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RECURSIVE GAME STRUCTURES AS EMERGENT POST-CAPITALIST CREATIVE STRATEGIES

This article will look at zero-player recursive game structures, focusing on a case study of computer-generated music composition by an algorithm called lamus, to explore the philosophical and political import of recursive game structures when they are used as creative methodologies in the process of artistic practice. In the first instance, I will define the concept of 'recursion' acknowledging its variety of meanings depending on the discipline within which it operates/manifests itself. In doing so, I will provide a brief cultural context of recursive techniques and then locate 'zero-player' recursive game structures within it. Secondly I will look at the case study of lamus, an algorithm (and computer) capable of generating, ('evolving') its music—a project created by Francisco Vico of the University of Malaga. The algorithm uses a mixture of rule-based selection processes and recursive strategies based on initial input to 'evolve' musical material and effectively compose 'original' musical pieces, with the aid of a zero-player recursive game structure. Finally, I will locate this practice within an economic/political context, namely the potential economic shift towards what some commentators, such as Jeremy Rifkin, Raphael Sassover and Paul Mason have termed as a 'post-capitalist economy'.

RECURSION

The Online Oxford Dictionary defines recursion as 'the repeated application of a recursive procedure or definition' (Oxford Dictionaries 2015). This may imply the repetition of a procedure in a self-similar fashion, but quite often it implies the repetition of that procedure within itself. This is an important feature of many recursive structures since they imply a process of self-embedment—a procedure, function or an item that is embedded within itself, resulting in a process that may be repeated ad infinitum. In mathematics, functions that call upon themselves are often recursive $F(n) = F(F(n))$. Classical examples are the Fibonacci Sequence $F(n) = F(n - 1) + F(n - 2)$ or the Ackermann Function. The Fibonacci Sequence is recursive because every successive term (n) is a sum of the two previous terms ($n-1$) and ($n-2$). This pattern is repeated ad infinitum to generate the sequence. Fractals are also examples of recursive structures. They are mathematical sets that can be generated by infinitely repeating a simple pattern at every scale of the fractal. They can be visualised to form dazzling intricate

shapes which extend into macro and micro infinity, like the pyramidal structures of the Sierpinski Triangle or the twisting spirals of the Mandelbrot Set.

Recursion in visual art is often exemplified by the mise-en-abîme effect, meaning 'placed into the abyss.' This is sometimes referred to as the Droste effect, after a Dutch cocoa advert from 1904 where a woman is depicted holding a tray with a cup and a box of Droste cocoa. Both on the box and on the cup in the picture she is depicted holding a tray with the box and the cup; the images are 'infinitely' nested within each other. In visual arts, recursion often comprises a picture recursively appearing within itself, as in the above case of the Droste advert or in the visual effect of standing between two mirrors and seeing oneself endlessly replicated or in the 'potentially' endless chain of Matrioshka dolls.

In the theater, the play-within-a-play effect may be recursive. In Shakespeare's Hamlet, the mousetrap is recursive, in that it is a mini version of the main play and references its earlier Danish iteration of which the Shakespearean version is a re-write. An interesting example of the use of recursive structures in theater can also be found in the works of Samuel Beckett. For instance, the song Vladimir sings in Act II of Waiting for Godot (1956), 'A dog came in the kitchen/And stole a crust of bread' (Beckett 2006), loops endlessly as the narrative is recursively nested within itself. Quad (1984) is another example of a play with recursive structures. In Quad, four hooded figures are trapped in a seemingly endless walking pattern encased in a square stage area. The piece has no words only a choreographic score that can be generated by sequencing two directional vectors and a rotational matrix (Woycicki 2012). Beckett's examples point to an interesting property of recursive structures, where they can generate material endlessly without or with minimal initial human input, thus acting as a mechanism that effaces or undermines human authorship. By implementing recursive structures in his plays, Beckett also questions the notion of history and memory as a static record of events positing that history and the act of re-membering can be thought of as mechanisms of an imaginary re-construction of past events in the present moment.

Thus recursive structures, particularly when applied to artistic practice, may exhibit some of the following properties: they are self-nested structures capable of infinite

sequencing and content-generation; they are placed in the abyss, regenerating themselves in the present moment while potentially forming a nonrelation to their history and future; they are automated and do not necessarily require a human author/agent to operate; they can process/generate linguistic sign systems but are in themselves self-nested structures of pure relations between variables and thus do not constitute 'language' in a Chomskian sense since they lack intentionality; they are 'self-reflexive' since their manifestation often exposes their modus operandi.

Now I would like to introduce briefly the concept of a recursive zero-player game, since as I will argue that there are similarities between lamus' modus operandi and that of these games. Zero-player games are games where 'no human involvement is required' (Björk and Juul 2012)—in short they are games without a human player. A classic example of a zero-player game is the Game of Life (1970), a cellular automation designed by mathematician John Conway. The game can be 'played' by placing a pattern of counters on a grid board and recursively applying a set of rules over and over again allowing the pattern to evolve, mutate and/or die out. As Martin Gardner describes it: '[t]he basic idea is to start with a simple configuration of counters (organisms), one to a cell, then observe how it changes as you apply Conway's "genetic laws" for births, deaths, and survivals' (Gardner 1970: 120). The game engenders many of the aforementioned properties of recursive structures and classifies as a 'setup-only game' (Björk and Juul 2012) since it does not require the involvement of a human agent apart from the initial state input.

IAMUS

lamus is an algorithm (and computer) capable of generating, ('evolving') its own music. Much like Conway's Game of Life, lamus uses a mixture of rule-based selection processes and recursive strategies based on initial input to 'evolve' musical material and effectively compose 'original' musical pieces. Critic Philip Ball recounts that the algorithm generates very simple 'musical genomes'—little motifs that are evolved, mutated and elaborated until they acquire genuine musical content' noting that the compositions are 'at the very least musically 'plausible', and some listeners have found them stimulating, both intellectually and expressively' (Ball 2012).

lamus has been used to score a variety of pieces for orchestral and chamber ensembles, and the London Symphony Orchestra has performed its music. Having listened to some pieces, the compositions are rather elaborate and complex falling into the category of high modernism and impressionism. For instance, Adsum (2012) for orchestra engenders heterophonic harmonies reminiscent of some of Karol Szymanowski's and Maurice Ravel's early 20th century work but with a more atonal approach to melodic figuration pertaining to Arnold Schoenberg, the second Viennese school and also to some of the more contemporary composers such as Per Nørgård, Esa-Pekka Salonen and Unsuk Chin to name a few. Per Nørgård The Infinity Series (1959), is a haunting orchestral piece based on recursive permutations of a musical series, arranged in such a way that its repeating phrases perpetually morph, echoing compositional strategies employed by lamus. In Esa-Pekka Salonen's Nyx (2010), the main melodic themes remain more or less the same throughout, while the main source of variation comes from the surrounding accompaniment and an ever changing sonic environment. There are also stylistic affinities to be found with the work of Unsuk Chin, like Alice in Wonderland (2004), a surreal opera which reconceptualises modernist aesthetics within a high expressionist, atonal framework.

Setting stylistic intertextualities aside, what becomes interesting here is the fact that lamus elicits a comparison between the effects of the labour of a human composer and that of a computer. If we consider lamus as a recursive zero-player game, then we effectively have an automated independent mechanism capable of creative labour. Nonetheless, despite the considerable recognition of the musical competence of lamus' compositions by the classical music establishment, the algorithm's creative capabilities have come under criticism. The chairman of LSO Lennox Mackenzie has commented that despite the impressive quality of the compositions they seemed to be 'going nowhere' (Mackenzie in Ball 2012: 458). I must admit that after a few minutes of listening to Adsum I got a similar impression elicited by the circular, repetitive structure of the piece. Considering lamus as a recursive zero-player game structure explains this phenomenon of a non 'goal-oriented' process and its self-reflexive structural quality—almost like Vladimir's song that reflects upon itself through a mechanism of self-nesting and ultimately 'goes nowhere', or the endless pattern iterations of the Game of Life.

Goal-orientation is linked with the notion of intentionality (the conscious intention to achieve a set goal). Thus, the perception of the score becomes more complicated once it is performed and listened to by humans who have the potential to inject the score with intentional expressiveness and thus a sense of goal at least if eliciting of emotions as a goal. Philosopher Daniel Dennett argues that ‘intentionality is not something inherent in subjects but something ascribed to them’ (Dennett in Björk and Juul 2012). From this perspective the introduction of the human agent as performer and listener could be indicative of a cultural bias: we perceive humans to have agency and while we perceive computers as not having agency. The aforementioned skepticism and perhaps slight animosity towards lamus can also be explained by the fact that we are dealing with a juxtaposition of human and A.I. labour except with reversed parameters. Historically machines have performed human concepts serving as slaves, not auteurs. In this case, the situation is reversed which may result in a certain feeling of tension, stemming from the fact that an authorial position historically reserved for humans has been taken up by an A.I. To an extent this tension can be explained by the aforementioned cultural bias, but it may also be useful to consider the materiality of live performance in this instance.

Discourses on live performance have posited it as ephemeral, differential, more than discreet structural forms and imbued with potentiality. A recursive game structure usually unfolds according to a finite permutable set of rules. As such it engenders some sort of ‘sameness’ in its repetitions—its evolutionary process is bound and limited by its conceptual rules. This is very visible in Conway’s Game of Life, which always reiterates the same set of rules. This is not to say that the outcome of repetition is always the same, but the manifestation of the recursive mechanism may very well be, since in most cases the formula repeats itself and does not morph. It is what could be defined, following Deleuze, a ‘multiplicity-with-oneness’ like a root-tree or a ‘tracing’ (Deleuze 1988: 12). It is not rhizomatic since rhizomes are ‘not amenable to any structural or generative’ (Deleuze 1988: 12) models. Live performance, however, due to its potentiality and materiality may introduce a ‘slippage’, ‘human error’, into the unfolding of a game structure in performance, not necessarily adhering to a discreet recursive formula—thus becoming a rhizomatic ‘multiplicity-without-oneness’. As a result, a potential perceptual tension emerges here, between perceiving mathematically

reducible game structures and a non-recursive irreducible live 'performance text' (Lehmann 2006). Perhaps within this tension one can experience what Jean-François Lyotard in his essay Acinema (1989) calls jouissance (Lyotard 1989: 171). He defines it as a sterile form of enjoyment, free dissipation of joy, one that is in excess of structure and is also essentially unproductive, not goal-oriented, like the enjoyment of firework explosions or of lighting a match in vain.

But what is the value of this juxtaposition? Is it merely a slightly peculiar experience of listening to a computer that is not quite as human a composer as one would expect? Or can this tension be telling of the socio-economic landscape we are currently living in? And in what way can the experience of this juxtaposition become a new mode of cultural consumption?

POSTCAPITALISM

Finally, I would like to locate this practice of A.I. creative labour within an economic/political context, namely the potential current economic shift towards what some commentators such as Jeremy Rifkin, Raphael Sassover and Paul Mason have termed as a 'post-capitalist economy'. In his recent book Postcapitalism: A Guide to our Future (2015), Paul Mason traces the evolutionary history of capitalism, pivoting his argument on the famous 'wave-theory' of capitalism put forward by the Soviet economist Nicolai Kondratieff in the 1920s. In short, the theory states that capitalism 'adapts and morphs in response to crisis' (Mason 2015: 38) and that this process is cyclical. For instance, the history of industrial capitalism can be divided into five long cycles from 'the late 18th century and the invention of the steam engine up to today' (ibid: 47). Mason puts forward a techno-deterministic argument via theories of Josef Schumpeter and Carlotta Perez that each cycle begins with an injection of new technology into the economic system, be it: steam-powered machinery (1790-1848), the railway system (1848-mid-1890s), heavy industry (1890s-1945), the transistors, nuclear power, factory automation (1945-2008) or networked mobile technology (late 1990s) (Mason 2015: 48). Each cycle lasts roughly 55 years, reaches a climax following heavy capital investment and capital accumulation and consequently hits a crisis, where eventually the government has to step in to regulate the situation and allow for a new

technological paradigm shift. Mason's argument is that we have reached a point in the history of capitalism where the cycles have stalled, and capitalism can no longer adapt. The gist of the argument is that new emergent technologies and mainly information technology no longer follow the logic of neoliberal capitalist markets and are un-commodifiable under a capitalist value system.

Mason imagines that future economic systems will be information-centric, where data and concepts will become the new human currency, replacing material goods and their monetary value as the field of exchange. He calls these economic systems postcapitalist. He outlines three main impacts of new technology over the past 25 years which will make postcapitalism possible: over-abundance of digital goods and information, collaborative production as a result of expanding digital networks and progressive computerized automation of production processes (Mason 2015: xv). Over-abundance of information is corroding 'market's ability to form prices correctly. This is because markets are based on scarcity while information is abundant' (Mason 2015: xv). New emerging forms of networked collaborative production no longer adhere to 'the dictates of the market and the managerial hierarchy' (ibid). Computerised automation of production processes is reducing the need for work.

The lamus algorithm resonates with these changes. As a zero-player game, it automates creative labour, making the human 'author' redundant to the process of musical composition. It can produce endless amounts of music hence undermining the notion that the value of a work of art is based on scarcity and the extensiveness of labour. Composers tend to take considerable time when composing music and 'seminal' works are for the most part scarce. Finally, multiple algorithms can work in tandem within a de-hierarchized network and generate open-source music.

Franco Berardi Bifo in his article Cognitarian Subjectivation speaks of a similar crisis of capitalism in the age of technology. He argues, however, that the 'digital-financial hyper-abstraction is liquidating the living body of the planet, and the social body' (Bifo 2010: 8) by attempting to govern a complex social body through abstract technological means that are essentially reductive and simplified models incapable of accounting for the complexity of social life. As he states '[g]overnance is the management of a system that

is too complex to be governed' (ibid). This is different to Mason's argument in that it posits technology and the digital networks as a managerial instrument of the late capitalist economy. Nonetheless, one of the premises is congruent; in both arguments we are dealing with a broken relationship between the materiality of labour and its economic and social value in the age of advanced technology. Bifo comments on our contemporary situation where A.I. is incapable of comprehending the complexity of the social world while Mason seems to hypothesise a future where it will begin to do so. In this light, despite lamus' undeniable efficiency as a generator of original musical structures, the algorithm is still an oversimplification of the social conditions under which musical composition comes about, a key aspect of musical experience articulated by composers such as John Cage and musicologists such as Christopher Small. John Cage was a prominent American experimental music composer, whose work spanned across a variety of media. Many of his pieces foregrounded the social conditions under which music is made, most notably perhaps the piece 4'33" (1952) for orchestra, consisting of 4 minutes and 33 seconds during which the orchestra remains silent, drawing attention to the sounds that the audience makes and thus foregrounding the social constitution of the auditorium. In line with this approach to music making lies Christopher Small's term 'musicking' which refers to an act that 'establishes in the place where it is happening a set of relationships [...]not only between those organized sounds which are conventionally thought of as being the stuff of musical meaning but also between the people who are taking part, in whatever capacity, in the performance' (Small 1998: 8). According to this line of argument the socio-historical milieu is a key component of a musical experience, something which lamus as a fairly self-contained mechanism is not particularly attuned to.

This is not to suggest that lamus' composition cannot be placed or performed within a social context, but as a composing, music generating entity, lamus is simply incapable of comprehending the social environment under which it composes. The recursive zero-player game engendered by lamus isolates the social body from the process of creation thus exemplifying one of the key proprieties of recursion, the *mise-en-abîme* —'to hang in the abyss'. An interesting parallel can be found here with Walter Benjamin's notion of the 'aura'. In The Work of Art in the Age of Mechanical Reproduction (1936), Benjamin

argued that a mechanically reproduced artwork lacks the 'aura' of the original, namely it is devoid of the socio-historical context in which the original was produced. In the case of Iamus' music, we are faced with a recursive reproduction not of the final product (like a digital copy of a painting or a music piece) but of the creative process itself. If we postulate that there is also a loss of an 'aura' involved then what kind of an 'aura' is it? Perhaps it is not so much the 'aura' of the artwork itself (the piece of music) but rather of the author (the generator of the creative process). This notion may bring us back to Daniel Dennett's argument that such a consideration is a result of cultural bias. Even though this is a very plausible way of looking at this phenomenon, albeit superficial and semiological, I have argued that there is another way. The recursive nature of the algorithm itself is abysmal and points to a process of loss— almost in a Beckettian sense. As a result, Iamus becomes a mirror that enables us to reflect on our relation to the progressively digitalised society in which we live. Arguably the experience of tension between the algorithm's quasi-organic musical structures and human embodiment through performance and the act of listening, re-articulates the relationship between the subject and the cultural product in a progressively digital age. In doing so, it brings to the fore the difference between the social body of the listener/performer and a zero-player game structure.

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