Creative Zombie Apocalypse: A Critique of Computer Creativity Evaluation

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***Abstract*—Using algorithms to generate creative work is a well-established transdisciplinary practice that spans several fields. Accessible and popular coding tools such as Processing and Open Frameworks, as well as the rise of hack spaces have significantly contributed to increased activity in this field. However, beyond art-technology curation and historical contextualisation, evaluation of the resulting artefacts is in its infancy, although several *general* models of creativity—and its evaluation—exist.**

There is a perceived distinction between human and computer creativity, whereas we argue that they are effectively the same thing. Computers are made and programmed by people, so it makes sense to measure the creativity of the human influence behind the machine, rather than viewing computers as truly autonomous entities.

By concatenating and enhancing existing models of creativity, we propose a framework that takes these issues into account, with a view to evaluating creative work that uses the computer as a medium more effectively.

***Index Terms*—Creativity, creative computing, evaluation**

I. Introduction

Although using computers to generate creative work has its foundations in the 1950s [1], John Maeda's Design By Numbers [2] and from around 2010 a slew of similar initiatives followed Processing's lead. However, due in part to the niche position of artists working with technology, and also because such activity was overlooked or ignored until relatively recently by arts bodies and critics, formal evaluation of the creativity in such work lagged behind.

In this context humans simply use computers as tools for their creativity—no matter how autonomous the machine output may appear, or how far it travels from the original intentions of the programmer, its origins nevertheless reside in the humanly-authored code that produces the output.

This is overlooked in anthropomorphic approaches that regard computers as being capable of creativity in their own right. Computer output cannot be conceptually separated from the craft/skill/intention of the programmer, even when the results are unexpected or accidental. The illusion of creativity can be produced by introducing randomness, serendipity, etc. but this is not the same as the intuitive decision-making that drives human creativity.

Hypothetical "zombies" (popularised by philosopher David Chalmers [3]) are entities that appear identical to humans in every way but lack conscious experience. We now borrow this term and apply it to computers which appear creative but lack real autonomous intent.

Further, creativity and the subjective properties associated with it, lack a universally accepted definition. As a human quality it has definitions that don't necessarily lend themselves to be applied to computers. However, there are several important theories and evaluation frameworks concerning human and computer creativity, and these are the basis for our work. Creativity has been studied at various levels (neurological, cognitive, and holistic/systemic), from different perspectives (subjective and objective) and existing research has identified specific characteristics (combinational, exploratory and transformative). Some aspects, like novelty and value, recur in many models of creativity but some, like relevance and variety, rarely appear; while other terms are problematic when it comes to computing. Computer systems are generally evaluated against functional requirements and performance specifications, but creativity should be seen as a continuum, there is no clear cut-off point or Boolean answer to say precisely when a person or piece of software has become creative or not.

> "The expression of our language systems in computer code confers no semantic understanding autonomously on the computer system. The computer system only acts as a tool for transferring symbols and communicating meaning between humans." [4]

True Artificial Intelligence and *true* Computational Creativity are equally elusive. For a computer to become truly intelligent and therefore creative, it would need to break out of the programming procedures by which it operates. Yet it is bound to follow rules, no matter how emergent the outcome. The paradox is that it needs to recognise its contraints in order to break free from them. Yet programatically defining yet more rules to allow that to happen—even when those rules enable machine learning—is tautological!

II. Emerging Disciplines

Initiatives that aim at a more rigorous understanding of computing and creativity have given rise to several fields, each

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having its own terminology and approach, but with significant overlaps.

The two main disciplines directly related to creativity and technology that have emerged in recent years are as follows. "Creative Computing" tries to reconcile the objective precision of computer systems with the subjective ambiguity of human creativity [5] and has an overarching theme of *unite and conquer*, i.e. drawing from a wide range of transdisciplinary knowledge to tackle a problem (as opposed to the principle of *divide and conquer* in computer science, which divides bigger problems down into smaller and easier parts) [6]. The main challenge, Andrew Hugill and Hongji Yang argue, is for technology to become "more adaptive, smarter and better engineered to cope with frequent changes of direction, inconsistencies, irrelevancies, messiness and all the other vagaries that characterise the creative process" [5]. In part, these issues are due to the transdisciplinary nature of Creative Computing; factors such as common semantics, standards, requirements and expectations are typical challenges. Hugill and Yang therefore argue that creative software should be flexible and able to adapt to ever-changing requirements, evaluated and rewritten continuously, and it should be cross-compatible.

"Computational Creativity" has emerged from within Artificial Intelligence (AI) research. Simon Colton and Geraint Wiggins argue that AI falls within a problem-solving paradigm: "an intelligent task, that we desire to automate, is formulated as a particular type of problem to be solved", whereas "in Computational Creativity research, we prefer to work within an artefact generation paradigm, where the automation of an intelligent task is seen as an opportunity to produce something of cultural value" [7]. They further explain that it models, simulates, replicates or enhances human creativity using a computer.

III. Existing Theories of Creativity

Richard Mayer identified five big questions of human creativity research and different approaches with their own methodologies and goals [8]; is creativity:

1) a property of people, products, or processes?
2) a personal or social phenomenon?
3) common or rare?
4) domain-general or domain-specific?
5) quantitative or qualitative?

These questions form a nice introduction to the four main theories of creativity which inspired our work.

The *Four P* model by Mel Rhodes [9] identified four elements of creativity: (1) the **person**—personality, intellect, temperament, physique, traits, habits, attitudes, self-concept, value systems, defence mechanisms and behaviour, (2) the **process**—motivation, perception, learning, thinking and communication, (3) the **press**—relationship between human beings and their environment and (4) the **product**—a thought which has been communicated to other people in the form of words, paint, clay, metal, stone, fabric, or other material. Rhodes highlights the importance of a holistic view on creativity through these four areas of study, which he hoped would become the basis of a unified theory of creativity. Ross Mooney independentely identified four aspects of creativity which he called the environment, person, process and product (as cited in [10]).

Margaret Boden defined three types of creativity: (1) **combinational**—making unfamiliar combinations of familiar ideas, juxtaposition of dissimilar, bisociation, deconceptualisation, (2) **exploratory**—exploration of conceptual spaces, noticing new things in old spaces and (3) **transformational**—transformation of space, making new thoughts possible by altering the rules of old conceptual space [11]. Boden also differentiates between two levels of creativity, a personal one and a historical one. Psychological creativity ("P-creativity") is a personal kind of creativity that is novel in respect to an individual, while historical creativity ("H-creativity") is fundamentally novel in respect to the whole of human history.

James Kaufman and Ronald Beghetto defined the *Four C* model of creativity [12]. They are **Big-C**—eminent accomplishments, **Pro-c**—professional expertise, **Little-c**—everyday innovation and **Mini-c**—transformative learning. The concepts of the uppercase C and lowercase c loosely correspond to Boden's H and P creativity, which in turn could be interpreted as objective and subjective creativity.

Henri Poincaré suggested a *Four Stage* model [13] (formulated by Graham Wallas [14]). The four stages are preparation, incubation, illumination and verification. This is reminiscent of George Pólya's description of the *problem solving* process [15]—understand, plan, carry out, look back.

Bipin Indurkhya argued that there are two main cognitive mechanisms of creativity: juxtaposition of the dissimilar, and deconceptualization. He said that we are constrained by associations in the concept networks we inherit and learn in our lifetime, but that computers do not have these conceptual associations and therefore have an advantage when it comes to creative thinking [16].

IV. Existing Evaluation Frameworks

Evaluating human creativity objectively seems problematic; evaluating computer creativity at all seems even harder. There are many debates across the disciplines involved. Taking theories on human creativity and directly applying them to machines seems logical but may be the wrong (anthropomorphic) approach. Adapting Mayer's five big questions [8] to machines does not seem to capture the real issues at play. Instead of asking if creativity is a property of people, products, or processes we might ask if it is a property of any or all of the following:

- programmers (and collaborators)
- users (audiences and participants)
- machines (this is problematic until the posited AI singularity [17])
- products (i.e. does a program output material that can be judged to be creative)
- processes (e.g. a Processing sketch, or in a self-modifying/learning program)

For instance, is the programmer the only creative agent, or are users (i.e. audiences or participants in interactive work) able to modify the system with their own creative input? Similarly for any instance of machine creativity, we might ask if it is:

- local (e.g. limited to a single machine or program?)
- networked (i.e. interacts with other predefined machines)
- web-based (e.g. is distributed and/or open to interactions, perhaps via an API)

For example, discussions from computational creativity often focus on very basic questions such as "whether an idea or artefact is valuable or not, and whether a system is acting creatively or not" [18].

Pease, Winterstein and Colton have argued that creativity may be seen as *output minus input* [19]. The output in this case is the creative product but the input is not the process. Rather, it is the *inspiring set* (comprised of explicit knowledge such as a database of information and implicit knowledge input by a programmer) of a piece of software. Simon Colton specifies that "the degree of creativity in a program is partly determined by the number of novel items of value it produces. Therefore we are interested in the set of valuable items produced by the program which exclude those in the inspiring set." [20]. Alison Pease et al. also suggest that all creative products must be **novel and valuable** [19] and provide several measures that take into consideration the context, complexity, archetype, surprise, perceived novelty, emotional response and aim of a product, although the measurement of these qualities isn't explicitely described. In terms of the creative process itself they only discuss **randomness** as a measurable approach. Elsewhere, Pease et al. discuss using **serendipity** as an approach [21].

Graeme Ritchie supports the view that creativity in a computer system must be measured "relative to its initial state of knowledge" [22]. He identifies three main criteria for creativity as **novelty, quality and typicality**, although he argues that "novelty and typicality may well be related, since high novelty may raise questions about, or suggest a low value for, typicality" [22], [23]. He proposes several evaluation criteria which fall under the following categories: basic success, unrestrained quality, conventional skill, unconventional skill, avoiding replication and various combinations of those [22]. Dan Ventura later suggested the addition of **variety and efficiency** to Ritchie's model [24].

It should be noted that *output minus input* might easily be misinterpreted as "product minus process", however, that is not the case. In fact, Pease, Winterstein and Colton argue that "the process by which an item has been generated and evaluated is intuitively relevant to attributions of creativity", and that "two kinds of evaluation are relevant; the evaluation of the item, and evaluation of the processes used to generate it" [19]. If a machine simply copies an idea from its inspiring set then it just cannot be considered creative and needs to be disqualified, so to speak.

Simon Colton came up with an evaluation framework called the *creative tripod* [25], [26]. The tripod consists of three behaviours a system or artefact should exhibit in order to be called creative. The three legs represent **skill, appreciation, and imagination** and three different entities can sit on it, namely the programmer, the computer and the consumer. Colton argues that if "the software has been skillful, appreciative and imaginative, then, regardless of the behaviour of the consumer or programmer, the software should be considered creative". As such a product can be considered creative if it *appears* to be creative. If all three behaviours are not exhibited, however, it should not be considered creative.

> "Imagine an artist missing one of skill, appreciation or imagination. Without skill, they would never produce anything. Without appreciation, they would produce things which looked awful. Without imagination, everything they produced would look the same." [25]

Davide Piffer suggests that there are three dimensions of human creativity that can be measured, namely **novelty, usefulness/appropriateness and impact/influence** [27]. As an example of how this applies to measuring a person's creativity he proposes "citation counts". While this idea perhaps works well for measuring scientific impact, it seems questionable whether popularity or social status can be a valid measure of creative quality.

Anna Jordanous proposed 14 key components of creativity (which she calls an "ontology of creativity") [28], from a linguistic analysis of creativity literature which identified words that appeared significantly more often in discussions of creativity compared to unrelated topics. These are active involvement and persistence, generation of results, uncertainty, domain competence, general intellect, independence and freedom, intention and emotional involvement, originality, progression and development, social interaction and communication, spontaneity/subconscious processing, thinking and evaluation, value, variety, divergence and experimentation. Jordanous also argued that "evaluation of computational creativity is not being performed in a systematic or standard way" [29]; an issue which further confuses the problem of objective evaluation. To remedy this she proposes a "Standardised Procedure for Evaluating Creative Systems" (SPECS) [30]:

1) Identify a definition of creativity that your system should satisfy to be considered creative.
2) Using Step 1, clearly state what standards you use to evaluate the creativity of your system.
3) Test your creative system against the standards stated in Step 2 and report the results.

The SPECS model essentially means that we cannot evaluate a creative computer system objectively, unless steps 1 and 2 are predefined and publically available for external assessors to execute step 3. Creative evaluation can therefore be seen as a move from subjectivity to objectivity, i.e. defining subjective criteria for objectively evaluating a product in terms of the initial criteria.

> "For transparent and repeatable evaluative practice, it is necessary to state clearly what standards are

> used for evaluation, both for appropriate evaluation of a single system and for comparison of multiple systems using common criteria." [30]

This is further strengthened by Richard Mayer stating that we need a "clearer definition of creativity" [8] and Linda Candy arguing for "criteria and measures [for evaluation] that are situated and domain specific." [31]

Candy draws inspiration for the evaluation of (interactive) creative computer systems from Human Computer Interaction (HCI) research. The focus of evaluation in HCI has been on usabilty, she says, which may not be as useful in creativity research. She argues that in order to successfully evaluate an artefact, the practitioner needs to have "the necessary information including constraints on the options under consideration" [31]. Evaluation happens at every stage of the process (i.e. from design → implementation → operation). Some of the key aspects of evaluation highlighted by Candy are aesthetic appreciation, audience engagement, informed considerations and reflective practice. She then goes on to introduce the "Multidimensional Model of Creativity and Evaluation" (MMCE) [31] with four main elements of people, process, product and context similar to some of the models of creativity we have seen above (e.g. the *Four P* model).

V. Thoughts and Critique

> "The uncodifiable must be reduced to the codable in the robot. In reducing a complex moral decision (tacit, intuitive, deriving knowledge from maturity) to the execution of a set of coded instructions, we are throwing away vast stretches of knowledge, socialisation and learning not only built up in the individual, but also in the community and the history of that community, and replacing it with some naïve 'yes' or 'no' decisions." [4]

Neil McBride's observation is echoed by Indurkhya, who argues that because computers don't make decisions based on personal or cultural concepts (even when these are included in code), they are more likely to make connections that humans will perceive as "creative leaps" [16]. These leaps *appear* creative only because we are athropomorphising not only the output, but in some cases even also the *intent* behind it, as if this originated in the computer itself rather than as an output from algorithmic processes. This phenomenon is most apparent in the "uncanny valley" created by those areas of robotics that seek to create human companions, or where the intent is to imbue the computer with a personality. This is even the case for simple web interfaces, let alone computers that might mimic human creativity:

> "Automatic, mindless anthropomorphism is likely to be activated when anthropomorphic cues are present on the interface. [...] it is noteworthy that anthropomorphic cues do not have to be fancy in order to elicit human-like attributions." [32]

The phenomenon of ascribing human qualities to non-human artefacts and machines depends on the prior associations (concept networks) humans have with certain activities, including creativity. It leads to metaphorical statements such as "this interface is friendly", "a bug snuck into my code" or "the computer is being creative", and appears in media article headlines such as "Patrick Tresset's robots draw faces and doodle when bored" [33], as if there were conscious intent behind the code generating such activity in Tresset's sketching bot *Paul*. This tendency has implications for the aimed-for objectivity when evaluating certain creative computing projects, one the most well-established being Harold Cohen's *AARON*, artist-authored software that produces an endless output of images in his own unique style. While documenting the process of coding his system, Cohen asked:

> "How far could I justify the claim that my computer program—or any other computer program—is, in fact, creative? I'd try to address those questions if I knew what the word 'creative' meant: or if I thought I knew what anyone else meant by it. [...] 'Creative' is a word I do my very best never to use if it can be avoided. [...] AARON is an entity, not a person; and its unmistakable artistic style is a product of its entitality, if I may coin a term, not its personality." [34]

He goes on to outline four elements of *behaviour X* (his placeholder for creativity): (1) **emergence** produced from the complexity of a computer program, (2) **awareness** of what has emerged, (3) **willingness** to act upon the implications of what has emerged, and (4) **knowledge** of the kind manifest in expert systems. He identifies three of these properties as programmable (within limits), but "as to the second element, the program's awareness of properties that emerge, unbidden and unanticipated, from its actions... well, that's a problem." [34], and concludes that "it may be true that the program can be written to act upon anything the programmer wants, but surely that's not the same as the individual human acting upon what he wants himself. Isn't free will of the essence when we're talking about the appearance of behaviour X in people?". In other words, a decision tree in computing is not the same as a human decision-making process. As for whether his life's work is autonomously creative:

> "I don't regard AARON as being creative; and I won't, until I see the program doing things it couldn't have done as a direct result of what I had put into it. That isn't currently possible, and I am unable to offer myself any assurances that it will be possible in the future. On the other hand I don't think I've said anything to indicate definitively that it isn't possible." [34]

In the same manner as in the field of computer ethics, i.e. "the ethics of the robot must be the ethics of the maker" [4], the creative computer must ultimately be a product of the creativity of the programmer. To hijack Barthes' conclusion in "The Death of the Author": *the birth of the truly creative computer must be ransomed by the death of the programmer* [35]—in other words, a truly creative computer must be able to act without human input, yet any computer process presumes

TABLE I
OBJECTIVE CRITERIA OF CREATIVITY

Criteria	Note
Product	Algorithmic sketch, poetry, audio, interactive installation
Process	Procedural, Experimental, Heuristic, Systems-based
Purpose	Accidental, Conceptual, Interactive, Time-based
Person	Skill, Aesthetic values, Influences, Collaborations
Place	Culture, Social environment, Education, Peers

a significant amount of human input in order to produce such so-called autonomous behaviour, so the question is whether that behaviour can ever be regarded as truly autonomous—no matter how independant it appears to be.

Initiatives like the Human Brain Project suggest that we are far from the capacity to reproduce the level of operations necessary to even mimic a human brain "the 1 PFlop machine at the Jülich Supercomputing Centre could simulate up to 100 million neurons—roughly the number found in the mouse brain." [36]. Even if it were possible today to scale this up to the human brain, would the result be an entity capable of truly intelligent creative activity, or would it actually be a *zombie*?

Current evaluation methodologies in creative computing disciplines have concentrated on only a handful of the facets previously discussed, for example studying only the creative end-product itself (out of context), only judging it by its objective novelty, assigning an arbitrary thresholds, etc. This also includes the assumption that machines "mimic" humans and are therefore not judged at their full potential. For example we generally do not take into account the differences between humans and machines or, more precicely, the differences between the human brain and computer processors. In fact, it could be said that we are in danger of limiting computers so that they *appear* more human.

VI. OUR PROPOSED FRAMEWORK

All of the theories of creativity and its evaluation mentioned above have value, but each alone may be incomplete and contain overlaps. There is a misconception that creativity can be measured objectively and quantifiably, but given the issues discussed above, it is unlikely that any system will yield truly accurate measurements in practice, even if such accuracy were possible. As Jürgen Schmidhuber suggests in the quote below, evaluation of creativity always happens from a subjective standpoint, originating in either the individual, or in the enveloping culture of which they are part.

> "Any objective theory of what is good art must take the subjective observer as a parameter." [37]

We therefore propose two facets of a new *fuzzy* approach that aims to obtain a more honest measure of the subjective judgements implied when evaluating creativity:

1) a set of scales that can be used to approximate a "rating" for the creative value of an artefact,
2) a set of criteria to be considered using the scales above.

TABLE II
SUBJECTIVE SCALES FOR CREATIVITY

Keyword	Scale
Novelty	Established ↔ Novel
Value	Playful ↔ Purposive
Quality	Minimal ↔ Complex
Purpose	Emotive ↔ Thoughtful
Spatial	Universal ↔ Specific
Temporal	Instant ↔ Persistent
Ephemeral	Accidental ↔ Experimental

The **criteria** listed in table I should be considered objectively, while the **scales** in table II are judged subjectively. The set of scales is directly derived from the various frameworks for evaluating creativity reviewed in the previous sections. An overview of recurring keywords in existing approaches suggests the following distillation of seven groups:

Novelty originality, newness, variety, typicality, imagination, archetype, surprise
Value usefulness, appropriateness, appreciation, relevance, impact, influence
Quality skill, efficiency, competence, intellect, acceptability, complexity
Purpose intention, communication, evaluation, aim, independence
Spatial context, environment, press
Temporal persistence, results, development, progression, spontaneity
Ephemeral serendipity, randomness, uncertainty, experimentation, emotional response

The "5 P's"—**Product, Process, Purpose, Person, Place**—are all components of any creative artefact (see table I).

This evaluation framework can apply to any kind of creativity, from the traditional arts to digital works to computational creativity. Because the scale element allows for the measurement of subjective qualities, it circumvents binary yes/no or check-box approaches and therefore makes it possible to gather quantitative values from the subjective judgements involved in evaluating creativity in general.

The terms on each end of the scales are suggestions only and should not be taken as value judgements. Rather, they should be adapted for each project individually. Numeric values can be assigned to the scales if needed according to specific evaulative requirements.

A. An example application

Below is an example assessment for a hypothetical piece of art:

PRODUCT:

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Established ————————x——  Novel
Playful     ————————x——  Purposive
Minimal     —-x————————-  Complex
Emotive     —-x————————-  Thoughtful
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Universal	————————-x—-	Specific
Instant	————————x——	Persistent
Accidental	————————-x——-	Experimental

PROCESS:

Established	—x—————————	Novel
Playful	————————x———	Purposive
Minimal	———x————————	Complex
Emotive	———-x————————-	Thoughtful
Universal	————————-x—-	Specific
Instant	————————-x—-	Persistent
Accidental	————————x———	Experimental

PURPOSE:

Established	——x————————	Novel
Playful	————————-x——-	Purposive
Minimal	—x—————————	Complex
Emotive	————————-x—-	Thoughtful
Universal	————————x—	Specific
Instant	————————————-x-	Persistent
Accidental	————————x——	Experimental

PERSON:

Established	—x—————————	Novel
Playful	————————x—	Purposive
Minimal	—x—————————	Complex
Emotive	————————-x—-	Thoughtful
Universal	—-x————————-	Specific
Instant	————————x——	Persistent
Accidental	———x————	Experimental

PLACE:

Established	—x—————————	Novel
Playful	————————x–	Purposive
Minimal	————————x–	Complex
Emotive	————————x——	Thoughtful
Universal	————————x—	Specific
Instant	————————-x—-	Persistent
Accidental	–x—————————	Experimental

Ideally, these scales would need to be applied by several people during the evaluation process, generating an intuitive assessment of the various values (e.g. Playful—Purposive) for each of the criteria (e.g. Product).

VII. Conclusion

Creativity is a transdisciplinary activity and is apparent in many diverse fields, yet it is often studied from within a single discipline within which other perspectives and theories can be overlooked. Therefore, creative evaluation is subjective, and involves an emotional component related to the satisfaction of a set of judgements. These judgements are mutable when subjected to personal, social and cultural influence, so we can only try to evaluate a creative activity objectively via approximisations.

True AI and Computational Creativity are equally elusive. Just as the Turing Test [38] is flawed (because it is designed to fool humans into thinking a machine is a person, but only through mimickry), the view that something *is* creative because it *appears* creative is similarly flawed. This is the premise behind by John Searle's Chinese Room Argument [39] where an individual with a map of English to Chinese symbols can appear to someone outside the room to "know" Chinese. By inference, just because a computer program appears to produce a creative output, this doesn't mean that it is inherently creative—it just follows the rules that produce output from a human creation in an automated manner. To take this further, we could even state that machines programmed to mimick human creativity and produce artefacts that appear creative are—in the philosophical manner defined by David Chalmers—*Zombies* [3]. Similarly Douglas Hofstadter argues that minds cannot be reduced to their physical building blocks (or their most basic rules) in his "Conversation with Einstein's Brain" [40]. This school of thought is employed to demonstrate that *mind* is not just physical *brain*. We are introducing it here to argue that computers do not *consciously create* as do humans, because they are not conscious.

Edsger Dijkstra pointed out that computer science is infantalised [41] and there is a danger that the same thing is happening to creativity research. In other words, it may be an over-simplification to reduce creativity down to a four step process, or a product that is novel, valuable and of high quality. A framework that makes the evaluation of creativity appear to be a matter of checking boxes is surely missing the subjective nature of creativity. The real picture is far more interwoven and—although creativity may spring from a finite set of causes—these can interact in a complex manner that cannot be assessed so neatly.

> "User of tools are much more prevelant than makers of tools. This imbalance has traditionally been rooted in the vast difference in skill levels required for using a tool compared to making a tool: To use a tool on a computer, you need to do little more than point and click. To create a tool, you must understand the arcane art of computer programming. A strange reverse phenomenon is in motion today: As programming becomes easier and more accesible, the tools for expression are becoming more complex and diffuclt to use. Programming tools are increasingly oriented toward fill-in-the-blank approaches to the construction of code, making it easy to create programs but resulting in software with less originality and fewer differentiating features." [42]

To sum up our approach: rather than a linear or cyclic series, or criteria that can be answered in a binary manner (i.e. present or not) we propose scales or spectra to aid in the evaluation of a creative artefact of any kind, by applying a series of overlapping principles that encourages a more intuitive assessment.

The next stage for this approach would be to test the eval-

uation framework with real-world examples and individuals responsible for creative output or its assessment, for instance: artists, dancers, musicians, arts administrators, critics, curators and commentators.

If anything that falls short of true computational creativity is considered a *zombie*, then as long as computers continue to be regarded as autonomously creative, we may already be trapped in a *zombie apocalypse*.

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