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Creative Robots

One of the merits of creativity is that it has become a focal point, and thus a point of access, for transdisciplinary research in fields including cognitive psychology, design science, and artificial intelligence. Contemporary AI recognizes creativity as an attribute that is highly desirable in artificial systems yet poorly defined and poorly understood.

Mitchell Whitelaw, *Metacreation. Art and Artificial Life*¹

Is it possible to come from that position and still believe in the possibility of machine creativity? Certainly! I believe that my dialog with AARON is an example of machine creativity, albeit a small one.

Harold Cohen, *Driving the Creative Machine*²

Innovation and imitation

Any discussion of creativity³ in relation to artificial intelligence and robotics must involve an important issue of how to define creativity in this type of analysis. This also raises questions whether intelligent robots are capable, in any way, even a very un-human way, to understand the nature of art and creativity, and can we expect anything like creativity from intelligent but non-biological beings? Moreover, is this phenomenon an exclusive property of human beings, while intelligent robots are merely able to imitate creative process through human agency? Let us imagine a computer software designed to paint pictures in the style of Jackson Pollock (Zheng et al., 2014) or Pablo Picasso.⁴ There are no obstacles for an algorithm to learn painting in their styles. Yet, this activity would not be creative in the sense of being innovative, since the software was designed to imitate and apply the features of Ab-

1 Whitelaw, 2004: 229.

2 Cohen, 2010:16.

3 On the one hand, the use of the term “creative” refers to intelligent artistic robots, but on the other hand, it may raise doubts arising from the defence of such traits on the basis of humanism, stating that such behaviour is overinterpreted. My thesis is that intelligent, artistic robots are creative, but not in the sense that applies to man.

4 A film in which artificial intelligence analyses cubism and on this basis paints subsequent images in this style: *Analyzing Picasso's cubism using Human Level Artificial Intelligence*, <https://www.youtube.com/watch?v=GepzHAWrEHU>, access: 21.11.2016.

stract Expressionism or Cubism and is unable to create a new style in painting, even though it is able to make new works in the style of Pollock or Picasso. In this sense, the software is “dead,” since it lacks certain quality or structure that would allow it to cross the limits of imitation and recreation in favour of innovation and novelty.

First, I distinguish creativity in terms of creating new forms only on the basis of a learned or programmed artistic style, or imitating or copying particular artistic work. Intelligent, artistic robots are creative in the sense that they make pictures that differ one from another; this involves adapting created artistic form to some general, but quite concrete model, defined on the basis of possibilities input into the data base and the software’s algorithms.

Second, I distinguish creativity in terms of originality and innovation. This form of creativity I associate with something more sophisticated, i.e. with making something completely new for art history. This would entail solving an artistic problem: be it formal, i.e. creating new style, or conceptual, i.e. investing the artwork with some general information about reality in an original way. This type of creativity allows us to expect breakthroughs in art that develop the nature of art through deeper changes of what art is, but I doubt this could ever be possible for an intelligent robot.

I share an opinion that intelligent robots are creative in the first sense of the word and I call this type of creativity *secondary creativity*, but they are not creative in the latter sense, which I refer to as *innovative creativity*. The difference between the two may translate into what distinguishes intelligent robots from humans. However, this situation changes when we point to the possibility of there existing a kind of creative structure: *creativity algorithm*, which originates in a creative human. If such structure existed and was isolated in a human mind, we would achieve a metaphysical foundation for its non-biological existence as well – for making creativity algorithm and implementing it into artificial intelligence.

My question is also whether artificial intelligence actually needs creativity and art? Perhaps it is the sign of our homo-centrism in reference to the non-biological, intelligent beings, which could perhaps have other behaviours and needs. The answer to this question gives rise to various opinions encountered in contemporary cognitivism, which stem from the question about the consciousness of artificial intelligence. Opinions vary in this respect and they are primarily based on taking up a thesis rather than justifying it. If we assume that artificial intelligence creates its own mental world, which might not be easily accessible to humans, then perhaps therein would be the space for some form of creation – perhaps not the kind we imagine in artistic categories, but, for instance, characterised by an ability to create new intelligent beings or create new problem solutions.⁵ Meanwhile, if we stand by the opinion that artificial intelligence has nothing in common with any form of

⁵ I discuss creativity only in relation to art. I do not analyse this issue in a broader, though probably important perspective, i.e. whether the original solution to a problem by artificial intelligence – e.g. an unexpected chess move – is creative. Interesting is Kasparov’s statement after losing a game of chess to Deep Blue, that the chess computer made a move which, according to his assessment, only a man could make. This statement shows that in this case the computer’s behaviour could indicate innovation. I take into account only the fact of creation of, for example, paintings created by intelligent robots, which are difficult to dismiss:

consciousness, then we are left exclusively with secondary creativity – artistic permutation, producing a series of similar artworks.

Art made by robots

In this time and age, it is difficult to find an example of an intelligent robot who would be able to create an innovative artwork or propose a new definition of art. Equally difficult is it to deny that these robots do indeed create art. Let us take a closer look at the robots whose creative behaviour raised some commotion in the artworld.

One of the best known among them is AARON,⁶ an art robot programmed since the 1970s by Harold Cohen. It is a robot that paints pictures, while its maker comments on its actions in the following way:

With respect to the composition as a whole, for example, the program has the option of placing dark figures against a light ground or light figures against a dark ground. And since some colour choices are mandated by subject matter – AARON will never choose to paint faces green or purple, for example – it may choose to generate a separate chord to deal exclusively with flesh tones. [...] Program does things in the same way that human beings do them. In functional terms AARON does what human artists do: it paints pictures. (Cohen, 1999)

AARON has no visual system at its disposal, such as cameras that would link it with the outside world. Everything it knows about the world is programmed and internalised, in the sense that, as Cohen writes, AARON devotes the largest amount of time to analyse its own inside, its own database, which allows it to understand the relationships in the physical world, e.g. between the shoulder and the torso. AARON is capable of creating a human figure surrounded by trees and this will be a unique picture, yet it cannot paint a human figure in such a way that this figure would be abstract:

Let me begin by reflecting that AARON is able to do what expert human beings do, and do it to a significant level of expertise, without the visual system upon which human beings rely and without the full range of experiential knowledge which they bring to bear, in this case to colouring. It is noteworthy also that the response its work is capable of evoking in the viewer appears not to be too badly constrained by the program's own lack of an emotional life. (Cohen, 1999)

AARON paints interesting abstract pictures as well, but not in terms of an innovative approach to content, but through its ability and freedom to paint in given style. It will never come up with Surrealist “soft clocks,” but it might paint them as similar to those by Salvador Dali. Moreover, it is unclear whether AARON distinguishes in its creative process whether it paints portraits or abstract works. Perhaps

they are works of art. A more general analysis of creativity in other areas of life is different in comparison to an analysis in the field of art, where the effects are visible to the “naked eye.”

⁶ AARON's homepage: <http://www.aaronshome.com/aaron/index.html>, access: 6.12.2016.

it is a “craftsman” whose electronic *techné* allows only for a mechanical, unreflective process of image making. Neither is it known whether AARON has a linear or holistic vision of the picture, yet it is more probable that it assembles an image from fragments in a non-linear fashion, seeing the whole in its inside. It is creative in its own way, since its nature is to paint pictures, but not developing art – in this respect, it is most possibly limited. It paints pictures, but it is doubtful if it understands the nature of artistic creation the same way humans do.

Perhaps it is for the better that AARON cannot move beyond the programme implemented by the human artist, yet Cohen’s speculations about what AARON really is in its inside raise considerable interest, specifically in a futurologist perspective, in respect to the development of this type of robots and their activity. In AARON’s case, for now, innovative type of creation should be seen as exclusively human domain that finds no equivalent in artificial intelligence.

Another example of a painting robot is *e-David* (2009),⁷ yet this case is easier to comprehend since it is a copying robot. *E-David* has a camera, it uses one of its five brushes, paints with dashes or dots and has a palette of 24 colours at its disposal. At the start of its creative process it might have a declared or non-declared scope of determination, that is, it may be completely subject to the operations of the programme or free from its control in some respect and extent, which offers it a choice of how to paint. *E-David* is interesting for two reasons: first, it is a good copyist, secondly, if offered some space for interpretation, it paints differently from when it is controlled.⁸ When discussing the robot-copyist we can pose a direct question: how are its actions different from the work of a human copyist? From cognitive perspective, both cases involve the working of a biological or technological Optical Character Recognition system, even though this technical term seems more applicable to robots than humans. As far as copying is concerned, the same situation applies to human artists and robot artists, that is, the process involves copying rather than creating. Since the goal is to produce the best copy of given image, this type of action leaves no space for individual creativity, merely imitation. Copying does not seem to trigger emotions as intense as when creativity understood as novelty or originality is discussed. In this case, we could even go further and claim that it is a human artist that resembles a robot, since nothing related to creativity is involved in the process, which requires, instead, a robot-like perfection. A detailed physical analysis of produced copies shows no significant difference between cop-

7 A film documentation of *e-David*’s activities: , (<https://vimeo.com/68859229>, access: 6.12.2016), *e-David*’s homepage: *eDavid the robot painter excels in numerous styles* (<https://newatlas.com/edavid-robot-artist-painter/28310/>, access: 6.08.2019).

8 “The whole eDavid experiment aims at approximating the manual painting processes by a machine, we want to find out to what extent we are able to produce artistically looking paintings. In art history it is also well known that physical limitations, e.g. interactions between ink and canvas, influence the formation of styles. We are looking for new forms of visual representations that are especially suited for painting machines; also we want to find out how to introduce high-level semantic information into the process. In recent years methods for image understanding developed a lot, so painting machines of the future could ‘know’ what they draw and automatically adapt their painting strategy.” (Deussen et al., 2012).

ies made by robots and those made by humans. Certainly, pictures may differ one from another, but an intentional genesis remains the same – the copy is supposed to provide a faithful reflection of the original. There is also an additional aspect – a homocentric attachment to such a definition of art that puts emphasis on the very origin of artworks. For some reason, copies made with human hand may be more valued than those made by a robot. Meanwhile, the possibility of developing the algorithm and improving systems, in the future, means that robots might become better copyists than humans. This resembles the process of passing the knowledge down from master to student, but here the knowledge is accumulated and enriched in a continuous way, and then passed on in its entirety, in the moment of copying the file to the next generation robot – thus, mimesis can reach perfection. Even if we agree that intelligent, creative robots are not able to create a new style or artistic trend, they still can become outstanding copyists with whom no human will be able to compete.

Another example is *Paul* installation (2011), by the painter Patrick Tresset.⁹ It is an interactive work, operating through several portrait-making robots, who make use of two types of feedback.¹⁰ The sitter is placed in front of a group of robots in a way that resembles drawing workshops at art academies. Robots “awoken” by knocking, for instance, on the tabletop on which they are positioned, become activated and look at the model through the cameras. They use the camera to compare the model’s appearance with what they are drawing, this way orchestrating the creative process. This is not about copying, but about making a portrait, which involves their own interpretation. Robots both recreate and create, yet most probably they are not equipped with the human-type creative intuition. Nevertheless, their actions produce portraits very much like those a human could make. If we move aside such features of creativity as human emotion, then what is the difference between a portrait made by Patrick Tresset’s robot and other portraits made by a human? According to Tresset, this is a matter of social contract, which invests artistic objects made by humans with special meaning – what matters is the origin of a painting rather than its artistic value. It would be enough to change our approach and look at a robot-made artwork in such a way to see that its features resemble those that are products of the human creative process. Such an approach could mark the beginning of understanding of ontological aspects of artworks in the context of its artistic genesis: human- or robot-made, and then to recognise artworks made by robots.

Our aim is to develop autonomous systems that are capable of conceiving and producing artifacts that have a range of qualities and characteristics that enable their status as a

9 A film documenting the operation of the installation: *5 Robots Named Paul*, <https://www.youtube.com/watch?v=EH0WFkcZNDg>, access: 6.12.2016.

10 In the article *Portrait Drawing by Paul the Robot*, the authors describe two types of feedback. The first serves the general scheme of drawing, i.e. comparing the current state of drawing with a database (computational or internal feedback) related e.g. to a given fragment of the drawing (arrangement of parts forming the face). The second feedback serves to compare what is drawn with the person portrayed (physical or external feedback) (Tresset and Leymarie, 2013: 354–357).

work of art. Objects, to be considered as having such status, must be exhibited–evaluated–appreciated–acquired in a contemporary art context, and in the same manner as artist-made artworks. (Tresset and Deussen, 2014)

Tresset’s robots are subject to randomness that stems from differences between the pens they use, the way cameras are positioned (distance, angle from which the sitter is seen), and lighting. It is not about the perfect conditions for robots, but about varying conditions that make them draw differently. Their creative process is determined by various physical conditions, which invite diversity between works. The robot creates by considering the rules of portraiture and, much like a biological artist, it analyses the distance between lips and eyes, as well as the position of the face. However, because it lacks semantic knowledge on what it is drawing, it is defined by its maker as a naïve drawer.

Other examples of creative robots are two music-making robots. The first is *Shimon* (2008), a music robot made by Guy Hoffman,¹¹ the second is *Emily Howell* (1980), made by David Cope.¹²

Particularly interesting behaviour is manifested by *Shimon*, who interprets the sounds it can hear, which makes the way it plays the marimba subject to external and changeable circumstances that determine each single note. *Shimon* improvises by drawing from the harmony and melody line of a piece played by a human at the piano at particular moment. Its ability to recognise harmony is programmed in such a way that its improvisation is compatible with the accompanying piano and melodically diversified. Improvisation changes particularly when there is a live concert, because the human performer is emotionally affected by the audience’s reaction which, in turn, affects the robot’s expression.

The latter robot – *Emily Howell* – composes music on the basis of previously uploaded music material. *Emily*’s improvisation is on-going, continuous, and autonomous. The robot’s memory contains a series of musical pieces, which are transformed by the software. The type of transformation is pre-determined by a human operative (e.g. sadder or more joyful), but the musical piece composed in real time is determined by nothing else but the robot’s intention. The emotional response of the audience present, for instance, in the cafe where *Emily* is playing resembles the one triggered by the human-made performance. *Emily*’s maker claims:

Nobody’s original. We are what we eat, and in music, we are what we hear. What we do is look through history and listen to music. Everybody copies from everybody. The skill is in how large a fragment you choose to copy and how elegantly you can put them together.¹³

11 See: G. Hoffman’s homepage with a film documentation of a joint concert with Shimon: *Human-Robot Jazz Improvisation* (<http://guyhoffman.com/category/topvideo/>, access: 2.11.2016) and Ness et al. 2011: 586.

12 D. Cope’s homepage: <http://artsites.ucsc.edu/faculty/cope/>, access: 21.11.2016.

13 D. Cope’s statement quoted on K. Pollard’s blog, <http://www.kevinpollard.com/blog/?p=467>, access: 21.11.2016.

Emily's music is not pre-determined, because it selects the sounds from its database in a coherent way, which is, however, not continuously variable by its co-performer. *Shimon* is more of an improviser, while *Emily* more of an interpreter.

Both aforementioned cases concern music made by computers in accordance with the human way of sensing melody and harmony, virtually unrecognisable in terms of who plays this music: a human or a computer. With respect to *Emily Howell*, an interesting stance was expressed by Kevin Pollard on his blog. He claims that the difference between computer-made music and human-made music lies in the music's semantics, that is, something like a musical Chinese Room, as conceived by John Searle:

The one thing that I would say is missing is *why*. Humans can now program a computer to know *what* a Mozart chorale sounds like and *how* to make one, or to combine the styles of Mozart and Scott Joplin, but the computer doesn't know *why* it's doing it. Only David Cope knows. And it's that understanding of "why" that allows humans to make value judgements about which mistakes are worth pursuing and which ones go in the bin. Humans have the advantage of understanding context and a bigger picture which inform their decisions. Once Emily can do that, she would be truly creative. Until then she's more just a proxy for David's compositions. The thing about music is that it is ruled by emotion, not just logic, so it's harder to predict where it's going to go. It's also why you don't necessarily need degrees and a formal education to succeed in music. I'd have thought that Mozart / Beethoven / The Beatles / Elvis / Michael Jackson didn't know why they were making a new type of music, it just felt right to them, and that was their "why."¹⁴

A hybrid artist and the creativity algorithm

The final example I would like to discuss is an intriguing case of a hybrid being: *Meart – The Semi-Living Artist*, funded by SymbioticA (The Art and Science Collaborative Research Laboratory) and the Institute of Technology in Atlanta. This robot is different from the ones described above in that this installation contains biologically processed information. The ideological difference is that robots discussed earlier are merely non-biological *devices*, while this one is a hybrid, in part similar to biological beings. It contains fragments of rat tissue, stored at the Institute of Technology in Atlanta, which connect with the Internet to process information involved in the creative process. This extraordinary being possesses the mystery of transformation that occurs in biological beings so that it cannot be easily dismissed as merely a more complex "coffee machine."

MEART has the ability to sense the outside world through a camera that acts as its eyes. It has the ability to process what it sees through the neurons that act as its brain. It has the ability to react accordingly through the robotic drawing arm that acts as its body.

14 K. Pollard's statement on his blog about Emily Howell, <http://www.kevinpollard.com/blog/?p=467>, access: 21.11.2016.

The Internet functions as its nervous system. MEART is a geographically detached entity ubiquitous on many levels.¹⁵

In this case, when a hybrid being is considered, our interpretation of the type of information processing we are dealing with becomes much more complicated than in the case of strictly non-biological artificial intelligence. The term “nervous system” brings justified concern if some form of boundary was crossed that stemmed from our definition of life, whose crossing should raise questions about the nature of this hybrid being. We cannot reject the possibility that the being’s biological parts are home to tiny processes typical for all biological beings, perhaps the ones that determine what we refer to as creativity.

This work explores questions such as: What is creativity? What creates value in art? One way of looking at these issues might be by thinking about creativity along a spectrum, from a reductionist mechanical device, to an artistic genius. What is it that makes a person a genius? Perhaps it is the ability to link together diverse inputs. We hope that our cultured neurons will have the potential to show signs of very basic “learning” or “creativity.”¹⁶

Despite all the questions raised by authors of this artistic project, we may assume that *Meart*’s expression is different from the ones discussed previously in that the matter where this expression is born is different. Perhaps for this reason *Meart* may strike us as more human. However, in this respect, we encounter another difficulty caused by the work of non-coordinated biological processes, which might distort the workings of the algorithm responsible for drawing – *Meart* has an electromechanical arm with which it seeks to imitate reality observed by its camera. In this situation, the hybrid *Meart* would have little in common with the process of creation, while its behaviour is merely a biological feedback to received information, quite problematic for the drawing artificial intelligence that struggles with it. In this case, biological nature does not have to define creativity, but common chaotic behaviour, which distorts the working of artificial intelligence. Its behaviour is random more than creatively intentional. Through the lack of internal complexity, a qualitatively defined biological nature and its connection with artificial intelligence, what we are dealing with here is merely behavioural connectivity. As far as creative abilities are concerned, this is an anti-example; still, it is interesting since it offers an opportunity to investigate creativity with respect to both natures: biological and non-biological. *Meart* is an example of a consistent, imitating, creative artificial intelligence, which struggles with its own double nature. The roles were reversed: it is artificial intelligence that tries to draw a portrait, while biological nature is disturbing this process. Most probably, in this case, the process at work in *Meart*’s biological part has nothing to do with creativity.

15 The *Meart* project’s homepage: <http://www.fishandchips.uwa.edu.au/project.html>, access: 21.11.2016; short film about the *Meart: Is This Art? – Volume 4: Meart The Semi Living Artist* (<https://www.youtube.com/watch?v=g2P66RV10vc>, access: 21.11.2016).

16 The *Meart* project’s homepage: <http://www.fishandchips.uwa.edu.au/project.html>, access: 21.11.2016.

What is it, then, that demands a definition in terms of innovative creation: made by humans or by artificial intelligence?

By comparing the above-discussed art projects I postulate the existence of *creativity algorithm* as originated by a creative human. This way, I seek to identify the metaphysical foundation and explain the nature of innovative creation.

If we assume that, in a general sense, creativity is a kind of algorithm shared by different beings, then the ontological difference between the substance in which they exist would lead us to consider the innovative nature of humans and to examine it in search of metaphysical sources of creativity. Innovative creation comes from the creative structure in human brain: *creativity algorithm*. If identified and implemented to artificial intelligence unit, it would possibly be able to exist therein and retain its essence, or even develop. This way, we would even possibly postulate that it is easier to be a creative, innovative robot than a creative human.

If all this is true, then we might expect that the greatest art in the future art history will come not from humans, but from intelligent robots, even though the very genesis of creation would still be located within the human brain.

Conclusion

The above-discussed examples of creative robots were meant to suggest that programmed robots can be creative, but only in a limited way. If the metaphysics of the human-born *creativity algorithm* is applied to robots, their innovative creativity is altogether possible. The most important aspect of the above-presented analysis of creativity is its ontological genesis, rather than ontological difference. Let us imagine that we are dealing with a human being on a primary stage of evolution, e.g. from the period of the cave paintings in Lascaux. Human nature is of this kind that it released the creative act on its own – we are not dealing here with some human “external software,” but with human’s natural evolution and thus construed “software” of the brain. In reference to what was discussed here, intelligent robots can only be independently creative inasmuch as they are equipped with this human quality. Perhaps then, they could understand the nature of art.¹⁷ Maybe then, they could express a quality comparable to artists from Lascaux.

Most probably it is safest to discuss artistic creation in the context of humans rather than intelligent robots, at least for now, even though machines do possess qualities that are not shared by humans, e.g. they solve problems that humans cannot solve. Perhaps it is the difference between these two disparate natures which makes genetic ability to make and understand art what distinguishes humans from other, even more intelligent beings.

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Abstract

We live in an era that witnesses an increasing significance of artificial intelligence and anticipates increasingly intelligent systems. With artificial intelligence and intelligent robots taking over some of the functions previously performed by humans, there are raised questions about the type and scope of their activity in relation to human abilities. This process raises a number of questions about the possibility of identifying those spheres of human activity that cannot be imitated by intelligent programmes or robots. At first sight, such human qualities include emotionality, feelings, and creativity. In this paper, I examine whether intelligent robots could potentially be artistically creative and supplant humans in these processes? Its thesis is that while it is difficult to find innovative and creative robots at this particular moment, it is equally difficult to deny that robots do create art on some level. This invites a perspective that emphasises that while in this respect, at present, human nature is not imitated by robots and artificial intelligence, yet, at the same time, the homo-centric approach is questioned by the assumption that creativity is merely a temporary human quality rather than its permanent property, and that some form of creativity is indeed performed by artificial intelligence.