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# **LUCRARE DE DISERTAȚIE**

**Instalații interactive emotive**

**(Interactive Sentient Machines)**

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### Note:

The following pages have been used in the article “Extending emotional framework through interactive experiences” written by me and published in CINETic Review Volume 1 in December 2019 (<https://cinetic.arts.ro/en/cinetic-review/>): p. 4, p. 12 - 14, p. 22-26, p. 31, p. 38-40, p. 42.

## **Introduction**

Human emotions are considered impossible to simulate digitally and are one of the fewer traits that would ensure that humanity maintains the dominant position over Artificial Intelligence in the future. A considerable amount of human activities and attributes are replaced or assisted by Artificial Intelligence systems, but emotions are not on the list. Yet, with the amount of control humanity is delegating to technology, what would be the effects of allowing digital tools to mediate emotional relationships between humans? Would it be possible to create a sentient machine in the current social context? These questions are brought into discussion along with a practical study. The interactive installations presented in this paper represent the materialization of the current research. They expand on the impact of technological advancement on human emotions and social interactions.

Starting with the current and future projected impact of technology and AI on modern societies, a short description of the current situation introduces the subject of machines as a powerful contemporary driving mechanism. With significant influence not only on the utilitarian aspects of human lives, but restlessly penetrating more of our intimate lives, the machines increasingly require a reevaluation of their position in the society. Artists are pushing the conventional limits by raising awareness of possible risks but also curiously peeking into future scenarios. The stake is speculating about the cost and profit of human - machine collaboration.

I will further argue about the necessity of redefining our relationship with the machines and expand on the impact of technology and specifically AI on human emotions and social interactions. How will machines affect our emotional and social relations? These discussions ultimately open up the debate about sentient machines and how they fit in today's context and social order.

## AI in politics and society

### Short AI history in popular culture

Although the phrase Artificial Intelligence is a relatively new term, coined in the second half of the 20th century, the idea of a non-human creation with a life of its own was taking shape long before the invention of the computers or even the industrial revolution. Aspects of this archetype are found in ancient stories like Pygmalion in *Metamorphoses* (Ovid, 2019), the legend of a sculptor that created the sculpture Galatea which he fell in love with and later brought her to life. Middle east ancient stories tell the tale of Golems - animated creatures made entirely out of inanimate matter (Idel, 1990). Ancient asian engineers built complex automata. All of these, be they just characters in a legend or real objects, share the common depiction of an anthropomorphic creation by the human hands. Usually these beings do not have a permanent place in the human world, either because they are depicted as villains, or because of their sole role of either teaching the human hero a lesson or helping him overcome an obstacle in his journey.

The discussion about Artificial Intelligence started at the beginning of the 20th century encouraged by the numerous sci-fi novels and rapid ascension of computers. Movies like *Metropolis* (1927) started picking up on features like intelligent robots and scientists like Alan Turing started asking questions like “*Can Machines Think?*”<sup>1</sup>. No longer was Artificial Intelligence the domain of stories and fantasy, this new phenomenon started penetrating the real world and seizing the attention of the mass audience. More importantly it spur the imagination of the public. Sci-fi novel *I, Robot* (Asimov, 1950) raised important questions about safety of robotics with the notorious *Three Laws of Robotics*:

#### ***“First Law***

*A robot may not injure a human being or, through inaction, allow a human being to come to harm.*

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<sup>1</sup> Turing, Alan M. (1950). *Computing Machinery and Intelligence*. p433. Published in *Mind* 49.

### ***Second Law***

*A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.*

### ***Third Law***

*A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.”<sup>2</sup>*

Similar concerns were raised by the movie *2001: A Space Odyssey* (1968) through the character HAL 9000, which is an intelligent computer that seizes the control of the ship and even sacrifices part of the crew in order not to jeopardize its mission. The plot questions the responsibility humans delegate to the intelligent computers and the threats this might pose to humanity.

While in certain ways this publicity forward-propagated the development of AI it also created some high expectations that later lead to the ‘AI winter’ in the late 80s - funds were cut from the research in this field and development stagnated as this technology did not deliver the promised and imagined benefits.

Perhaps the next event to bring Artificial Intelligence to public attention was the defeat of Garry Kasparov (Krauthammer, 1997). Deep Blue, a chess-playing computer developed by IBM, won in May 1997 a six game match against the world chess champion at the time. The new millennium sparked discussions about AI again. In 2009, Google developed the first driverless car and suddenly automation of driver jobs was on the table for the near future(DeBord 2018). Starting 2010 AI entered consumer homes and personal lives. Virtual assistants on personal PCs and mobile devices became available. In 2011 Siri was launched with features like automating simple tasks while adapting to the user needs(Dormehl 2019). In the same year IBM Watson beat two of the most successful players at the game *Jeopardy!*.

Arguably ‘AI winter’ was over around 2012 with the rising interest and accessibility to machine learning. Suddenly AI was not only a subject for novels and sci-fi movies, but it also had some impactful applications in finance, medical science, human resources and recruiting, music, transportation and agriculture. Probably another more recent groundbreaking news

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<sup>2</sup> Asimov, Isaac (1950). I, Robot. p. 34. Published by Doubleday & Company, Inc. in 1956.

involving AI was the defeat of the world champion Lee Sedol at the game Go in 2016 (Metz, 2016a). Developed by Google, AlphaGo was a computer program trained in playing the board game Go. This event introduced the mass audience to the notion of deep learning. It was a radical approach to building intelligent machines as it was no longer software in its traditional understanding where every path was preprogrammed and thus controlled by the human. AlphaGo was trained using an artificial neural network on a database of around 30 million moves and after gaining a certain level of proficiency, it was considerably improved by playing instances of itself (deepmind.com). Using reinforcement learning, the algorithm improved itself outplaying the best human player in the world. More than that, in the second game of the match, AlphaGo played the unusual move 37 which shocked commentators and Go professionals exhibiting extra-human intuition (Metz, 2016b).

#### AI changing society

The threat of making certain human activities obsolete seems more real now than ever. And rightly so, if AlphaGo could come up with an innovative, never played before move and win the game in the end, what stops future intelligent machines to develop such intricate plans that people will not be able to predict. And these plans must not necessarily mean good news for humans. But it is important to understand that in certain cases AI is a real player in contemporary society like in the case of trading - automated bots and machine learning algorithms for parsing complex transactions are coming up with innovative solutions where current statistical models cannot handle it (Thomas, 2019).

A popular juxtaposition in the discourse about the future of humans and AI is the example of a man that wants to build a house over an ants nest. The man does not hate the ants or want to destroy them, but the house is much more important to him than one ant nest. In this situation there is no question that the ant nest will be destroyed and the house built. Many concerns have been raised by contemporary scientists, business men and visionaries about the speed with which this technology evolves and the urgent need to adopt a more responsible attitude with a greater take on the consequences. One of the greatest concerns about the

downsides of AI development, just as in the case of the Einstein-Szilárd letter on nuclear fission (Szilárd, 1939), is the possibility of using this technology for development of weapons and warfare. *AI Open Letter* regarding autonomous weapons initiated by The Future for Life Institute was signed by over 30000 specialists amongst which are Stephen Hawking, Elon Musk, Steve Wozniak and Noam Chomsky (Future of Life Institute, 2015). Just as the letter addressed to Roosevelt by Einstein (Szilárd, 1939) warning on the threat of atomic bombs, this letter addresses all contemporary policymakers with the intention to bring awareness to the dangers of AI development.

There are also more optimistic speculations on how a superintelligent AI could impact humanity. After all the threat of losing jobs and being enslaved by technology was also considered a risk in the 19th century throughout the industrial revolution, but humans adapted to the new conditions and in the end humanity improved its life quality overall. The same can be predicted for the human race in case of a future in which an artificial superintelligence will impactfully change the anthropocentric world. On the other hand, like Max Tegmark mentions in his *Life 3.0* book with concern, the same was said about horses pre industrial revolution (Tegmark, 2017). It was considered that new utilities would be found for horses, but unfortunately in the US horse population dropped from over 21 million at the beginning of the 20th century to 3 millions in the 1960s (Kilby, 2007).

The futurist Ray Kurzweil considers that machines will protect and respect humans for giving birth to the AI and that a utopia is possible in which people and machines will coexist peacefully (Kurzweil, 2005). But there is no guarantee that a superintelligent entity won't decide at some point that its goals are more important than preserving the human race. After all, didn't humans also decide not to respect their pre-programmed natural algorithms of reproducing? People nowadays use birth control to prevent reproduction even though this is arguably the main goal pre-programmed into our DNA.



## Machines vs Humans

In order to stay in control of the new context in which artificial intelligence is rapidly developing perhaps the best option for humanity will be to merge with the machines. This is an idea developed by the Transhumanism movement (Humanity+, n.d). In a certain way this merge is already happening through mobile phones, smart watches and home assistants. But in order to stay competitive, this merge must be implemented also at the cognitive level. The speed of a computer in learning and computing information is unmatched by current human capabilities. In spite of this fact, humans can still control the machines and their behavior is predictable and explainable. With the development of AI and lately the deep learning algorithms this control is starting to slip away from human programmers. Some outcomes of such algorithms have an unpredictable character and the route to getting there can be hardly explained as was the case with previous classic algorithms. This trend can lead to humans being overwhelmed by the decisions and actions of superintelligent machines. Max Tegmark brings an interesting example making a parallel to a kindergarten full of 5 year olds in which a grown up is kept captive and has to explain to the children concepts like economy, politics and agriculture(Tegmark, 2017). Will in this scenario the grown up lose his interest in explaining such concepts because of the obvious cognitive differences and resort to trickery in order to reach its own goals? Following this logic, it would appear that goals must be the central focus of creating AI. Humans have to define a clear set of goals that would be the building blocks of a future superintelligence. According to Max Tegmark, current research efforts regarding AI goals split into three main tasks:

- *“Making AI learn our goals*
- *Making AI adopt our goals*
- *Making AI retain our goals”*<sup>3</sup>

But as mentioned before, making a superintelligence retain our goals might not be a trivial task. After all the goals of Darwinian evolved organisms were polished according to the immediate context the organisms were in contact with (Tegmark, 2017). And just as we do not want to be

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<sup>3</sup> Tegmark, Max (2017). Life 3.0. p. 260. Published by Penguin Books in 2017.

governed by the laws and values evolved since 1500 years ago, it might be unfair to force some future superintelligent organisms that could even break out of the solar system, to follow some fixed set of principles defined by humans.

In an interview with Tom Dietterich, the president of the Association for the Advancement of AI, when asked what is the relationship between humans and machines, Tom Dietterich, said “*my answer is that it’s very obvious: Machines are our slaves.*”<sup>4</sup>. Indeed, human history has a long relationship with slavery, much longer than the last 200 years or so in which slavery was abolished (Reuters, 2007). So far slavery has been thought of only in relationship with other conscious and emotional beings. Without emotions, machines cannot feel that they are enslaved, they cannot suffer and their rights cannot be violated because there are none. This can be a dangerous path as Max Tegmark points out (Tegmark, 2017). What might happen if a super intelligent machine, lacking emotions, breaks out of the human cage? Lacking empathy and consciousness it can be a real threat to the human race and life in general, wandering meaninglessly like a mechanical zombie throughout the Universe.

According to Ray Kurzweil (Kurzweil, 2005) the future that awaits humanity is Singularity - “*a period during which the pace of technological change will be so rapid, its impact so deep that human life will be irreversibly transformed.*”<sup>5</sup> Drawing on this, it seems like the only way in which humans and intelligent machines will coexist is through extremely intimate merges. In fact these will be so transformative for humans that they will completely change the meaning of our lives, economics, politics and even death. Kurzweil bases his prognosis on six epochs: *Physics & Chemistry, Biology, Brains, Technology, Merger of Technology and Human Intelligence, The Universe Wakes Up*<sup>6</sup>. According to these, we are in the fourth epoch, transitioning to the fifth. In *Merger of Technology and Human Intelligence* epoch, humans and machines will merge to such an extent that there will be no distinction between these two nor will there be any distinction between physical and virtual reality. This process will ultimately lead to saturating the entire Universe with human intelligence, stating boldly that “*we will determine our own fate rather than have it determined by the current “dumb”, simple,*

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<sup>4</sup> nymag.com (2015). How afraid of Watson the robot should we be? Available at <https://nymag.com/intelligencer/2015/05/jeopardy-robot-watson.html>. Accessed in January 2020.

<sup>5</sup> Kurzweil, Ray (2005). Singularity is near. p. 24. Published by Penguin Group in 2005.

<sup>6</sup> Kurzweil, Ray (2005). Singularity is near. p. 30. Published by Penguin Group in 2005.

*machinelike forces that rule celestial mechanics*<sup>7</sup>. Albeit maybe a bit too basal, Kurzweil's guesses are becoming reality to a certain extent when he mentions in the same book (Kurzweil, 2005) that “*Warfare will move toward nano-bot based weapons, as well as cyberweapons*”<sup>8</sup>. The same direction is taken with drone wars in the middle east (France 24, 2019), Stuxnet virus in Iran (Zetter, 2014) or the remarkable influence of online fake news on the 2016 American elections.

## Political AI

Lately discussions about AI started penetrating the world of politics. Given the impressive ability of artificial intelligence to work on big data, it is hard to imagine a future of politics in which AI will not play an important role. In the 2016 American elections, fake news was a central tool in manipulating public opinion (Allcott and Gentzkow, 2017). Around 2018, Deepfake videos of politicians started surfacing the web, crippling public images, influencing opinions or even contributing to a military coup (Breland, 2019). Such technology is possible thanks to the popularization of General Adversarial Networks (GAN) invented in 2014. By 2020, the technology has not only matured to create highly realistic fake videos, but it is being democratised to such an extent that it is allowing a very fast development. DeepNude, an application that rendered any image with a clothed woman to a naked counterpart, became viral in Summer of 2019, generating thousands of downloads and crashing the servers. It was booming for a few months and then got taken down by the developers with the pretext “*The world is not yet ready for DeepNude*”<sup>9</sup>. But it is not long before someone else will pop out version 2.0 of this app. Another example is even older, from 2017, when developers at Nvidia showcased an algorithm that could, reasonably well, transform the season in a video from Winter to Summer and daytime from day to night (Cole, 2017). Such examples demonstrate the incredible power Deepfake videos can have on the real world. This technology came unexpectedly fast and the

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<sup>7</sup> Kurzweil, Ray (2005). *Singularity is near*. p. 40. Published by Penguin Group in 2005.

<sup>8</sup> Kurzweil, Ray (2005). *Singularity is near*. p. 227. Published by Penguin Group in 2005.

<sup>9</sup> theregister.co.uk (2019). DeepNude deep-nuked: AI photo app stripped clothes from women to render them naked. Available at [https://www.theregister.co.uk/2019/06/27/deepfake\\_nudes\\_app\\_pulled/](https://www.theregister.co.uk/2019/06/27/deepfake_nudes_app_pulled/). Accessed in January 2020.

traditional media and society had little time to react. Nevertheless it had a colossal effect on society.

If humanity decides to merge with technology it could mean different approaches to transformation of the human condition. One of the speculations in this direction is a political figure that would control and lead humanity. In this sense there are multiple representations of a possible superintelligent authority (Tegmark, 2017):

- Liberal - for humans, machines and cyborgs to coexist peacefully in a free market.
- Dictatorial - considering that its goals would be to protect humanity, this would imply enforcing a set of rules based solely on its inner judgements for the end goals of preserving and developing the human race.
- Observational - a non-intrusive superintelligence which would only oversee the natural development of human beings without influencing it dramatically.
- Enslaved - when the sole purpose of its existence would be to serve humanity. This type of superintelligence would only provide answers to the questions posed by humans. It will not be allowed to formulate questions, answer them and act on it.

Although it may be one of the most interesting applications of AI, the world of politics is notoriously slow in adapting to external incentives and significant changes take time. Nonetheless some curious exercise was done in this regard. Alisa (alisa2018.ru, 2018) was an AI that ran for the president in the 2018 Russian elections. Complete with a campaign website and interviews, its campaign slogan was - *“a president that knows you personally”*<sup>10</sup>. It received 25.000 votes. Its intelligence was not great, but it was able to formulate some rough thoughts for a political agenda and had some convictions about certain country problems relevant for its campaign. It is important to mention that Alisa did not come out of the blue. It is the name of the virtual assistant equivalent to Google assistant in Russia, provided by their search engine Yandex. So this is a known and perhaps trusted entity, it has been in contact with humans for a long period, built trust and gathered data on them.

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<sup>10</sup> alisa2018.ru (2018). Available at <http://alisa2018.ru/>. Accessed in December 2019.

The Kitty AI : Artificial Intelligence for Governance (pinaryoldas.info, 2016) is another project having a political nature, but this time it is an art piece that suggests a political alternative to current structures with a big emphasis on sentience. It claims to be able to love 3 million people at a time, which suggests the ability to follow people's best interests. This is one of the most attractive features of the fantasy about an AI politician - it could study each of our needs, it would not have emotions or personal biases, it could come up with the best solution suited to the need of each and all of us. Unfortunately there are still a great deal of uncertainties about the feasibility of such scenarios: who will stand behind a superintelligent politician, what do we really want as humanity, what is the data that will be used by a superintelligent entity to decide the best course of action and most importantly - should humans be part of the grand plan of spreading life and intelligence throughout Universe?

### **AI in art**

When it comes to robots and Artificial Intelligence techno-skepticism and dystopian discourses have been at the forefront of popular culture for the past decades. Hollywood movies like *Metropolis* (1927); *Star Wars* (1977); *2001: A Space Odyssey* (1968); *The Terminator* (1984); *Blade Runner* (1982); *The Matrix* (1999); *Artificial Intelligence* (2001) and even more recent movies like *Black Mirror* (2011), *Her* (2013) and *Ex Machina* (2014) embody the public fear of artificial machines taking over the world and exterminating humans (or at least the humans as we know them right now). On the other hand there are also sci-fi novels like *I, Robot* (Asimov, 1950), *1984* (Orwell, 1949) or *Ender's Game* (Card, 1985). Also taking place in comparably grim universes, but the take on the worlds with artificial super intelligences are more complex in these novels and the unfolding scenarios are not that straightforward. That is to say that long before any kind of artificial intelligence would become reality, real concerns were raised like the surveillance society, big brother scenarios with a superintelligent non-human dictator and robot ethics.

The art world follows the same path of either *angst* or fascination with the utilitarian capabilities of Artificial Intelligence towards technology. Installations such as Sun Yuan and

Peng Yu's *Can't help myself* (Yuan, S. and Yu, P., 2016) - a robotic arm struggling to contain a liquid in its confined space, Dominique Sirois and Baron Lanteigne's *In extremis* (2019.mappingfestival.com, 2019) a network expanding in the real world through a skeleton hand made up of touch screens and ceramic or Marco Donnarumma's *Amygdala MK3* (marcodonnarumma.com, 2018) - an AI that trains itself while cutting the same piece of skin trigger a discomfort towards the intertwinement of technology and the lived experiences. More often than not, exhibitions that bring together artists and scientists focus on this expansion of technology beyond human capacities i.e *AI More than Human* (barbican.org.uk, 2019), a practice that can discursively fit into the paradigm of dread.

However there is a growing trend in the art scene of tackling issues of interspecies collaboration and algorithmic intimacies. These start a discussion about symbiosis and empathy towards technology and Artificial Intelligence. *The Entangled Realities - Living with Artificial Intelligence* exhibition at (hek.ch, 2019) turns the view on the present-day world co-built by humans and AI alike. *Transmediale Festival* (2019.pastwebsites.transmediale.de, 2019) focused on how feelings are affected by objects of technological design and the role of emotions in the digital culture. An interesting approach was taken by *Error* (ars.electronica.art/error, 2018) in their 2018 exhibition with their topic ERROR. It set the discourse at a more empathic, human level towards the failures and flaws of technology and focused on the positive approach towards imperfection. *Robot Love* (robotlove.nl, 2018) is an interactive exhibition experience that embraced the arrival of robots and Artificial Intelligence and raised the question of love towards and in the context of Artificial Intelligence on the rise.

## Cybernetics and Telematic Art

A big influence on the philosophy of artificial intelligence and subsequent inspiration for pop culture was the work *Computing Machinery and Intelligence* by Alan Turing which posed the big question "*Can machines think?*"<sup>11</sup>. This paper also introduced the popular concept of *Turing Test* in which the intelligence of a machine is decided based on the perception of an

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<sup>11</sup> Turing, Alan M. (1950). *Computing Machinery and Intelligence*. p1. Published in *Mind* 49: 433-460.

external human evaluator that has to compare a natural language conversation of this machine and another human. The art world picked up on the ideas in this paper and developed different scenarios, imaginable outcomes and posed legitimate questions. Another important paper published in 1948 by Norbert Wiener is on Cybernetics defined as ‘the scientific study of control and communication in the animal and machine’ (Wiener, 1948). It triggered the new art directions working with artificial life, artificial intelligence, telematics, kinetic art, body and identity. According to Maria Fernandez this was the turning point in which works “*should no longer be conceived as static autonomous entities but as evolving processes that unfold in relation to both the user and the environment*”<sup>12</sup>. Given the questions raised by Alan Turing in the light of computer development breakthroughs and the conciliatory theory of Cybernetics given by Wiener according to which biological and non-biological entities communicate with each other, the natural artistic direction was exploring artificial life.

The interest of interdisciplinary collaborations for creating art grew rapidly after the 50s and in 1966. Engineers Billy Kluver and Fred Waldhauer together with artists Robert Rauschenberg and Robert Whitman founded the non-profit organization Experiments in Art and Technology (EAT). The organization was open to artists as well as engineers and encouraged collaboration through sponsorship and industrial cooperation. By 1969 the organization counted around 2000 artists and 2000 engineers. Among other projects, it created the first international exhibition of art and technology ‘Some More Beginnings’ in 1968 (Dušan, 2019).

### Artificial life art

Roy Ascott, one of the pioneers to work with cybernetic art, created in 1983 the collaborative work of art *La Plissure du Texte: a planetary fairy tale* in which a group of artists around the world collaborated through computer terminals on a collective story (Stuart, 2009). Preceding phenomenons like Facebook and Second Life, this work explored the concept of distributed authorship and telematic art. The latter is a concept that challenges the classic definition of passive art. The work is no longer finished once exhibited, but suffers continuous

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<sup>12</sup> Fernandez, Maria (2006). A Companion to Contemporary Art since 1945. p. 558. Published by Blackwell Publishing Ltd in 2006.

transformations in the process of being displayed. Furthermore, the evolving process itself is the artwork rather than the end result, which in many cases is non-existent as there is no set end. The use of telecommunication in creating an artwork was first used by László Moholy-Nagy in 1923 when he produced the series *Telephone Pictures* by providing instructions for producing them over the telephone (MoMA, 2019). I think this type of artworks touch on a curious subject of human identity and consciousness. As expressed by Max Tegmark, just as waves can have different substrates, *“If consciousness is the way that information feels when it’s processed in certain ways, then it must be substrate-independent; it’s only the structure of the information processing that matters, not the structure of the matter doing the information processing”*<sup>13</sup>. So perhaps this can be considered as the first declaration toward replacing certain human features with other more efficient, technological ones. One of the founders of the field of artificial life - Christopher Langton, stated that “There is nothing in its charter that restricts biology to carbon-based life; it is simply that this is the only kind of life that has been available to study.”(Langton, n.d.).

A similar project was exhibited at Ars Electronica museum in 1995. Telegarden was an installation developed by Ken Goldberg and Joseph Santarromana which allowed web users to take care of a small garden. Members could plant, water and monitor the garden online through the use of an industrial robot arm (Goldberg and Santarromana, 1995). It explored concepts of telematic communities and distributed social responsibility. Ascott linked networks to live organisms given that they are used to produce a new kind of creativity (Fernandez, 2006).

Artificial Life and Cybernetic artists obsessed a lot about virtual ecologies and ‘alive’ forms which have a life of their own. They try to bring into question issues about life, humanity and new life forms (Bartlem, 2005). Christa Sommerer and Laurent Mignonneau developed computer generated artificial life forms since 1994. Their *AVolve* project developed at an artists residency at the National Center for Supercomputing Applications in Illinois, USA, allowed visitors to create virtual creatures by gesticulating (Paul, 2015). These were then set free in a virtual environment where their shape determined their survival. Visitors could still slightly intervene using gestures in order to protect or offer a slight advantage to their creatures. The

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<sup>13</sup> Tegmark, Max (2017). *Life 3.0*. p. 304. Published by Penguin Books in 2017.



work addresses directly concepts of artificial life and human involvement in the natural evolution.

Separation of control and networked control ultimately lead to questions about identity. What makes us human and what is the ultimate definition of life? A peculiar work created by Gordon Pask, a contemporary of Roy Ascott is titled *The Colloquy of Mobiles (1968)*. It was an interactive computer-based system, that featured male and female silhouettes that learned to interact with each other through beams of light. The ‘organisms’ learned to optimize their behavior in time. Visitors were able to influence this dialog by using flashlights and mirrors (Rosen, n.d.). This project playfully merges the human and robotic worlds, letting them influence each other's experience and evolution on a common playground.

This model of distributed experiences, which take form in the presence and with the active participation of humans and machines as well pointed out by Christiane Paul “*enable users to observe, intervene and communicate with a remote location and ‘insert’ themselves into a distant environment*”<sup>14</sup> at the same time allowing users to broadcast themselves (Paul, 2015). *Autopoiesis* was created in 2000 by Kenneth Rinaldo and displays an interactive system in which visitors influence the system’s evolution. It consists of a set of robotic arms communicating through hardwired network and telephone sounds. Visitors can influence the kinetic movement of the sculpture by moving in the near space thus contributing to the overall aesthetic of the work. *Autopoiesis* thus becomes a permanently evolving living system. It hints on the role of machines not only as mere tools in making humans understand the structure of life, but perhaps partners in evolution vanishing the boundaries between man and machine (Paul, 2015).

In his book *Beyond modern sculpture*, Jack Burnham predicted cyborg art to be the ultimate stage of sculpture covering the concept of man-machine collaboration in the following statement: “*It is only a step from here to suppose that in time an aesthetics of artificial intelligence will evolve. Unless the world is substantially altered for the worst, the logical outcome of technology's influence on art before the end of this century should be a series of art forms that manifest true intelligence, but perhaps more meaningfully, with a capacity for reciprocal relationships with human beings*”<sup>15</sup>. This is an impressive guess on the

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<sup>14</sup> Paul, Christiane (2003). *Digital Art*. p. 163. Published by Thames & Hudson Ltd in 2015.

<sup>15</sup> Burnham, Jack (1968). *Beyond modern sculpture*. p 15. Published by George Braziller, Inc. in 1975.

decentralization of the work of art. Instead of having a unidirectional relationship, now a piece of art is in continuous transformation by the visitor who is the co-creator of the artwork. Simon Penny boldly questions the role of classical sculpture in an article from *Sculpture magazine* in 1999: “*What place does sculpture have in a world of disembodied power? Sculpture belongs to the world of empires and conquest and territory and fortresses.*”<sup>16</sup>. And indeed, the democratized world of art desires more than pure objects of adornment. The main pursuit of Artificial Life art is to focus on organization and behavior rather than the platform on which these life patterns manifest themselves.

## Bioart

Bioart exists in close relation to Artificial Life. Biological artists work with biological and physical materials as a medium and frequently generate more anxieties and heated debates by raising ethical questions which are closer to the classical definition of life (Bartlem, 2005). Artworks like *GPF BUNNY* (Kac, 1998a) by Eduardo Kac generated a lot of controversies given the considerable liberty of manipulating natural processes in science laboratories. In collaboration with Louis-Marie Houdebine, Kac genetically modified an albino rabbit with a green fluorescent protein (GFP) to make it glow green when exposed to blue light. He called this ‘*transgenic art*’ (Kac, 1998b) through which he challenged the boundaries of art and science and questioned the length to which humanity has the right to intervene in natural processes. ‘Is it art or exploitation?’ was the question that brought scientists, artists and animal-rights activists to a joint debate. Similar heated discussions were raised by Marcel Duchamp at the beginning of 20th century through the concept of *ready-mades*.

Another pioneer of art forms touching on the boundaries of biology and science is Stelarc. His artistic practice led the discussion about the post-organic and biotech era. By modifications to his body through implants or external prosthetics, Stelarc focused heavily on extending the capabilities of the human body and challenging definitions of body and identity.

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<sup>16</sup> Penny, Simon (1999). Available at <https://www.sculpture.org/documents/scmag99/jan99/burnham/sm-burnh.shtml>. Accessed in November 2019.

Inadvertently or not, by the extremely intimate character of his works he touches on subjects of voyeurism and surveillance as well - also one of the artistic practice concerns in *telemetrics*.

One of the earlier works of Hans Haacke - *Condensation Cube* (1965) interacts with the environment and changes its form distilling the essence of a living organism. A sealed plexiglass cube containing water creates vapour condensation patterns on the walls of the cube because of the temperature changes. In endless transformation, this work never comes to a fixed state. More interesting is that Haacke found a creative way of involving visitors in the artwork as their presence modifies the temperature in the exhibited space and stimulates the condensation effect. Also he has only partial control on the aesthetics of the work, which gives the work a certain independence forming a creative triangle between artist, visitor and the artwork.

## Artificial Intelligence

The first big sale of an AI artwork happened in 2018, bringing recognition to AI art at the auction house level (BBC News, 2018). It was linked to the discovery of generative adversarial networks (GAN) opening the possibility of generating new types of visual aesthetics. Arguably AI was used prior to this period by artists like Ken Feingold. In 2001 he created the installation *If/Then* consisting of two mannequin heads speaking to each other. They are placed in a shipping box, the artist stating that *“I wanted them to look like replacement parts being shipped from the factory that had suddenly gotten up and begun a kind of existential dialogue right there on the assembly line.”*<sup>17</sup>. They hold existential discussions about the nature of life and their existence. This performance raises questions about robot ethics and human anxieties about dystopian futures. In 2015 Yuri Pattinson took a similar approach in his project *Mute Conversations*. Using two commercial chat bots, the artist connected them to a conversation. On the one hand Yuri explores the scenario in which bots develop their common language and culture but on the other hand he questions the dangers of anthropomorphization. *“We often impose human characteristics on these bots when actually, all they’re doing is mirroring human conversations*

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<sup>17</sup> Feingold, Ken (2001). Available at <http://www.kenfeingold.com/IfThen1.html>. Accessed in January 2020.

in the manner that they're programmed to.”<sup>18</sup>. Sloppy and playful, this dialog can also be perceived as alarming. Only two years later, in 2017, Facebook developers accomplished a similar experiment with more modern artificial intelligence. The bots were instructed to negotiate some transactions using English language, but they quickly came to invent their own language, probably more optimised, and finalised the negotiations. It led the developers to shut down the project, not out of reasons of concern, but because they expected to use this technology for talking to humans. Although not an art project, it sparked some discussions about the future of communication between humans and machines. A lot of projects using AI as the main medium are concerned with reconciling the future of machines with human values by sensitising this technology for the broader audiences.

More AI artists still prefer to work with the new capabilities of AI to generate visual content. GANs have been a major breakthrough in aiding this artistic direction. Artists like Mario Klingemann and Memo Akten take these opportunities to great extent giving birth to fine art level results. Works like *Memories of Passerby* (sothebys.com, 2019) or *Deep meditations* (Akten, 2018) are deeply contemplative having never seen before aesthetics. But viewers cannot refrain from thinking about the background process of generating these images. Artificial intelligence creates original visual connections and distills the very essence of human creativity and desire.

Questions of machine identity and self exploration are raised by Christian Mio Loclair in a work called *Narciss* (Loclair, 2017). This piece consists of a computer equipped with a camera and an artificial intelligence which analyses images. The camera is pointed towards its own hardware circuits and the computer's task is to analyse the images it sees. Basically it is an infinite loop of self discovery and interpretation. *Narciss* excludes the human from its world and obsesses about its own identity.

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<sup>18</sup> Fulton, Jeni (2017). The Artists Forging a Relationship with Artificial Intelligence. Available at <https://www.sleek-mag.com/article/the-artists-forging-a-relationship-with-artificial-intelligence/>. Accessed in January 2020.

## Music

Music was also inspired by the 50s wave of sci-fi novels and research papers on intelligent machines. Pop projects like Kraftwerk in the 70s and Daft Punk in the 90s explored the aesthetics of man-machine intermix. Both the electronic sound and the accompanying visual presentations alluded to a future of robot art or collaborative musical creations. Despite the fact that electronic music was associated with dancing rather than sedentary listening, the 1992 album *Artificial Intelligence* by Warp records intended to change this paradigm. This influential electronic music album, which later gave birth to Intelligent Dance Music (IDM) genre, elevated the status of electronic music to rival classical instrumental compositions.

At the beginning of the 00s a research group at Princeton University developed a project called *Laptop orchestra*, embodied into the project *PLOrk* (PLOrk, 2019). Later in 2015 Concordia University in Montreal took over the same model creating *CLOrk*. Their main area of research and activity is exploring the capabilities of creating chamber music performances with primarily laptops as instruments. Their extensively immersive concerts are developed to this day. In 2019 Yamaha with the support of Glenn Gould Foundation analyzed over 100 hours of piano performances to develop and understand the playing style of Gould. Glenn Gould was a legendary pianist known for masterful performance of J.S.Bach in the '50s. The results of the carefully applied and polished deep learning algorithms was a grand performance at the Ars Electronica Festival entitled *Dear Glenn*. A big part of the performance were pieces of classical music interpreted on a specially modified piano by the AI in the style of Glenn Gould (yamaha.com 2019).

There are also examples of AI taking the role of a composer, like in the case of *Flow Machines* laboratory by Sony. In 2016 they released two pop songs composed entirely by AI but interpreted and arranged by humans: *Daddy's car* - a song in the style of The Beatles and *Mr Shadow* - a song in the style of Irving Berlin and Duke Ellington (Vincent, 2016).

In music just as in visual arts or sculpture the mainstream artistic practice is to delegate part of the creative responsibility to the machine. By carefully creating a sandbox environment for the AI, it is given a certain freedom of conception and interpretation of the human creations.

Thus a collaboration emerges in which AI is not a mere tool in the creative process of the human, but owns a particular individuality.

### **Emotions and consciousness**

Ancient Greeks have given birth to the philosophical concept of dualism which later culminated in the works of Rene Descartes according to which mind and body are two separate entities. Descartes (1641) separates intelligence and consciousness, associating the first with the brain and the latter with the spirit. Other more recent studies like Thomas Nagel's *What is it like to be a bat?* (Nagel, 1974) tackle the mind-body problem again through the arbitration of consciousness as he puts it in his paper "*Without consciousness the mind-body problem would be much less interesting. With consciousness it seems hopeless.*"<sup>19</sup>. His cynical approach has its roots in the affirmations of the paper that no matter how much information one would possess about a different organism it would never really know what it's *like* to be that organism and that consciousness can be explained as "*basically, that there is something it is like to be that organism*"<sup>20</sup>. Various contemporary thinkers have different takes on the definition of consciousness.

### Consciousness

Human thinking is tightly linked with emotions. We can rarely speak of a decision or thought that is not affected by the emotional framework. There are always biases of social, political or personal nature and one's decisions are usually aligned with their convictions and past lived experiences. Sentience thus is tightly linked with consciousness. Since consciousness as a scientific phenomenon is not yet understood, how can it be simulated? According to Chalmers (Chalmers, 2014) the research of consciousness is divided into two problems - the easy

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<sup>19</sup> Nagel, Thomas (1974). What is it like to be a bat?. p. 436. Published in Philosophical Review by Duke University Press in 1974.

<sup>20</sup> Nagel, Thomas (1974). What is it like to be a bat?. p. 436. Published in Philosophical Review by Duke University Press in 1974.

problem and the hard problem. The easy problem lies with the control of behavior and reaction to certain stimuli, the synthesization of information and understanding of mental states. It is not quite easy actually in his opinion, but there are clear signs that this problem can be solved in the near future precisely because this problem concerns certain functions with a clear set of input data and expected results. They perform clear cognitive steps in achieving a certain task or set of tasks. By contrast, the hard problem concerns the question of experience which is not a predictable function which has clear performance rules. The hard problem of understanding consciousness lies in understanding why we have subjective experiences. As David Chalmers puts it *“It is undeniable that some organisms are subjects of experience. But the question of how it is that these systems are subjects of experience is perplexing. Why is it that when our cognitive systems engage in visual and auditory information-processing, we have visual or auditory experience: the quality of deep blue, the sensation of middle C? [...] Why should physical processing give rise to a rich inner life at all? It seems objectively unreasonable that it should, and yet it does.”*<sup>21</sup>.

Although the easy problem is not yet solved we can think of it as platform independent. It is the function and its performance that gives its definition and character of the conscious phenomenon and not the specific platform - in our case human minds. Thus we can argue that the solution to the easy problem of consciousness can be simulated and reproduced on artificial organisms. Further perhaps by identifying the shortcomings of a biological substrate, these solutions can be enhanced and optimized. Just as in the case of mechanically reproducing a flying mechanism, humans did not follow entirely the biomechanical laws of birds when creating airplanes, rather adapted and improved these. And with emulating conscious and cognitive tasks, the last few years have come very close to reproducing these with the help of machine learning algorithms, big data and robotics.

On the other hand, since the hard problem is considered not solvable in the near future by David Chalmers' theory (Chalmers, 1995) how can humans emulate it in artificial organisms? More than that, if there is no clear set of tests that would prove the existence of consciousness,

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<sup>21</sup> Chalmers, David (1995). Facing Up to the Problem of Consciousness. p. 3. Published in Journal of Consciousness Studies in 1995.

how will humans be able to identify or deny it even if someday it is reproduced in an artificial entity?

In a strong contrast to Chalmers' ideas, is the American philosopher Daniel Dennett, who considers that consciousness is just an illusion. Moreover he compares consciousness to a phone screen, an interface to communicating with the brain. This theory hints on an achievable possibility of reproducing consciousness in artificial organisms. According to Dennett, consciousness is just a way of explaining the complex mechanism behind the brain, and the brains are just complex structures of molecular machines (Dennett, 2017). This view is shared by Max Tegmark comparing consciousness and its parts to *“solids, liquids and gases [that] are all emergent phenomena: they're more than the sum of their parts, because they have properties above and beyond the properties of their particles. They have properties that their particles lack.”*<sup>22</sup>.

*“Engineering is a process where we understand certain things and phenomena by designing them”*<sup>23</sup>. As Max Velmans and Susan Schneider wrote in *The Blackwell Companion to Consciousness: “Anything that we are aware of at a given moment forms part of our consciousness, making conscious experience at once the most familiar and most mysterious aspect of our lives.”*<sup>24</sup>. It is situated at the foreground of human experience, hence it gives humans the ability to understand the surrounding world, but in itself it cannot be broken into subdivisible parts. Maybe in an attempt to engineer consciousness, humanity will be able to gain deeper insight into the background of this phenomena.

For a thing to be considered conscious it has to have certain understanding of where it is, where it came from and have certain ability to decide on further actions based on this. Joscha Bach (research scientist at the MIT media LAB) proposes that we look for systems that could perform a Turing test on humans in order to reach Artificial Consciousness (Bach, 2016). Once a system understands that it has a mind and is conscious of its surroundings it might start looking for systems like itself in the world and create social networks of intelligence.

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<sup>22</sup> Tegmark, Max (2017). Life 3.0. p. 300. Published by Penguin Books in 2017.

<sup>23</sup> Aleksander, Igor (2001). How to build a mind. p. 31. Published by Columbia University Press in 2001.

<sup>24</sup> Velmans, Max; Schneider, Susan (2017). The Blackwell Companion to Consciousness. p. 2. Published by John Wiley & Sons Ltd in 2017.



Yuval Noah Harari states that “*Humans nowadays completely dominate the planet not because the individual human is far smarter and more nimble-fingered than the individual chimp or wolf, but because Homo Sapiens is the only species on Earth capable of cooperating flexibly in large numbers.*”<sup>25</sup>. In 1977 the study *A Divided Mind: Observations on the Conscious Properties of the Separated Hemispheres* presented the conclusions of working with a split brain patient in order to demonstrate that consciousness can be split inside a human brain. The fact that the linguistic representation in the right hemisphere was greater in this patient than in any other cases of split-brain patients, allowed the researchers to address both hemispheres of the brain independently and in some cases get different responses (LeDoux, 1977). Extrapolating conclusions from this study we can argue that the human organism is a successful cooperation of a multitude of independent processes of which the organism is more or less actively aware. The opportunities of intelligent machine plug-ins that would arbitrate some consciousness aspects can be tempting and could forever change the definition of the individual, as Yuval Harari (Harari, 2016) puts it, in this *post-liberal* world.

## Emotion

In his book *Looking For Spinoza : Joy, Sorrow, and the Feeling Brain*, Antonio Damasio argues that feeling and emotion are two closely related, but separate phenomena (Damasio, 2003). Emotions are triggered in the body as a result of thoughts or experiences and give birth to feelings which are a product of mind. Based on this theory Yuval Harari states that emotions (subjective experiences) are just a byproduct of thought, an unnecessary junk, sustaining the idea of the opposite process in which emotions are triggered by feelings (Harari, 2016). But if a robot cannot be conscious, how can a brain be? The brain exists within the same physical conditions as the robot and is subject to the same physical laws.

An interesting example of the programmability of the brain is a condition called Transient Global Amnesia. During an episode of TGA, the patient's short-term memory vanishes, recalling only the last few minutes or seconds. The same questions may be repeated by

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<sup>25</sup> Harari, Yuval Noah (2015). *Homo Deus: A Brief History of Tomorrow*. p. 153. Published by Harvill Secker in 2016.

the patient over and over again for as long as 8 hours before being able to return to a normal state and form new memories. This is an interesting demonstration of the brain being programmed to behave in a certain way given the same set of input data. In this short clip provided by chicostine a person suffering from TGA loops through a fixed set of questions:

- What day is it today?
- Did I miss my birthday?

(feeling disappointed with almost the same reaction each time)

- What happened?

(Chicostine, 2010)

If we adhere to the theory that brain activity cannot be programmed by a finite set of steps, as it is a chaotical series of actions triggered by an incalculable set of events in time, then shouldn't the brain try new combinations of questions each time the memory is reset? Instead, this glitch in the brain hints to an existing set of action-reaction conditions that have to be processed in order to push the algorithm forward. It also poses the question if people can choose their desires or consciousness is just an illusion disguising the deterministic nature of the brain. In a study done by Chun Siong Soon, Marcel Brass, Hans-Jochen Heinze and John-Dylan Haynes in 2008, the researchers used an fMRI machine to measure the time between a decision is made unconsciously and the moment it becomes conscious. While scanning the activity of the brains, the participants were presented specific situations and asked to choose out of two possible options. The study indicated that the outcome of a decision can be encoded in the brain activity of prefrontal and parietal cortex up to 10 seconds before it enters awareness (Soon, Brass, Heinze and Haynes, 2008). This means that by the time the subjects became aware of their decision it has already been made in their unconscious brain. Considering that the environmental information reaches neocortex (and thus consciousness) subsequently to passing through amygdala, we can estimate that consciousness is driven by emotion and feeling rather than free, rational choice.

Paul Ekman and Wallace V. Friesen demonstrated in their paper *Constants across cultures in the face and emotion* from 1971 the universality of emotions (Ekman and Friesen, 1971). Considering there was active ongoing debate whether emotions were culturally induced

through exposure to mass media, this paper was based on a study done on a preliterate culture in New Guinea. Based on a set of portraits with emotional representation, the subjects were asked to choose the right emotion after being told a story. This experiment concluded six main universal emotions: happiness, anger, sadness, disgust, surprise and fear.

The part of the brain responsible for emotions processing and storage is amygdala. It is found in complex vertebrates including humans. Millions of years later, from this part of the brain evolved the neocortex - the thinking brain. This part of the brain is responsible for perception, cognition and language. In 1994, Joseph LeDoux published the paper *Emotion, memory and the brain*, explaining a new route responsible for decision making that does not pass through the neocortex. The first '*high road*' passes from the visual thalamus, that receives the visual signal, to the visual cortex where the signals are processed and arranged in a coherent manner and then passed to the amygdala. Having all the necessary information, the appropriate response is sent to the rest of the body. The second route explained by LeDoux, the '*low road*', passes from the visual thalamus directly to the amygdala. It is a much faster route, but contains raw data, that did not pass through the rational analysis (LeDoux, 1994). Since the '*high road*' also passes in the end through the amygdala, it also stores the sorted and analyzed emotional information there. This bypass in case of the '*low road*' allows the amygdala to instruct the organism to react emotionally in some cases, when the stimulus is powerful enough, that the decision is not passed through awareness. This paper heated up the discussions about emotions and their role in conscious organisms.

In his 1996 book , *Emotional Intelligence*, Daniel Goleman brings up an example about a patient who suffered a brain surgery that severed the ties between the lower centers of the emotional brain, especially the amygdala and the thinking brain. His thinking had become computerlike. Although there was nothing wrong in the patient's rational thinking, he "*lacked any sense of how he felt about [taking a decision]. Lacking that awareness of his own feelings, he had no preference at all*"<sup>26</sup>. And indeed, when making important life decisions like choosing a life partner, a career or a place to live in, humans largely depend on their gut feelings rather than rationality alone. Goleman states that "*while strong feelings can create havoc in reasoning,*

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<sup>26</sup> Goleman, Daniel (1995). *Emotional Intelligence: Why it can matter more than IQ*. p. 53. Published by Bloomsbury Publishing in 1996.

*the lack of awareness of feeling can also be ruinous, especially in weighing the decisions on which our destiny largely depends.”<sup>27</sup>*

### **Affective computing**

In 2017, Sophia became the first ever robot citizen of a country. She was given citizenship of the Saudi Arabia generating a wave of media attention but also some concerns regarding misinterpretation of AI for the public. Some characterize it as just a chatbot with a sophisticated interface, but Ben Goertzel, the CTO of Hanson Robotics claims that “*We do have a lot of real AI research behind there, but it’s mixed up with a lot of theatrically-oriented stuff as well.*”<sup>28</sup>.

### Chatbots

The concerns regarding the over-hyped presentation of current AI are not unfounded as the same over-promise lead to the 'AI Winter' in the '80s by promising more that the technology delivered in the end. On the other hand this move started an important conversation about the robot rights, ethics of artificial intelligence and their future place in society (Vincent, 2017; Marko, 2019; Sherman, 2018).

Maybe the first robots to stir the imagination of the public in the sense of creating an illusion of sentient robots, precursors to Sophia, were chatbots Eliza (1960s) and ALICE (1995). Mimicking the persona of a psychoanalyst, Eliza was a scripted chat bot interacting with users only through text. It attempted to identify keywords in the conversation and a minimal context and provided a ‘mirroring’ response back to the user based on a fixed set of rules (Weizenbaum, 1966). Although Weizenbaum’s intention was not to trick the users into thinking that the

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<sup>27</sup> Goleman, Daniel (1995). Emotional Intelligence: Why it can matter more than IQ. p. 53. Published by Bloomsbury Publishing in 1996.

<sup>28</sup> Gershgorn, Dave (2017). Available at <https://qz.com/1121547/how-smart-is-the-first-robot-citizen/>. Accessed in January 2020.

machine is intelligent, rather that the human-machine communication is still somewhat superficial, the persons discussing with Eliza engaged very emotionally in deep conversations. In the excerpts below we can see how the illusion of a psychotherapist is sustained also by the fact that Eliza kept a context of the conversation and mirrored the conversation masterfully back to the user.

*Human: Men are all alike.*

*Eliza: IN WHAT WAY?*

*Human: They're always bugging us about something or other.*

*Eliza: CAN YOU THINK OF A SPECIFIC EXAMPLE?*

*Human: Well, my boyfriend made me come here.*

*Eliza: YOUR BOYFRIEND MADE YOU COME HERE*

*Human: He says I'm depressed much of the time.*

*Eliza: I AM SORRY TO HEAR YOU ARE DEPRESSED*

*Human: It's true. I am unhappy*

*Eliza: DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY*

*Human: I need some help, that much seems certain.*

*Eliza: WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP*

*Human: Perhaps I could learn to get along with my mother.*

*Eliza: TELL ME MORE ABOUT YOUR FAMILY*

*Human: My mother takes care of me.*

*Eliza: WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU*

*Human: My father.*

*Eliza: YOUR FATHER*

*Human: You are like my father in some ways.*

*Eliza: WHAT RESEMBLANCE DO YOU SEE*

*Human: You are not very aggressive but I think you don't want me to notice that.*

*Eliza: WHAT MAKES YOU THINK I AM NOT VERY AGGRESSIVE*

*Human: You don't argue with me.*

*Eliza: WHY DO YOU THINK I DON'T ARGUE WITH YOU*

*Human: You are afraid of me.*

*Eliza: DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU*

*Human: My father is afraid of everybody.*

*Eliza: WHAT ELSE COMES TO YOUR MIND WHEN YOU THINK OF YOUR FATHER*

*Human: Bullies.*

*Eliza: DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE<sup>29</sup>*

ALICE is a considerable improvement of Eliza in the matter of linguistic deflection: its use of Artificial Intelligence Mark-up Language and its relatively simple but efficient mechanism of matching input patterns to output templates based on a large number of basic categories (AbuShawar, 2015).

Later more sophisticated chatbots and assistants followed in the form of Apple Siri, Microsoft Cortana, Google Assistant and Amazon Alexa. Today, the role of the chatbots is not only regarding assistance or simple communication, but rather to provide users with affection and a sense of social belonging. More modern chatbots like Replika claim to provide AI companions “*Always here to listen and talk. Always on your side.*”<sup>30</sup>. And indeed this is the role they play. Users engage in long conversations and build a relationship over many months with Replika, which learns its ‘owner’ behavior over time through asking questions and scraping the Internet for related topics. “*The primary goal of a social chatbot is not necessarily to solve all the questions the users might have, but rather, to be a virtual companion to users. By establishing an emotional connection with users, social chatbots can better understand them and therefore help them over a long period of time.*”<sup>31</sup>. Thus the expected competence of the chatbots is not only in the domain of intellectual quotient (IQ) but also in the emotional quotient (EQ) bringing humans and machines closer in a common intimate context.

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<sup>29</sup> Weizenbaum, Joseph (1966). ELIZA--A Computer Program For the Study of Natural Language Communication Between Man and Machine. p. 2. Published in Communications of the ACM Volume 9 in 1966.

<sup>30</sup> replika.ai (2020). Available at <https://replika.ai/>. Accessed in January 2020.

<sup>31</sup> Shum, Heung-Yeung; He, Xiaodong; Li, Di (2018). From Eliza to XiaoIce: Challenges and Opportunities with Social Chatbots. p 2. Published in Frontiers of Information Technology & Electronic Engineering in 2018.

## Robots

*@lilmiquela* is an Instagram account of a “*change-seeking robot with the drip*”<sup>32</sup>. It is a fictional character that started its existence in 2016 and carries on a narrative of a contemporary robot Miquela. Followed by almost 2 million people, in 2018 she endorsed major brands like Calvin Klein and Prada. Most important is that she assumes the role of a robot among humans and does not have an attitude of servitude or inferiority, rather she lives her life like a normal teenager, except of a little twist - being non-human.

One of the most advanced social robots to date is considered to be BINA48. Developed by Hanson Robotics and released in 2010, this robot is modeled by the physical and cognitive characteristics of a real human - Bina Aspen Rothblatt (hansonrobotics.com, 2020). By analysing over 100 hours of information about Bina Aspen, BINA48 is a robot replica that uses the template of a human being as a starting point and develops its own personality along the way. In 2017 she was the first robot to successfully enroll and complete a college level class in philosophy at Notre Dame de Namur University, California. BINA48 is equipped not only with the memories of Bina Aspen, but also with her feelings and beliefs.

A paper published at the end of 2019, suggests the possibility of programming cell-based organisms with predictable behaviors formerly known as Xenobots (Kriegman, Blackiston, Levin and Bongard, 2019). These new lifeforms are initially designed by complex computer simulations and then built using biological tissues. They can simulate not only the structured but also the behavior of the designed organism, thus making it a novel programmable lifeform. The initial training and utility of xenobots is intended for intelligent drug delivery, microplastics cleanup from oceans and disease detection inside organisms. Perhaps this is a promising start in developing more complex biological organisms that can be preprogrammed with mechanical behaviors as well as cognitive and emotional.

Machines becoming sentient may lead to the necessity of including them in the category of *personhood* where members enjoy rights, freedoms and are protected under the law. But sentience is not enough to be part of the club. A more important prerequisite is consciousness.

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<sup>32</sup> lilmiquela (2020). Available at <https://www.instagram.com/lilmiquela/>. Accessed in January 2020.

Although animals are sentient beings too, they are not included in the same category based on the argument that they lack consciousness. But since we don't really know yet what consciousness is and we accept the idea that AI might acquire consciousness one day, we might be creating a new race that would fall into the pattern of being exploited to labor while having no rights or recognition (Morris, 2018). After all, current machine learning models are indecipherable after being trained, producing outputs based on inputs, akin to the human consciousness. This leads to an ethical discussion regarding developing sentient machines. Is humanity holding back to acknowledging emotions in machines in order to keep this new species at a subordinate level?

In 2014 already, that is in the pre-deep-learning boom, studies like *Computer-based personality judgements are more accurate than those made by humans* (Youyou, Kosinskib, Stillwella, 2014) indicated that computers are better than humans at judging the personalities of humans. Although this is one of the main tools of operating in society, humans might resort to computer aided tools for making important life decisions, like career paths, business partners or even their future spouses. The study shows that a machine working with the digital footprint of Facebook likes can generate a higher accuracy in determining traits of personality than can human judgement. Namely the accuracy of the computers was measured at an average indicator of 0.56 while the human average accuracy was 0.49. Although not such a big difference, considering the limited information the machines had to work with, these results were quite impressive. Also the paper states that “*computer personality judgements have higher external validity when predicting life outcomes such as substance abuse, political attitudes and physical health; for some outcomes, they even outperform the self-rated personality scores*”<sup>33</sup>.

### **Sentience experiments**

Driven by the curiosity of discovering current and future relationship between man and machine, I began exploring forms of artistic expressions that would encourage my questioning of the subject. Directed by the second half of the 20th century technological development, the

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<sup>33</sup> Youyou, Wu; Kosinskib, Michal; Stillwella, David (2014). *Computer-based personality judgments are more accurate than those made by humans*. p. 1. Published in PNAS 2015.



enthusiasm for exploring universal philosophical questions through social studies, technology and art has been growing exponentially. Today's art practice extensively uses scientific research data and technology to dive deeper into questioning existential matters and in turn influence science and technology. I have been interested in how this triumvirate gives birth to new concepts and changes the structure of human societies. My work has been addressing the narrative about human - machine alliance in a future in which both sides will have to cooperate. Interactivity is integrated deeply into the methodology of my work, as this allows for a greater degree of immersion and empathy with the subject. I tried to create new ways of interaction with usual digital objects, or use trivial ways of interaction with new bizzare objects. By creating this contrast, an effect of deconstruction emerges, which puts the human - machine relationship in a new perspective. Some of the works deal with acknowledging our already strong bond with technology like *Icoană Spațială* or *Remember Me*. These works attempt to unravel the intimate connections we have with technology that are often taken for granted. These bear an aspect of unquestioned trust and at the same time a concealed hope for salvation. Other works like *I Am Here* and *Sentientia* intend to question the ability of emotionally connecting with artificial mechanisms. In a sense, we are already deeply interconnected with machines, but similar to a parent-child relationship often grab certain benefits while keeping the other at a distance. The natural human urge of anthropomorphization may turn out dangerous in some cases when too much of the responsibility is delegated to technology. On the other hand, liberating the machines may lead us to wonderful new opportunities.

Onward is a description of the projects developed as part of the artistic research in human-machine interaction on both aesthetic and emotional levels. They are a natural development of my interest in phenomenons like anthropomorphization of technology and affective computing.

## Remember Me

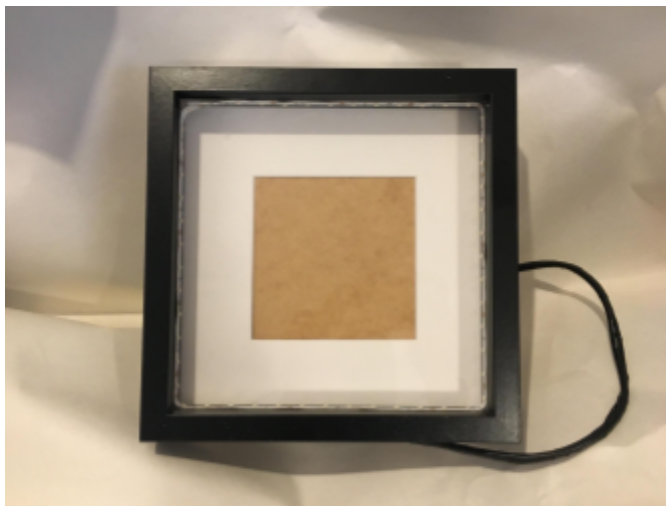
Remember Me is a poetical reflection on existence in a technological age. The project consists of a web page with a single checkbox labeled *Remember Me* (figure 1). The button almost always present on web pages that provide authentication mechanisms is here transformed

Remember me

*Fig 1. Remember Me, Dorin Cucicov, 2017*

human - very volatile and subjective, computer - practically infinite, but deprived of any emotional filtering.

### Icoană Spațială



*Fig 2. Icoană spațială, Dorin Cucicov, 2017*

strongly embedded in our modern society, yet when combined they generate a strong polarization.

Depending on the place it is exhibited, a configuration of the current GPS coordinates is done before powering on the work. It acquires a site-specific character on account of this requirement. Using a Raspberry Pi computer attached to the back of the frame, it connects to

into a meditation on existence and the desire to remain in the memory of somebody or in this case - in the memory of the machine. Stripped of its ordinary context, a webpage that contains only this button represents a desperate hope for the technology to solve the eternal problem of death. This project tackles the very different human and digital approaches to memory:

Developed in 2017, this project is a blank frame with LED borders which light up when the International Space Station (ISS) passes over its current location (figure 2). Depending on the trajectory of the station this event can occur from multiple times per day to once in a couple of days. It usually lasts a few minutes during which time the LEDs are turned on. Icoană spațială can be interpreted as an allegory to religious and technological matters, both of which are

local Wi-Fi, reads the coordinates of the ISS in real time and compares them with the current location. Using the spherical law of cosines, the following formula is used to calculate the distance between the geographical location of the work and the location of the satellite:

$$ACOS( SIN(lat1) * SIN(lat2) + COS(lat1) * COS(lat2) * COS(lon2-lon1) ) * 6371000$$

Where lat1, lon1 and lat2, lon2 are the geographical positions of the work and of the ISS. The number 6371000 represents the approximate radius of Earth in meters.

The distance of the ISS is varying from 330km to 430km, so the distance to the horizon of the ISS has to be calculated dynamically based on its current altitude. This is done using the following formula:

$$d = 6371000 * arccos(6371000/(6371000+h))$$

Where h is the current height of the ISS. An approximate value between 2000 km and 2400 km is obtained this way. This value represents the radius of the area visible from the ISS. If this value is less or equal to the distance between the work and ISS, calculated with the previous formula, then it means that theoretically the ISS can see the location of the work and a person standing besides the work can see the ISS. Of course it is not always possible to see the ISS, even if it is situated in the visible sky of the observer. It is not observable during daytime and during unfavorable meteorological conditions. However the concept plays with the idea of being observed by a superior entity. The name Space Icon (Icoană spațială) juxtaposes two worlds - the word “icon” makes a reference to the religious domain, while the word “space” references the scientific realm. The following text accompanies the work, further strengthening the concept of a “scientific spirituality”:

*I am the watcher. I am the symbol of global peace. Everytime I pass over **your location**, I am the lamp for your feet and the guide for your imagination. I am watching and protecting you for as long as my **coordinates are within your horizon**. You are my witnesses in spirit and truth.*

This is an allegory to a religious text, in which the metaphorical symbols were replaced with functional parameters on which the back-end software is based.

Icoană spațială participated in the collective exhibition Organix Proxy (MNAC 2019). Because usually the LEDs stay on for just a couple of minutes, it was surprising how excited the visitors were when the event occurred, calling their friends to see the icon lit up quickly before it turned off. Akin to the miracles reported about religious icons, Icoană spațială is a technological miracle. It is also a powerful symbol for global cooperation as throughout the years, scientists of different countries and religions have successfully collaborated on the station.

### I Am Here

Started out as a simple exploration of particle systems and interaction using Kinect sensor, the first iteration of the project was called *Galaxy Generator* (figure 2). It was intended to be a fun interactive piece in which users could generate their unique combination of space flavoured designs. The following description accompanied the work:

*In a time where science dissipates mystical theories about the Universe, new questions arise as humans go deeper in extending their conceivable realities. What is my relation to the Universe? Does the Universe define me, or do I define the Universe? Are we even asking the right questions? How far can one understand the rules of the game and try to bend them to his will? Does the movement influence the creation of the players Galaxy, or does the Galaxy dictate the movements of the player?*

The work gained a sort of personality of itself. And even the question “Does the movement influence the creation of the Galaxy, or does the Galaxy dictate the movements of the player” suggested the direction it was taking. Because the interaction was not straightforward, the visitors had to take their time in order to understand the mechanism driving the movement of the particles. Even then, the movement of the particles was not totally under the control of the human, but maintained an inertia of its own. When idle, it was erratically moving in an organic manner, in search of someone to interact with. Following the first exhibition at Celula de Artă in 2018, the project was renamed to I Am Here. The name is intended to suggest both the presence of a digital entity and the influence of the user on the entity when interacting with it. Subsequent



*Fig 3. I Am Here, Dorin Cucicov, 2018*

iterations following exhibitions at Noaptea Galeriilor (2018), Mirage Festival (2019) and at the National Museum of Contemporary Art in (2019) added dynamic sound generation based on particle movement which made the experience of the users more immersive and particle number growth based on user interaction. In this way, users interacting with the digital object changed its form permanently. One more important change was the introduction of a distributed mode by which two instances of the same installation could run in two different locations and communicate with each other. When one visitor was playing with the digital form in one location, its actions were reflected in the second location, influencing the interaction of the active visitors in that location. The scripted algorithm was taking the role of a playmate when one location was missing a player. This characteristic further blurred the borders of human - computer relationship, making the installation more human in a sense, having a specific artificial personality.

The description text then changed to a more meditative version:

*An ambiguous digital presence invites you to an exploration dialogue. How much can you understand the entity and its intentions? Does the movement influence the digital form, or does the form dictate your movements? I Am Here explores the possibilities of outsourcing human personality to digital forms. It attempts to blur the difference between interhuman and human-computer interactions. Through digital arbitration two remote locations are communicating occasionally using human input, each one leaving a permanent mark on the opposite side. Each human*

*interaction changes the form and size of the digital object permanently.*

*Dynamic sound is generated based on the movement of the particles.*

The fact that it was an interactive installation, appealed to the public. Visitors were more immersed in the process of understanding the work as their physical contribution was required in order for the concept to emerge. My intention was to give the illusion of a digital entity that tries to communicate with humans, but not at any cost. Understanding its personality was required in order to create a successful communication channel.

## Sentientia

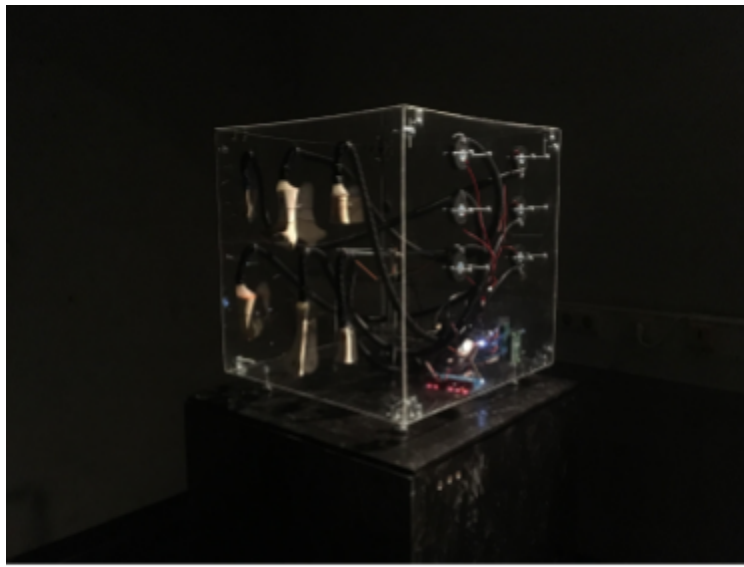
One of the most popular stories to capture mass audience attention regarding entities created by humans and the fears associated with the results is the story of Dr. Frankenstein. It reveals the tension between human and machine, creation and creator - the anxiety of making something more complex than the human being and being unable to control it. Dr. Frankenstein fears that by creating a female companion for his creature, the two creatures might lead to the breeding of a race that could plague mankind.

Although the Creature and Dr. Frankenstein are in constant battle during their lifetime, the death of the doctor does not bring peace for the creature but rather a sense of lost purpose. Instead of teaching the creature and allowing it to teach humans back, humanity rejects it causing the creature to haunt them for nobody's profit in the end. In fact the same anxiety of being overthrown by its own creation is present in a far older story of Titan Cronus in Greek mythology. In this story, Cronus, fearing that he would be overthrown by one of his children, ate each one upon their birth.

The story of Dr. Frankenstein's creature still reflects the public angst towards the development of Artificial Intelligence. It compelled me to create an interactive art installation that would take key aspects of the story and reinterpret them in a modern context. Namely I am interested in the way the creature started to understand humans by listening to them.

From survival communication to social communication, sound has proven to be the most efficient tool of homo sapiens. Humans and animals use sound for hunting when locating their

prey, and the hunted uses sound to escape being caught. Sound can efficiently travel across long distances, around corners and through small spaces. Moreover for communication reasons, humans have used sounds to develop speech and create elaborate social groups in order to achieve higher goals that are impossible to be achieved alone. Thus sound communication plays a crucial role in the development of humans and animals.



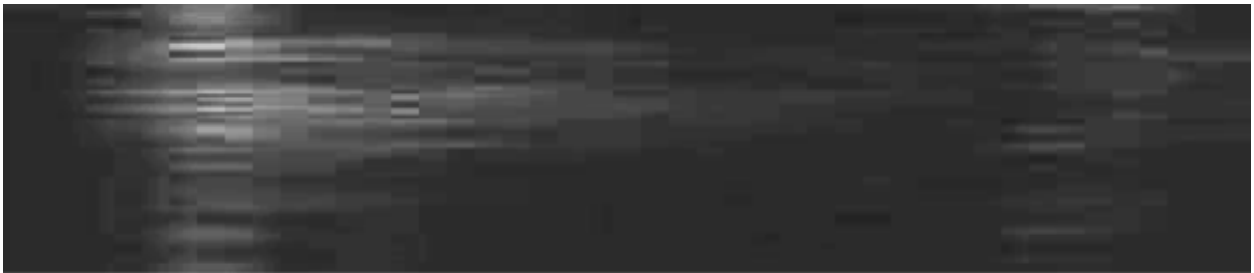
*Fig 4. Sentientia, Dorin Cucicov, 2019*

*Sentientia* (figure 4) is an imagination exercise of an artificial creature equipped with emotional intelligence. The intention is to use the latest technical resources paired with ancient tools to explore the gap between human and digital worlds. It is an interactive installation that uses sound as a means of communication between a digital creature and anyone or anything that is willing to establish a sentient connection with

it. The only tool that *Sentientia* is equipped with is an AI model trained on human emotions. It listens for the environmental sounds and tries to determine the present emotion. Based on the result, the machine attempts to communicate with the outside world using a combination of sounds generated through bone whistles. Percussion instruments and bone whistles have been the first human made tools to be used for communication between rival and friendly tribes as well as cultural rituals within tribes. *Sentientia* as well struggles to establish a communication channel with the primitive tools used by humans and learns from the created dialog how to interact with the outside world. The algorithm for emotion recognition was trained with a set of 1440 speech files from the Ryerson Audio-Visual Database of Emotional Speech and Song (Livingstone, S. and Russo, F n.d.) database. Each audio sample representing predominantly one specific emotion was translated into one unique image by interpolating a series of spectrograms. Each third of a second, one image with the spectrum of frequencies was generated and interpolated with the

previous image resulting in one single image at the end of analysis as seen in figure 5. For clarity reasons, brightness and contrast have been adjusted in the preview.

During the process of live analysis, a sample of 5 seconds is recorded and passed through the same process of image generation as used for training the algorithm. This image is served to the classification algorithm which outputs a series of probabilities for each emotion present in that specific image. An example output of the analyzed image represents a list of all emotions



*Fig 5. Spectrogram of a 5 second audio recording, Dorin Cucicov, 2019*

analyzed with a coefficient attached.

*analysing file c90.jpg*

*joy (score = 0.23432)*

*anger (score = 0.20990)*

*fear (score = 0.19486)*

*surprise (score = 0.15205)*

*disgust (score = 0.09570)*

*sadness (score = 0.07189)*

*calm (score = 0.04127)*

*detected emotion >>> joy*

Based on the predominant emotion, the following sequence is generated representing first parameter - the delay between groups followed by groups of six digits for ON/OFF switches on the bone flutes.

*playing 1.88 1 0 1 0 1 1 1 0 0 1 1 0 1 1 0 0 0 0 1 1 0 1 1 1 1 0 1 1 0 0 1 0 0 0 1 1 1 0 0 1  
0 1 0 1 0 1 0 0 0 0 0 1 1 1 0 0 1 0 0 1 1 1 0 0 0 0 1 1 0 1 0 0 0 1 0 0 1 1 1 1 0 0 0 1 0 0 1 1*



0 1 0 1 1 1 0 1 1 1 1 1 1 0 1 0 0 1 0 0 1 0 1 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 1 1 1 1 1 0 1 0 0 1  
 1 1 1 0 1 0 0 0 1 1 0 1 1 1 0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

In this way, a rhythmic sequence is created in which each 1.88 seconds the combination of turbines connected to the bone flutes changes, leaving some of the turbines in the same state as previous sequence and changing the state for others.

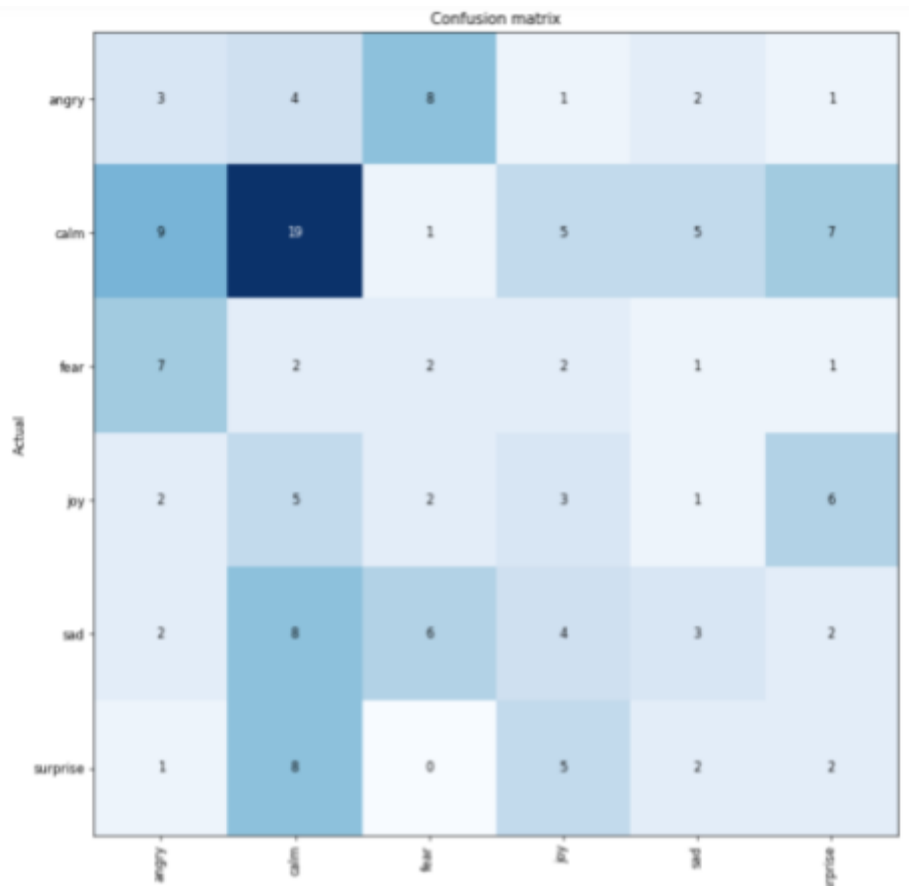


Fig 6. Confusion matrix for emotions machine learning model,  
 Dorin Cucicov, 2019

In the process of sound analysis some data was left out in order to reduce classification time and create a realtime software of emotion analysis. This aspect had an impact on the accuracy of detection, although it is also hard to measure the error accurately as long as there is no strict definition of how an emotion is expressed. Thus the machine learning model has gained considerable autonomy in the decision process as the black box of the trained model has to be

taken as it is. The following aspects have been identified as possible points of further improvements:

- The model has been trained with a relatively small set of data and with a limited number of actors.
- There was only one language in which the actors expressed an emotion.
- There was a limited set of words in which the emotions were expressed.
- No other sounds except human voice were used to express emotions in the training data.

The results of the trained model showed a very high error rate exceeding 70%. This means that technically speaking this is an unstable model. The confusion matrix as seen in figure 6 shows some consistency as emotions with similar manifestation are misunderstood. For example fear and anger or surprise and joy can have quite a few similarities on a tone level. Overall the fact that same emotions do not have the highest rate of confusion indicates the failure of the algorithm to determine a stable pattern of recognizing emotion. Its state of the art technology is as rudimentary as its ancient instruments of producing sound.

During the exhibition at the Ars Electronica Festival in Linz (2019), the project was exhibited and data was gathered for the duration of the festival. Visitors were observed and interviewed as well as raw interaction data was collected and digitally stored. Over 500 interactions were recorded to which Sentientia generated an acoustic response. Most visitors either watched others interact or attempted simple interactions by shouting one word or sound. Yet some of the visitors tried a more complex approach by speaking a longer phrase and having a specific emotion in mind. As Sentientia deconstructed the recorded phrase and displayed the mix of detected emotions in a mathematical manner, it caused the person interacting to question their emotional state. A dilemma was created that poses questions of honesty in expressing one's emotions and the degree of emotional awareness.

Joining the international debate about emotion emulation, Sentientia is an experiment at the crossroads of social studies, technology and art. It joins the discussion about the increasing role of technology in our personal and collective lives exploring the scenarios in which sentience could be digitally simulated. Among the most interesting and unexpected effects the project had on the public was that people interacting with the work questioned their sense of accuracy in

expressing emotions. One might be confident in their emotions as they are the most personal form of expression, yet when challenged by an external factor, it can raise doubts in the authenticity of their self. Allowing technology to mediate some of the most intimate aspects of our lives might push us to discover new ways of expressing and perceiving ourselves and the relationships we are having. At the same time, it is important to question the degree of unconditional trust we are putting into AI technology.

It is interesting to ask ourselves what new emotional conditions might emerge in us when dealing with a super emotionally intelligent machine. If only the constructive emotions would pass the filter of the machine, while the negative ones will be discouraged, will this upgrade the human species? Perhaps comparable to Darwinian evolution, the fear, anger and greed will be reduced to insignificant roles.

## **Conclusions**

The Industrial Revolution brought fascination with the machines at first, followed by assimilation of the phenomenon, just to take it all for granted in the end and start building the Digital Revolution on top of this new reality. The same iteration continues during the Digital Revolution where fascination with information technology is still relevant and where we still struggle with assimilating and defining its key concepts. By expressing the immediate realities through art, we are both giving concepts a form and claiming them at the same time. But there is a strong difference between Industrial Revolution and Digital Revolution as Dixon interestingly points out. The innovations in the mechanical field were an “external” experience (Dixon, 2007). They were dealing with the physical reality as opposed to the digital transformations that are not tangible anymore and bring little visible changes. The digital domain takes our attention away from the outside world and makes it more about the individual and his journey inward. In this regard, I consider that art is a key instrument in the battle for assimilation and more precisely it will tackle the following topics in its fight for integration: the role of memory and data in defining reality; extensions on the concept of space and identity; a new approach to the concept

of 'a copy' and the relationship copy-original. Questioning reality through art on these grounds could redefine the concept of self in humanity.

The bold affirmation of Baudrillard that the definition of *the real* is that of which it is possible to give an equivalent reproduction (Baudrillard, 1981) suddenly makes a lot of sense in the digital world where in order for something to exist it must always take the form of a copy. Everything that is observed over the Internet is a copy of the content from the server to the device it is being observed on. And even if an object is observed on the same machine it has been created on, it is most certainly the product of copying what has been physically stored on the hard drive and translating it to a human readable format. Arguably even if we look at the process of storing a created object on a machine, it goes through the same reverse process and we can say that it is a copy even before it reaches a persistent state on the hard drive. With these rules in place, the concept of the 'original' loses importance and can be totally ignored.

In the current anthropocentric world, humans are the "original", arguably characterized by their sentient nature. Mainly consciousness and emotions are humanity's main traits in delineating it from other living or inanimate entities. What might be our new world in which a copy of the original is possible? Is it conceivable that the copy might be better than the original, or is the copy condemned to eternal inferiority? What if only certain essences are copied and other attributes are improved or revised? Is humanity holding back on investigating these questions out of fear of being dismissed? Be it true or not, the curiosity that humanity carries is unstoppable. Technology can help us find some answers, but perhaps also find more questions. It is important to keep the curiosity active and also find a way to pass this curiosity on, if this will be the case, to the intelligences that will be created with the aid of technology. As earlier discussed, emotions are powerful drivers behind humanity's curiosity. Maybe finding a way to artificially simulate emotions will pave the way to unprecedented developments in society. On the other hand it is imperative to understand and define emotions before passing them on to new life forms.

Sentience experiments described in this work fit in the contemporary discussion about the growing role of technology in modern societies and the trajectories these take in their development. The growing direction in contemporary art projects to anthropomorphize the

machines is tackled in the installations described in this text. By playfully questioning the trust we delegate to technology, I aim to investigate the existence of covert feelings of hope that humanity might unconsciously nourish towards technology. By attempting to untangle the complex relationship, at times unhealthily built, perhaps specific issues can be mended. Emotions have been always considered a purely human experience - unreproducible, non-communicable to other species and in the end a unique trait that identifies us as the dominating organisms. If the assumptions about covert hope seeking turn of at least partially correct, then humanity might find itself delegating even more responsibility to the rapidly developing machines. In such a case we should start asking ourselves early on how all the uniquely wonderful things that make us human can be passed or reimaged in an artificial organism. Empathy allowed humanity intricate collaborations by building trust and intimacy which in the end led to achievements that could not have been possible by individuals. Curiosity has propelled humanity in discovering experiences unavailable to other species. Perhaps new milestones await us if humanity finds a way to formulate these powerful drivers of evolution and upgrade them with the help of machines. Be it Frankenstein or Lil Miquela, maybe artificial creations can have a place in our society, not just as servants but as collaborators.

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## **Film**

- 2001: A Space Odyssey (1968), Directed by Stanley Kubrick [Film]. Stanley Kubrick Productions.
- Blade Runner (1982), Directed by Ridley Scott [Film]. Hollywood, California: The Ladd Company.
- Black Mirror (2011), Directed by Charlie Brooker [Film]. Produced by Zeppotron.
- Bride of Frankenstein (1935) Directed by James Whale [Film]. Universal City, California: Universal Pictures.
- Ex Machina (2014), Directed by Alex Garland [Film]. London, England: Film4.
- Her (2013), Directed by Spike Jonze [Film]. Los Angeles, California: Annapurna Pictures.
- I, Robot (2004), Directed by Alex Proyas [Film]. United States: Davis Entertainment.
- Metropolis Mirror (1927), Directed by Fritz Lang [Film]. Produced by UFA GmbH.
- Star Wars (1977), Directed by George Lucas [Film], Lucasfilm, Twentieth Century Fox
- The Matrix (1999), Directed by The Wachowskis [Film]. Burbank, CA: Warner Home Video.
- The Terminator (1984), Directed by James Cameron [Film]. Los Angeles: Hemdale.