and tells human what it did and it, the computer, decides he should be told. (sic)
10. computer does whole job if it decides it should be done, and if so tells human, if it decides he should be told. [6]

One can almost imagine a Bakelite dial on a control panel labeled 'autonomy' being turned from 1 to 10, shifting the decision-making capacity proportionally from human to machine. But looking closer, there is a definite asymmetry in the level descriptions: at no point does the human 'help' the computer, nor is the computer given an opportunity to approve human action. Instead, the human is imagined to have full autonomy—until the computer removes it in level seven by excluding the human from the process. This asymmetry may be an effect of framing these levels in terms of 'automation,' but I find it notable for what it suggests about ideas of shared autonomy (which I will return to shortly). The point of highlighting this list from the early days of implementing

autonomous systems is to demonstrate that system autonomy, from the beginning, was conceptualized as being a matter of degree. For reasons that aren't clear, the description for level ten ("computer does whole job if it decides it should be done, and if so tells human, if it decides he should be told.") is somewhat hilariously cited by later investigators as "The computer decides everything, acts autonomously, ignores the human." [7] [8]

Of course, Sheridan and Verplank were concerned with operating submersibles, not making art. They were also already using computers; so, allow me to back up a little.

As Philip Galanter notes, autonomous art systems (or 'generative' systems, as he prefers, although I will argue generation is only one possible role for such as system) do not necessarily entail digital technology, computers, or even sophisticated tools or machines. [9] [10] The ancient divinatory system of the I-Ching, for example, relies on nothing more advanced than casting yarrow stalks or flipping coins. Although arguably not an 'art' outcome, the system does function to algorithmically generate graphic symbols with no decision-making from the human consulting it (beyond, of course, the initial human decision to use the rules-structure and the continuing decision to honor that rules-structure). In this sense, the system is fully autonomous, even if it is profoundly lacking in 'agential sophistication' or power (more about that soon).

## THE ARTIST-STRUCTURE RELATIONSHIP

Autonomous art systems have been persuasively described as an "indirect production method" for artists. [11] This method entails a relationship between an artist and a system in which autonomy, understood as the capacity to make decisions, is somehow shared along a spectrum between an artist and a system, with each entity separately bounded. I argue that the notion of 'system' in AAS necessarily includes both the artist and a rules-structure; a structure which may or may not be an extension or projection of the artist involved. In the example of the *I-Ching*, to derive hexagrams as output the human must animate the rules-structure. These two, human and rules-structure, taken together, then constitute an autonomous system.

The notion of autonomy, within the context of a relationship, is not a completely straightforward proposition. It does not, as articulated by the submariners, necessarily result in a zero-sum condition since autonomy in any domain could be understood both this way (as proportionally shared) or as expressed independently in either a synchronous or asynchronous mode.

This "peculiar situation" may not rise to the level of organizational closure demanded by Varela's formal definition of an autonomous system, but his observations of the implications of both specifying and being enmeshed in a system are useful in thinking about the artist as always part of the rules-structure, unable to get outside it: "In the characterization of organizational closure, nothing prevents the observer himself from being part of the process of specifying the system, not only by describing it, by being one link in the network of processes that defines the system. This situation is peculiar in that the describer cannot step outside the of the unity to consider its boundaries and environment simultaneously, but it is associated with the unity's functioning always as a determining component." [12] From this perspective, the 'system' in an AAS cannot be thought of as something apart from the artist, but rather as container for a spectrum along which both artist and rules-structure negotiate autonomy. Conditions toward the opposite end points of this spectrum may appear to support a zero-sum interpretation, since at one extreme of this relationship the rules-

structure is largely excluded from the system, and, at the other, the rules-structure not only plays the game alone, but decides its own rules (and, perhaps, even which game to play).

Putting the rules-structure on an equal footing with the artist within an AAS instead of seeing the artist in a supervisory role outside the system is not necessarily a nod towards 'flat ontology,' but is an acknowledgement that we are not so separate from our systems, structures and technologies as we may think. [13] To be clear, though, in this notion of AAS I am laying out, the human artist must cede some degree of autonomy to the rules-structure as the price of admission to the AAS.

## A CRUDDY REST

Within an AAS, first and foremost, the human artist is always the selector of one or more rules-structures; s/he is also sometimes also their author. Outside the AAS, these two meta-roles combine globally with the features (or methods) of specific rules-structures to offer several non-mutually-exclusive roles for an artist to inhabit. These are the roles that generally come to mind when discussing an AAS as something the artist exists outside of. The most conventional role for the artist is that of creator; in this role, the artist employs some aspect of a rules-structure to express authorship in artistic production. A second role is that of collaborator. This is a role familiar to artists from working with other humans, but shifted, in this instance, to working with a rules-structure instead. A collaborative position implies an adaptable rules-structure that has some capacity to interact, or at least respond, to the artist. A third role-position is that of artist as curator. If the rules-structure is abundantly generative (or particularly opaque), the artist may act primarily (or exclusively) to limit or select from the generative output. Finally, because some rules-structures have the capacity to surprise even their authors, it is entirely possible for an artist to be a spectator or audience to their own work through an automated art system. [14] These roles are outward-facing; explanatory. They tell a story of how an artist might work with an AAS, but not how an artist + rules-structure AAS works. While these roles of the artist distinct from an AAS may be readily understood as variations of or extensions to those found in traditional art practices, I want to go a bit further afield to illuminate the potential operational roles of rules-structures by analogy to concepts and applications from contemporary software development.

'CRUD' is the not-so-charming acronym that represents a widely accepted concept of a set of primitive operations that may be performed on any data. CRUD is short for Create, Read, Update and Destroy/Delete. A related concept is 'REST' (which is short for REpresentational State Transfer), a high-level application programming interface (API) style based on CRUD, and used mostly for the web. So-called 'RESTful' APIs generally have a set of methods (which have 'verbs') like PUT, GET, POST and DELETE. CRUD is the overriding concept, while REST is a specific implementation of that concept for 'live' data of the sort that lives on and makes up the web. (The fine particulars of these definitions are debated and parsed with nearly rabbinical intensity in online forums such as stackexchange.com). [15]

Beyond their narrowly specific meanings in software engineering, though, RESTful methods (with some modified verbs) can be adapted as a useful metaphor for thinking about the range of rules-structure roles inside an AAS. If we render Get as 'gather' (aggregating visual, textual or audio material for instance), Put as 'alter/mutate' (transforming materials, elements or rules in various ways), Post as 'generate' (creating new material, content or rules) and Delete as 'curate' (in the sense of preferentially selecting some elements and rejecting the others), we have a nearly

comprehensive model of the possible methods employed by AAS-based rules-structures. We may round out the verbs by adding a fifth method, 'distribute' (here, also the inverse function of gather), for methods that disseminate material/content without generation or mutation (an example of which is the networked AAS known as the Poietic Generator). [16]

The symmetry between roles of the artist as described apart from the AAS and those of the rules-structure inside the AAS is not perfect. 'Collaborate,' for example does not map to the CRUD concept in a convincing way since, by definition, it implies a negotiated, multipart interaction that must exist between and among the other five. This strictly verb-based classification scheme contrasts with Boden & Edmonds classification of AAS which is based partly on medium or underlying technology, and partly on the role the technology plays: computer art (C-art), generative art (G-art), digital art (D-art), electronic art, (Ele-Art), etc. [17] I argue that a technology-based classification system will, on the leading edge, tend to constantly require new terms as technologies emerge, and, on the trailing edge, may become clogged with less and less used and useful terms as technologies become quaint or obsolete (even in the long tail of art-making contexts). This accumulation of terms, in addition to the difficulty of untangling overlapping classifications leads me to favor a role-based scheme.

## AUTONOMY AND AGENCY

Now that we have a potential framework for categorizing operational roles on the rules-structure sides of AASs and have conceptualized some of the methods of structure, I would like to return to a discussion of autonomy to introduce the notion of 'agency' to this developing model. If autonomy entails a capacity to act independent of outside influence, agency is that acting or exerting of power. This distinction is teased out in an anti-consumerism essay this way:

"There seems to be a tension between a certain kind of agency and a certain kind of autonomy, and this is worth thinking about. In particular, there is a tension between autonomy understood as the limitless choice of an unfettered self (let's call this freedomism—the anthropology that is tacit in much advertising) and the kind of agency that is exercised in any skillful performance." [18]

Within each of the various rules-structure methods outlined above, autonomy may be understood as the capacity to act, while agency may be conceived of as acting in a vertical hierarchy in terms of 'agential sophistication.' This represents a gradualist approach (rather than all-or-nothing) to agency that I believe is useful to the model; it is further assumed that the artist has 'perfect' agency. What constitutes a notion of agential sophistication within methods or verbs of a rules-structure inside an AAS?

At its most basic level, agency may be ascribed to almost anything at all: "Such a liberal definition allows agency to be attributed even to fixed, inert objects such as coins, clarinets, and cups" [19] Even art materials can be thought of as stubbornly agential, actively resisting manipulation by an artist. [20]

At the lower end of agential sophistication in rules-structures, we could imagine a rules-structure that proscribes certain actions – prohibitive rules that put limitations on the artist's actions. Examples of this sort might include drawing without lifting the pen, writing a novel without gendered pronouns or designing a typeface without diagonal strokes. Prohibitive rules-structures

like this (with a 'black-list' rather than 'white-list' approach) according to Galanter, do not fall within the realm of generative systems. [21] Let's call this most basic form of agential sophistication (AS) level 0.

Next, at AS level 1, we find step-by-step rules-structures that, like Brustolini's autonomous Regulation Agents "always know what to do." [22] Rules-structures in this tier do not test, learn or adapt, but have in-built, invariable imperative rules. The class of AS level 1 rules-structures are those that apply single transformations, actions or operations. Examples might include rules like scaling each object in a series by its position in the series, deleting every third record in a database, swapping the red and blue components of each pixel in an RGB image, dropping the next digit of pi number of pebbles at each step along a path, running from the camera, etc. [23]

Making up the second tier, AS level 2, are rules-structures that perform some sort of evaluation or testing, usually by employing logic-based conditional rules. These sorts of conditional statements, implemented as 'if/then,' 'while' or 'case-switch' commands in many coding languages, may be driven by the outcomes of chance operations or used to provide branching behavior based on some other sort of criteria for the rules-structure. Examples might include: if the drawing robot senses a wall ahead and the generated random number from 0–9 is less than 5, turn right 90 degrees; otherwise, turn right 90 degrees. The previously mentioned I-Ching would fall into this category of sophistication; even at AS level 2, a computer or other digital technology is not required.

The next higher agentially sophisticated tier, at AS3, consists of rules-structures which learn and adapt. At their simplest, this class of rules-structure combines conditional rules and branching behavior with memory of prior inputs and/or decisions. These rules-structures can 'learn' by recalling (or even simply tallying) the results of previous conditional statement tests or environmental, artist or other inputs. This type of behavior can lead to direct results/outputs or in the formation of meta-rules, sets of rules to select or activate/deactivate other rules or even other meta-rules. [24]

Beyond the ability to merely learn from previous experiences, AS4, or constraint-based rules-structures, have the additional capacity to evaluate the relative 'fitness' of a solution. This powerful leap in sophistication of agency endows rules-structures with a kind of goal-seeking behavior. This puts the artist in the position of defining the parameters of preferred outcomes rather than performing, selecting or generating step-by-step procedures for the rules-structure. The most familiar examples of constraint-based systems are genetic-based evolutionary solvers that breed solutions and check for fitness against desired outcomes generationally, discarding divergent solutions and preserving convergent solutions for continued breeding until either a close enough fit is found or a preset generational limit is reached. Note that this approach restricts the role of artist-as-spectator because it limits the degree of surprise for the artist (since s/he must know at the outset what preferred outcomes are), but the means of achieving those goals (and the failed attempts along the way) may still be gratifyingly novel.

At the apex of agential sophistication for rules-structures, AS level 5, is the capacity for rules-structures to not only derive rules and meta-rules and evaluate fitness, but to also generate their own constraint-based, goal-directed behaviors. This capacity to generate one's own criteria for fitness is a hallmark of what Franklin and Graesser deem a fully autonomous agent. [25]

In addition, this ability to modify the rules has an analogous in a term in sociology known as 'meta-power.' "Meta-power entails the capacity to shape and determine, to a greater or lesser extent, social and material structures: to change basic relationships, processes, rules, procedures, definitions of appropriate (and inappropriate) agents, their rights and responsibilities, conceptions of appropriate methods, options available (and not available) and some of the values, costs and benefits as well as risks for agents engaged in interaction situations." [26]

As previously mentioned, the artist is assumed to have perfect agency; s/he may cede autonomy in one or more methods inside the AAS, but always acts with full agency. The decision to restrict consideration of agential sophistication to the rules-system is a pragmatic one, because the notion of sophisticated agency is bound up in the initial decision for a human artist to share autonomy at all. The full repercussions of this assumption are an area for further study.

## STARFISH DIAGRAMS

To better visually grasp and graphically compare different AASs, I have developed a simple five-lobed radar plot or starfish style diagram. Each lobe of the starfish represents one of the five rules-structure methods: gather, alter, generate, curate, distribute.

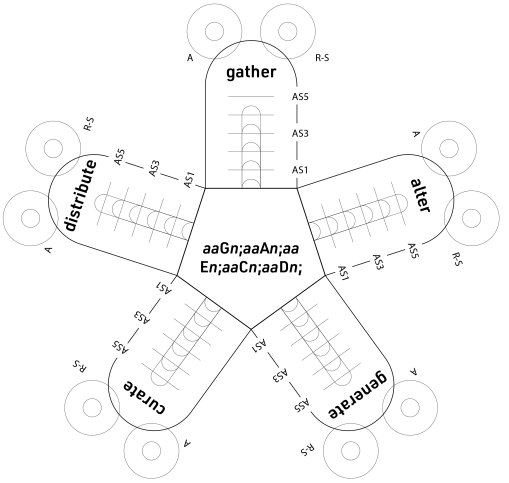


***Figure 1.** Blank starfish diagram*

The outer bubbles, left and right, at the ends of lobes in diagram reflect the autonomous capacity of the artist (A) and the rules-structure (R-S). The possible conditions are no bubble (no capacity for autonomy), a small bubble (semi-autonomous capacity) or a large bubble (full autonomy). This relationship is not necessarily proportional, nor is it a zero-sum game since both the artist and the rules-structure could each operate independently in any one method (without the necessity of this situation carrying over into other methods). For instance, both the artist and a rules-structure could 'gather' images with complete autonomy (two large bubbles), but afterwards the artist could 'curate' with complete autonomy without any input from a rules-structure (one large bubble, one absent bubble). Furthermore, if the diagram represents an iterative AAS process (rather than a

single event in which a combination semi-autonomous and fully autonomous combination would not make sense together), any combination of autonomies is possible.

The graduated marks within the five lobes indicate the level of agential sophistication of the rules-structure within that method. A bar radiating outward terminates at a specific mark to indicate the AS level.

In the center of the starfish is a string that encodes the entire diagram that might be used for digitally storing, searching, sorting and comparing diagrammed AASs. The structure of the string is as follows: Each lobe first has an autonomy character pair (aa). The first character in the pair represents the artist's level of autonomy in that method and the second character, the rules-structure. Possible values for each character are 'n' for no autonomy, 's' for semiautonomous, and 'f' for full autonomy. The next character pair starts with the method identifier for that lobe: G (Gather), A (Alter), E (gEnerate), C (Curate), or D (Distribute) and is followed by the agential sophistication level (n) with a semicolon for the method terminator. The whole AAS can thus be encoded as:

*aa*G*n*;*aa*A*n*;*aa*E*n*;*aa*C*n*;*aa*D*n*;

Figure 1 is an example of a blank diagram showing all possibilities simultaneously. Figure 2 shows an AAS in which the artist first takes a series of photographs with no formal rules-structure in play. Next, a computer program uses the images, without alteration, as seeds for a genetic solver (AS4) that generates a multitude of three-dimensional tower structures. Finally, both the artist and the rules-structure have a role in the curation method for the generated 3D forms. The rules-structure performs a simple check (AS2) on the resulting geometry to determine the technical suitability for the structures to be 3D printed (with full autonomy), while the artist selects the most aesthetically or thematically interesting objects to print (semi-autonomously). In this case the artist's autonomy is partial within the method since the rules-structure's determination of feasibility for printing may override the artist's determination of interestingness.

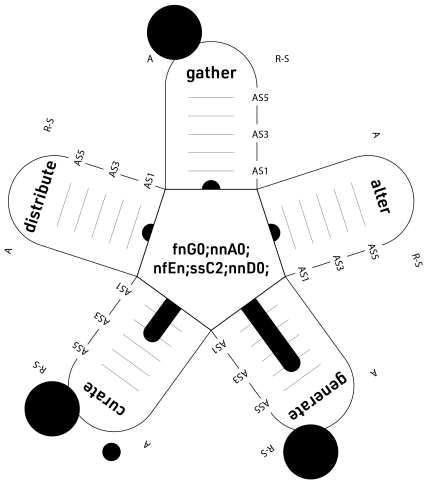


***Figure 2.*** ***Example starfish diagram***

The practical utility of the application of these diagrams is yet to be seen, but as a scaffolding for from which to hang thoughts about AAS, I believe they are already modestly successful.

## CONCLUSION

At the far end of an axis of shared autonomy, what might the most extreme example of rules-structure autonomy look like? A science-fictional example of extreme agential sophistication combined with total rules-structure autonomy in an AAS is the artificial intelligence boxmaker, Wintermute, featured in William Gibson's 'Sprawl' trilogy. In the story, the rogue AI eventually slips human control to not only makes its own rules, but to decide what game to play and when. [27] This example is particularly interesting because the 'artist' in this AAS is imagined only after the fact; the assemblages that Wintermute builds from the debris field in the Villa Straylight are initially mistaken for the work of Joseph Cornell. With no role for an artist with the capacity to act (even as curator), a pure rules-structure AAS seems unappealing, but, with apologies to Arthur C. Clarke, is a sufficiently agentially sophisticated rules-structure distinguishable from an artist? [28] In a sense, this is the bogeyman (bogeymachine?) of the singularity: a highly agential, fully autonomous system that turns its production interests to better and better AASs.

At the other end, is it the case that an artist is always already part of an AAS? If autonomous art systems are as old as art itself, as Galanter asserts, and techno-social rules-structures are pervasive to the point of ubiquity, to what degree can all rules-structures be excluded from an artistic practice? [29] Is it even possible, as a contemporary artist, to avoid the influences of systems and the autonomous impulses they threaten/promise to bring to an art practice? In other words, is it possible to not be part of an AAS? How would extreme autonomy in an AAS differ in degree and kind from a human practitioner who intended to eschew systems altogether?

Even in the middle, there is some muddiness. A landscape photographer may exert only a small effort in the transformational 'alter' method (although photographer Edweard Muybridge claimed to have cut down dozens of trees for a better composition) and primarily a curatorial effort working with the utterly inhuman rules-structure of wind, water, light and vegetation. [30] Or is it the case that the wet-plate photographer is also sharing autonomy with a physical rules-system of chemical processes, which, s/he arranges, sets in motion and then arrests at just the right moment to produce an image?

Other objections may well be raised. This line (or tangle!) of reasoning has been ripped from any sort of socioeconomic and cultural context, and does not consider real limitations on human autonomy due to the action of states, discipline imposed by laws, customs, traditions, etc. There is also the issue of individualist bias; I suspect a consideration of collectivist impulses (and perhaps even market forces) could enrich the model in terms of expanded roles.

Why do the machines wave back? In 2011, James Bridle seductively posited a parallel pixelated world, bleeding over into ours, becoming real, wishing to communicate; "Technology wants to be like us, and we kind of want to be more like it." [31] I think he's right, but I'd short-circuit that logic. We wave at the machines, and the machines wave back, because we are the machines. Technologies (our technologies) and their attendant rules-structures are deeply human expressions. They are also mirrors. As the resolution increases in the optics of our machine-mirrors, I suspect that more and more we will recognize ourselves looking back.

## ENDNOTES


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