Artificial Intelligence. Graphical and Creative Learning Processes

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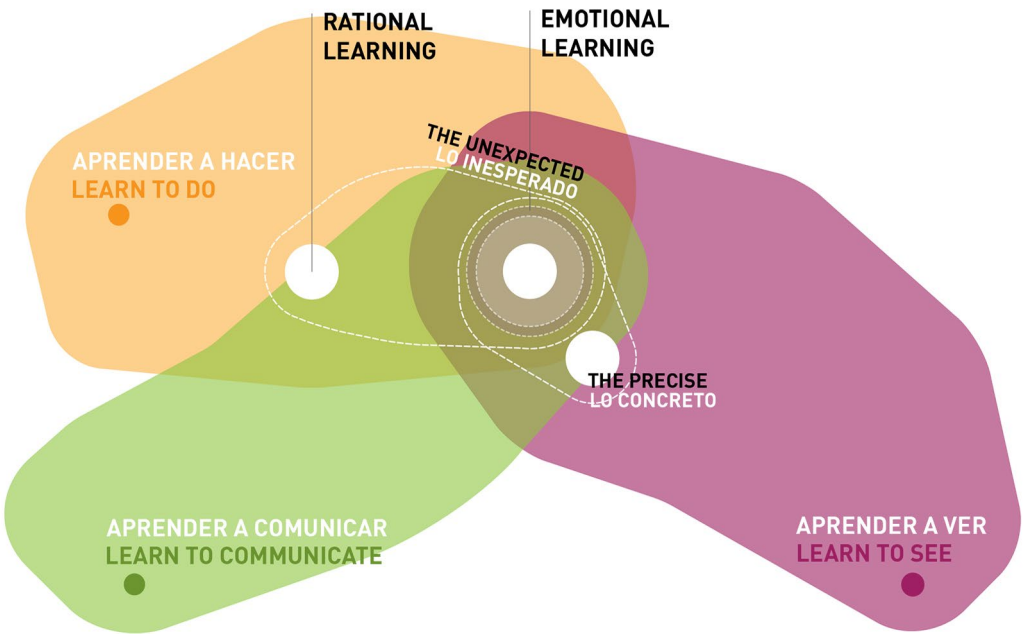
Abstract

Artificial intelligence is responsible for the creation of computer programs that perform operations similar to those performed by the human mind. This is comparable to the traditional procedures used by humans when approaching different disciplines of knowledge. One of the limitations faced by programmers are the non-logical aspects involved in the creative processes of artistic activities.
The relationship between artificial intelligence and creative processes in the field of graphic expression is not only a matter of technological development but must also solve the articulation of logical/rational processes with creative/emotional ones.
The experience based on the teaching methods of drawing at the School of Architecture of Madrid aims to explore how these educational strategies allow the development of work habits which promote aspects that can be used in other environments, including Artificial Intelligence.

Keywords
artificial intelligence, creativity, imagination, education.



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Introduction

The achievements of human beings have been sustained on an imaginary basis, on the maxim that all creation first passes through a state of imagination. Both, society and business, demand creative professionals capable of "imagining" those changes that are yet to come and raise new solutions for the future. A demand that clashes head-on with the decisions that, in education, have drastically limited the presence of teaching methods that promote creativity in recent curricula.

In his writings on creative learning, José Antonio Marina draws attention to the lack of consideration with which this subject is treated in the field of education. Marina points out: "When we talk about creativity we are not talking about artistic activities, but about a way of facing life, its opportunities and its problems" [Marina 2013, pp. 138-142]. In this sense, she alludes to Erich Fromm's postulates on his recommendation for a productive personality orientation [1], understanding this mental productivity as an activity contrary to inertia, passivity or slowness. Understanding creativity as an activity contrary to routine and the inability to face the new, he warns us about the need to educate in productivity in order to educate in creativity. Assuming this to be true, we understand that artistic activities are more permeable to these postulates than the rest of the subjects, which is why it is doubly alarming the progressive elimination of these disciplines in education programs. The need to train students in artistic activities should not be understood as an end to obtain specific results, but to encourage this productivity learning in the search for processes and the opening of new avenues of experimentation.

Since the publication in 2003 of *The Future of employment: How susceptible are jobs to computerization?* in which the authors, Carl Benedikt Frey and Michael A. Osborne, warned of the progressive disappearance of millions of jobs due to robotization, society began to become aware of the magnitude of the challenge, although, contrary to what is desirable, little has been done to meet it.

Only those activities linked to artistic creation are salvaged, since robotics cannot "create" as it is considered a behavior of the human mind. There are several experiments published in this regard, but it is surprising that most of them make a very clear differentiation between the various artistic disciplines, which implies separating musical creativity from literary or artistic creativity.

The article focuses on exploring the advances that artificial intelligence has experienced in graphic-architectural processes of artistic creation, understanding the learning mechanisms of the machine in order to comprehend the keys to these creative processes, as well as their peculiarities and differences. Along the way, some questions will be asked to which there is still no clear answer: is a machine capable of creating and in what terms? Does it make sense to teach the machine to create? What benefit does this learning bring to society? Although it is still too early to answer these questions, some conclusions can be drawn that will make us reflect on creative learning itself.

Artificial Creative Thinking

Professor José Antonio Marina defines talent as "the triumphant intelligence", stating that when we talk about "education for talent, we are talking about something that includes a part of knowledge, a part of feeling, and a third part about the executive functions of the brain" [Marina 2011, p. 7].

Creativity implies novelty understood as the ability to solve problems by providing solutions that have not been employed by that individual before. Experts such as Ramón López de Mántaras, CSIC's Artificial Intelligence Research Institute (IIIA) director, believe that "human intelligence is versatile, general and that the machine lacks common sense and an understanding of the world" [López 2017], at least for the moment, far removed from artificial intelligences as complex as those suggested by cinema or science fiction in films such as *Ex machina* [2] or *Blade Runner 2049* [3], (Figs. 1, 2).

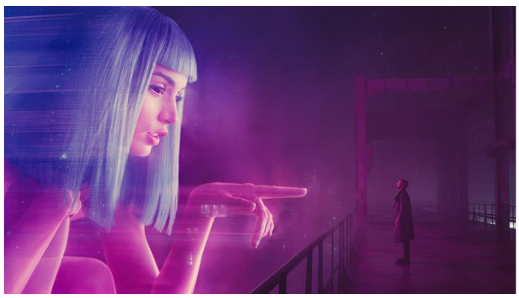

Fig. 1. Cinematic representations of AI. Still taken from the film *Blade Runner 2049* (2017) directed by Denis Villeneuve.

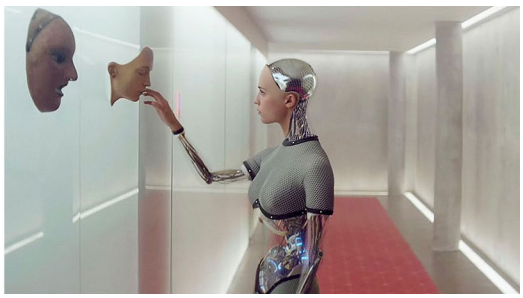

Fig. 2. Cinematic representations of AI. Still taken from the film *Ex machina* (2014) directed by Alex Garland. Source: Alcon Entertainment, Columbia P. C, Sony (UPI)

This advance seems distant because it is based on the foundations that were laid five decades ago. However, other voices speak of the advances achieved in this field through a technology based on multilayer neural networks or GAN (Generative Adversarial Network), which consist of pitting two algorithms against each other in a zero-sum game framework [González 2018, pp. 36-37].

The algorithms used in the development of Artificial Intelligence (AI) seek to implement automatic machine learning in an unsupervised manner. Some experiments conducted with this technology allow a certain degree of invention from the machine when creating images, musical compositions or texts, based on previously collected data. In the case of music, Artificial Intelligence (AI) has made great advances in the field of machine-assisted composition.

At the last edition of Sónar+D, several proposals were presented that aimed at helping the user compose melodies, such as *Magentea,* an AI designed by Google whose algorithms are programmed to listen to the artist and suggest changes, variations and improvements. Algorithmic advances implemented through Deep Learning applications enable the machine to learn to pick up nuances as the musical database in its library grows, to the point of composing its own pieces [Nadal 2018, pp. 67-71]. Other software that excel in this field are also capable of composing small melodies such as Flowmachines, but still under human supervision, or Xiaoice, a software that generated 10,000 poems in 2,760 hours.

In the visual arts, compared to other disciplines, it is highly disappointing to define an advance in creative intelligence as proposals that, through Machine Learning technology, have managed to program a 3D printer that emulates Rembrandt's style to create a painting that looks like it was painted three centuries ago. Anyone who understands what an artistic process involves, knows that imitating is not interpreting. To interpret is not to reproduce another author's way of painting, nor to compose a work from fragments of other authors.

Another example of an AI prototype applied to the visual arts is AARON, a robotic system programmed over several years by the late artist Harold Cohen, which is apparently capable of painting on a canvas without assistance. Its creator claimed that the system was capable of painting scenes not based on copying one or more existing models, but rather generating a multitude of unique drawings on the same subject (Fig. 3).

Another less predictable attempt regarding its possible implementation through AI is the project presented in June 2017 in the context of the Sónar festival held in Barcelona and entitled "My Artificial Muse". Using software developed by German artist Mario Klingemann, an expert in neural networks and algorithms, which was "capable of imagining" art, his colleague the also artist and researcher at the University of London Albert Barqué-Duran, confined himself to executing for three days a canvas devised by the machine. The human merely "printed" manually what a machine had conceived.

According to the explanations of Klingemann and Barqué-Duran, the use of several neural networks was decisive for the confrontation of an algorithm consisting of a large network of nude images capable of creating a sketch from these data, with another capable of putting it in critique, based on a large database of similar information previously evaluated. Theoretically, both networks learn from each other, until they reach a sufficient degree of sophistication to produce something resembling an image. A third network would formally complete each fragment until it is endowed with lights, shades and textures that allow scaling up to a precision of 60 x 60 pixels for each original unit (Fig. 4).

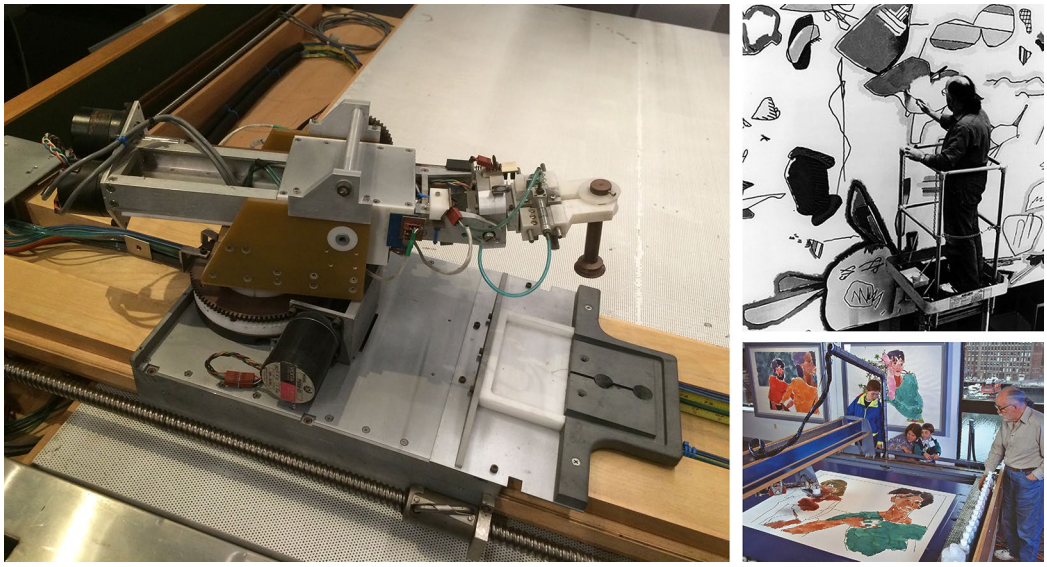

Fig. 3. Harold Cohen. 1995 version of AARON/ Harold Cohen coloring shapes produced by AARON titled "Turtle" at the Computer Museum, Boston, MA, 1982. Source: Collection of the Computer History Museum, 102627459.

Inspiration, Work and Self-criticism. Creative Learning Linked to Graphic Production

Historically, one of the main stumbling blocks we have encountered when considering creative learning is the lack of knowledge on the mental processes that foster creativity. Often this lack of understanding has been justified by alluding to a necessary inspiration without which it is impossible to start, a very weak explanation in our view.
It is surprising that this allusion to inspiration is still so widespread in the collective ideology, especially when most artists confirm the importance of work. We are reminded of some famous phrases expressed by various architects, painters or writers, such as the one attributed to Miguel de Unamuno when he declared that "the way to hit the nail once is to hit the horseshoe a hundred times" [Palomo 2013, p. 23]. Pablo Picasso himself conceived his pictorial work as a continuous process, an endless becoming of variations from an initial subject [4]. In one of his most famous phrases Picasso stated that "inspiration exists, but it has to find you working" [Palomo 2013, p. 169]. Both quotes allude to the two aforementioned aspects with which creative intelligence is built, the work and the decision making derived from this work, based not so much on data analysis, but on random and surprising aspects, which implies a very complex cognitive development more linked to emotion than to reason. All this points to a concept that is difficult to associate with the machine, but essential in the creative process, which is the assumption of error as a tool for exploration and discovery of new ways of creation. Humans learn from our failures through trial-and-error procedures, and we take advantage of them to develop this creative learning through surprise, reinterpretation and reformulation. When a machine makes a mistake, it is not aware of it, unless this variable is introduced into its algorithm.

Fig. 4. A. Barqué-Duran. My Artificial Muse. Sónar + D 2018. Source: A. Barqué-Duran. Source: https://albertbarque.com/myartificialmuse/. (30 August 2018).

In his essay on aesthetics, the philosopher Immanuel Kant alludes to artistic processes, which he defines as an activity of the spirit whose result comes from the imagination [5]. Regarding the process, Kant draws a parallel between nature and the artist, stating that, when creating, both follow an established itinerary. Unlike a technician or a scientist who can establish these guidelines or itineraries in his work process, the artist is not able to explain what he does or how he does it. The artist does not follow rules, but they emerge as the work progresses. The creative process is not linear, it is multidirectional and contemplates learning through error.

In the teaching processes that we carry out in the subjects of Drawing, Analysis of Ideation in the Degree in Foundations of Architecture at the School of Architecture of Madrid (ETSAM), we try to encourage an approach to graphic work which is free of preconceived ideas and without finalist vocation, emphasizing the importance of the process versus the result.

The underlying idea is the learning of drawing as a thinking tool to project, in a productive orientation of the creative personality. By identifying the graphic processes of "architectural drawing" and "architectural design" as processes of architectural research methodology, we validate situations based on graphic operations, which seek to interpret observable realities (Fig. 5). It also allows us to "handle a certain degree of uncertainty and unclear conclusions, validating in a remarkable way as fundamental content the applied method (methodological processes) and not the conclusion" [Raposo 2010, pp. 102-111].

The thinker Giulio Carlo Argan pointed out that "projecting is a provocation, a leap into the future. It is born from an internal obsession, from a very clear and assumed vital purpose" [Argán 1965]. As architects, we experience this urgency. The need to design implies a productive attitude that leaves a graphic record of what is being produced. This way of thinking by drawing implies not only a continuous movement of action-reflection on the traces of what is produced, but also a permanent learning process that helps to internalize the transition from the intuitive to the reflective (Fig 6).

It is a learning process based on the search for its own creative process through the production of graphic artifacts, which requires a series of phases that must be implemented and intertwined in the same way that the different layers of algorithms on which AI is currently based are superimposed.

These phases are not always linear and involve human qualities such as memory linked to experience, skill, curiosity, intuition, emotion and language. During this learning process the student must "learn to see", to encourage graphic research on the project, "learn to do" by experimenting with different graphic techniques that enhance their imaginative abilities and, finally, they must "learn to communicate" to promote the interaction of the project with other agents. This learning is completed with a process of self-knowledge and emotional management, which through the practice of this "drawing to project", tries to deal with concepts such as error, frustration and uncertainty (Fig. 7).

Fig. 5. Patricia Romero. Spatial graphic processes developed in the subject Drawing, Analysis and Ideation I of 1st year of Fundamentals in Architecture at ETSAM, during the 2017-18 academic year. Source: Javier Fco. Raposo; Mariasun Salgado; Belén Butragueño. Drawing, analyzing, projecting (2017), 2018. Madrid: Arcadia Mediática, p. 25.

We can establish that rational and emotional aspects coexist in the learning process. Visual learning feeds on images, observing and documenting as many visual references as possible, in order to create a context that allows them to be critiqued, interpreted and ultimately reformulated. The rational component of this learning, whose data collection is cumulative, would, in first instance, place us at a disadvantage compared to AI if we consider that machines "learn to see" through the elaboration of huge databases to which they have massive access, but we should not underestimate the importance of the emotional component. The criteria by which they interpret these images depend on search algorithms that sift through a series of parameters established in the programming. The interpretation of these images is a very complex process that is not free of conflicts.

The differences in the interpretation of the content of each image, which occur between humans and machines, lie in the literalness of their reading. While humans rely on a memory that alters its meaning according to their experience, the machine can similarly analyze fragments and the whole, converting them into data that it interprets in an unalterable way without paying attention to the message, which, from a creative perspective, is not very flexible. The most important part of "learning to see" in the construction of a creative learning process is not based on analyzing in detail quantities of color, shapes or techniques, it consists of reinterpreting, incorporating what has been visually apprehended into our own process. That is why it is fundamental to reinforce that "visual memory", trusting in a memory that we know will not be faithful to reality, but it will be faithful to our way of seeing.

"Learning to do" poses a similar problem to the previous one. From the point of view of execution, the machine is much more precise than human beings. We have been living for decades with machinery that transforms our designs into perfect executions. But learning to do is not execution, it is the ability to approach work processes on which to experiment and evolve. We learn to do by making mistakes, once again, taking advantage of error. Experiments such as AARON or My Artificial Muse are attempts to approach this field, but they remain at the rational level, trying to make up for the emotional with human interventions. But

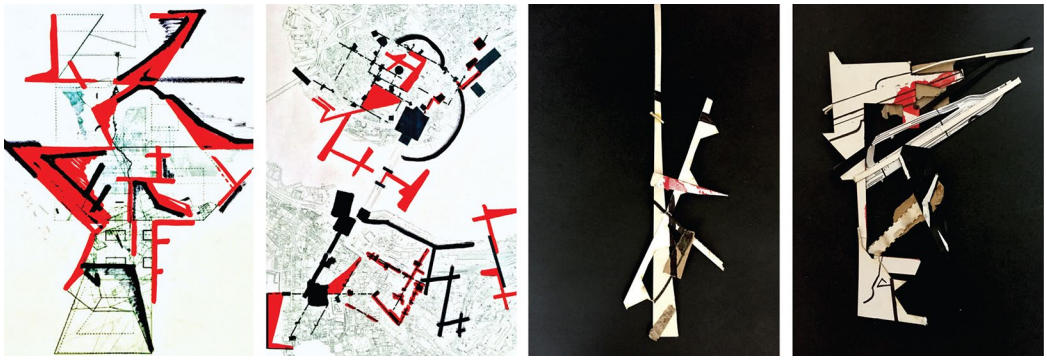

Fig. 6. María Sevillano. Graphic processes of intervention on an urban space developed in the subject of Drawing, Analysis and Ideation 2 of 1st year of Fundamentals in Architecture of the ETSAM, during the course 2017-18. Source: Javier Fco. Raposo; Mariasun Salgado; Belén Butragueño. Hybrid Structures. City, architecture and landscape, 2018. Madrid: Arcadia Mediática, p. 125.

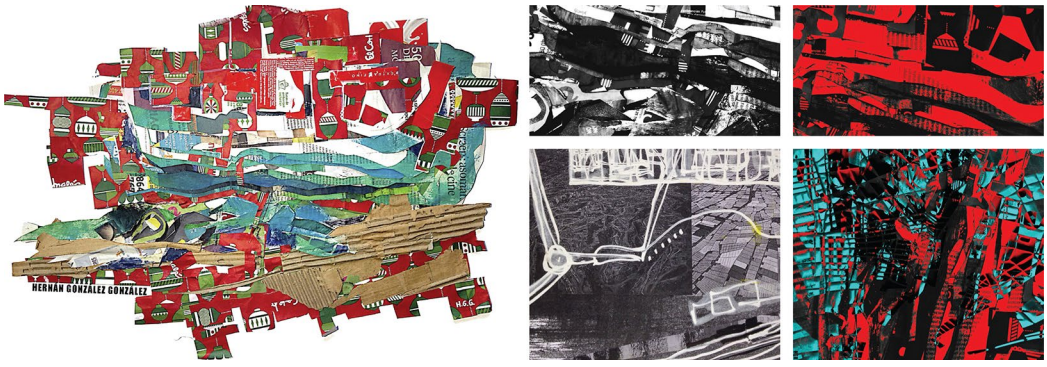

Fig. 7. Héctor González. Graphic processes of intervention on an urban space developed in the subject of Drawing, Analysis and Ideation 2 of 1st year of Fundamentals in Architecture of the ETSAM, during the course 2017-18. Source: Javier Fco. Raposo; Mariasun Salgado; Belén Butragueño. Hybrid Structures. City, architecture and landscape, 2018. Madrid: Arcadia Mediática, p. 25.

the fact is that the emotional and the rational are not placed in watertight compartments, but should intermingle and change shape, like two liquids of different densities.
"Learning to communicate" is the weakest aspect so far for AI, because it consists of empathizing and interacting with other human beings. In this sense, there are games of interpretation on which much of the artistic construction from modern times to the present day is based, for which it is difficult to propose an algorithm. In these cases, the understanding of the message does not always follow preset rules but is built through new rules that have certain emotional components of the sender and receiver. It is enough to recall Magritte's painting "This is not a pipe".
One of the keys to creative learning lies in its singularity, to the extent that its development depends on the pace of each individual to self-formation. This level of self-learning is based on a process of self-knowledge applied to one's own work. To conceive, to design, to create are actions that are not always conscious, that imply a decision-making process that responds to rational and emotional impulses, in which a series of objective data coexist with a mixture of experiences and desires that can hardly be assimilated to a programmable environment.
Despite warnings from Elon Musk or Stephen Hawkings of the risk to the human race posed by uncontrolled advances in AI by private companies, many experts are impressed with the progress made in this field, recalling how inconceivable it was for a computer to win at "go", (a Chinese game of logic that dates back 2500 years), in which Google, in a few years of programming, managed to beat the best, forever changing the way the game is played. Musk warns that "until people see robots killing people in the street, the dangers of artificial intelligence will not be understood. [Machines] could start a war by publishing fake news, stealing email accounts and sending out fake press releases, just by manipulating information" [Musk 2017].
We find it hard to believe in true creative intelligence if we look at the results associated with machine learning. Unlike Musk or Hawkings, we believe that we are still far from dystopias in which a HAL [6] can hatch a creative plan to get rid of the humans around him, much less to design a space, because such constructions require a certain emotional component, which we have yet to see.
In the meantime, it wouldn't hurt to reflect on our own learning processes so that we don't fall behind.
In our experience, the dynamics of collective work between teachers and students has made it possible to establish the relationship between artificial intelligence and creative processes in teaching activities throughout the different phases of learning, solving the relationship between artificial intelligence and creative processes through the articulation between logical/rational processes with creative/emotional ones rather than with the use of technological tools.
Imaginary skills have been developed with the creation of specific exercises designed for this purpose, enabling the establishment of the appropriate connections between the skills to be acquired, the cultural areas of exploration for transversal learning and the tools necessary for the development of these skills.

Fig. 8. Drawing, Analysis and Ideation 2 of 1st year of Fundamentals in Architecture of the ETSAM. Source: Javier Fco. Raposo; Mariasun Salgado; Belén Butragueño.

The course exercises have been articulated and designed to acquire certain capabilities by covering and reinforcing logical and emotional areas, as variables that must establish a certain balance in this linkage between artificial intelligence and graphic and creative learning processes. It should be noted that the verbal/linguistic, bodily/kinetic, and visual/spatial capacities are a further contribution to the theory of Multiple Intelligences [Gardner 1995], as a further contribution to the theory of talents, being in this case these three (of the nine described by Gardner) the most suitable for learning, supported in the generation of artistic processes, so that students have shown specific skills, dedication and creativity in these specific areas.
As for the teaching requirements of the subjects, these have been pleasantly surpassed by the development of the group dynamics proposed, and by the exercises elaborated by the students throughout the course.

Notes

[1] Fromm, Erich (1986). *Ética y psicoanálisis.* México: Fondo de cultura económica.

[2] Ex Machina. DNA Films, Film4, Scott Rudin Productions. 2015. Director: Alex Garland.

[3] Blade Runner 2049. Alcon Entertainment, Columbia Pictures, Bud Yorkin Productions, Torridon Films3, 16:14 Entertainment3. 2017. Director: Denis Villeneuve.

[4] Ramírez, Juan Antonio (1999). *Guernica: La historia, y el mito, en proceso.* Madrid: Electa.

[5] Kant, Immanuel (1919). *Lo bello y lo sublime: ensayo de estética y moral.* Madrid: Calpe.

[6] HAL era un proyecto de software que proveía una capa de abstracción de hardware para sistemas Unix-like.

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