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Kohei Nawa, PixCell - Deer #24 (2011)

SMART
MACHINES
FOR
ENHANCED
ARTS

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MANIFESTO

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Digimag Journal is an interdisciplinary online publication seeking high-standard articles and reviews that focus on the impact of the last technological and scientific developments on art, design, communication and creativity. Following the former Digimag Magazine (72 issues in 7 years), it is based on international call for papers on given subjects and provides readers with comprehensive accounts of the latest advancements in the international digital art and culture scene.

Digimag was born as a monthly magazine and published 72 issues in over 7 years. It provided readers with comprehensive accounts of the latest advancements in the international digital art scene and culture. The magazine evolved year after year, issue after issue, morphing into a hybrid instrument able to reflect the complexity of contemporary artistic and cultural production. It quickly became a cultural instrument, a tool for academics, researchers, students, artists, designers, geeks and practitioners connected to the main international media centers, universities, contemporary art galleries, digital art festivals and hacktivist networks.

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SMART MACHINES FOR ENHANCED ARTS

Artificial Intelligence (AI) and Machine Learning (ML) might be considered by many as synonyms, also because they are the buzzwords of this decade. But actually they are not. They both question though, the ability of the machines to perform and complete tasks in a "smart" way, challenging human intelligence and specificity.

With machines becoming more and more intelligent, Machine Learning is nowadays not only an interesting and challenging topic, but also a crucial discipline. If initially computing was just a matter of calculations, now it has moved beyond simple "processing" and implies also "learning". In the age of Big Data and IoT, machines are asked to go beyond pure programming and algorithms procedures, introducing also predictions of data, OCR and semantic analysis, learning from past experiences and adapting to external inputs, reaching out the domain of human productions and processes.

As Gene Kogan and Francis Tseng write in their in-development book "Machine Learning for Artists", we can "pose today to machines a single abstract problem: determine the relationship between our observations or data, and our desired task. This can take the form of a function or model which takes in our observations, and calculates a decision from them. The model is determined from experience, by giving it a set of known pairs of observations and decisions. Once we have the model, we can make predicted outputs"".

So, the subject of Machine Learning and Artificial Intelligence methods more in general, are going thusly much further the technology or science fields, impacting also arts, product design, experimental fashion and creativity in general. As ML features can fit with digital arts practices, we're lead to explore the way some AI techniques can be used to enhance human performative gestures and creativity models.

How biological systems and machine intelligence can collaborate to create art, and which is the cultural outcome for our society? Which is the new role of creativity in this scenario? How the contemporary will face a future generation of automated artificial artists/designers, able to learn from the creatives themselves, or to have a direct impact on human creativity? Will the anthropocentric vision of the creative process behind the artistic creation, affected by new intelligent Neural Networks?

>

Neil armstrong was the forerunner
the calf of the human

body.

> human

>

A.I.A.
ARTIFICIAL
INTELLIGENCE
FOR ART

I hope that i am a human being, wh
what i was going to avoid
that one!

An alphabet is an animal that eats

animal matter.

> transhuman

>

Obviously you'll never be accused
ing wit!

>

> human

by Robert Lisek

We observe the success of artificial neural networks in simulating human performance on a number of tasks: such as image recognition, natural language processing, etc. However, There are limits to state-of-the- art AI that separate it from human-like intelligence. Humans can learn a new skill without forgetting what they have already learned and they can improve their activity and gradually become better learners. Today's AI algorithms are limited in how much previous knowledge they are able to keep through each new training phase and how much they can reuse. In practice this means that it is necessary to build and adjust new algorithms to every new particular task. This is closer to a sophisticated data processing than to real intelligence.

This is why research concerning generalisation are becoming increasingly important. Processes such as intuition, emotions, planning, thinking and abstraction are a part of processes, which occur in the human brain. Abstraction allows for making analogies, coding relations and relations between relations. Generalization is a process in which the brain observes that a certain fact referring to a set of objects, refers to a greater set of objects. Processes occurring in the brain have an extremely plastic and dynamic character and cannot be reduced to one basic construction and operation. Many processes have very distributed character, for instance memories are not located in a particular place; the brain has holographic character [Pribram 1991]. A special role of a kind of creators is played by random processes, which allow for collision and splitting of structures, and leaps between different levels of generality. A generalization in AI means that system can generate new compositions or find solutions for new tasks that are not present in the training corpus.

General Neural Model and intelligent agent should have very general learning capabilities, should not just be able to memorize the solution to a fixed set of tasks during creating of stories, but learn how to generalize to new problems it encounters. It can generalize problem in the sens that solving one or more of tasks should make solving other task easier. There is domain called AGI where will be possible to find solutions for this problems. Artificial general intelligence (AGI) describes research that aims to create machines capable of general intelligent action. "General" means that one AI program realizes number of different tasks and the same code can be use in many applications. We must focus on self-improvement techniques e.g. Reinforcement Learning and integrate it with deep learning, recurrent networks, etc.

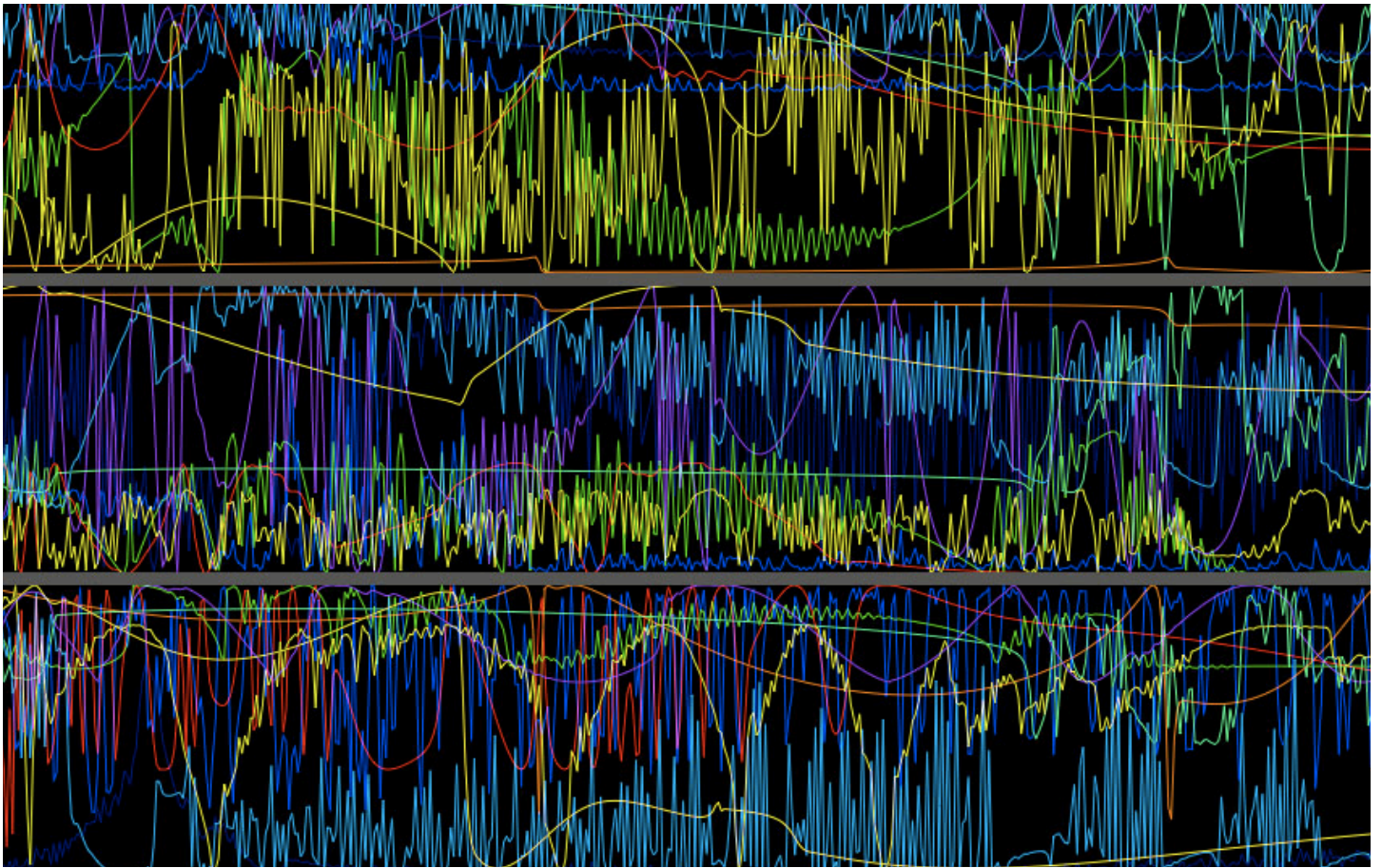## RECURRENT NEURAL NETWORKS

Models of sequential data, such as natural language, speech and video, are the core of many machine learning applications. Recurrent Neural Network is a powerful model that learns temporal patterns in sequential data. A recurrent neural network (RNN) is a class of artificial neural network where connections between units form a directed cycle, meaning that Recurrent Neural Network contains feedback connections, connections from any unit to itself. This allows it to exhibit dynamic temporal behavior. Unlike feedforward neural networks, RNNs can use their internal memory to process arbitrary sequences of inputs. This makes them applicable to tasks such as handriting recognition, speech recognition and after modification as a performative and/or compositional tool for composer and musicians.

Creating of feedback in RNN provides interesting creative posibilities, recurrent neural networks can evolve to a unstable states and they can create chaotic or random outputs. Chaotic behavior of recurrent neural networks has been observed before eg. by Maas (Maas et all, 1990). It was shown that smooth variation of one of the parameters of the original map gives rise to period-doubling bifurcations. Feedback and chaotic behavior of RNN causes that some artists and composers are starting to use RNN in their artistic work. For example CTRNN Continuous Time Neural Networks are implemented in modular extensible computer music platforms such as Supercollider, Pure Data, MaxMsp. Sound or video parameters can evolve and be formed by using Recurrent Neural Networks.

RNN models can be uses to tasks such as handwriting recognition, speech recognition, natural language processing, video recognition, etc. Natural language modeling has been widely studied in the past (Goodman, 2001b; Young et al., 1997; Koehn et al., 2007). In particular, models based on RNN have been very successful in automatic speech recognition (Dahl et al., 2012), language modeling (Mikolov, 2012) and video classification (Simonyan & Zisserman, 2014).

RNN represents time recursively. For example, in the simple recurrent network, the state of the hidden layer at a given time is conditioned on its previous state. This recursion allows the model to store complex signals for arbitrarily long time periods, as the state of the hidden layer can be seen as the memory of the model. However there is a prob-

CTRNN in action

lem of learning long term patterns in Recurrent Neural Networks. Recurrent networks was difficult to train using simple optimizers, such as stochastic gradient descent, due to the vanishing gradient problem. For example the sigmoid function have a gradient which is close to zero almost everywhere or the gradient can be backpropagated through time, its magnitude is multiplied over and over by the recurrent matrix. If the eigenvalues of this matrix are small (i.e., less than one), the gradient will converge to zero rapidly. Learning longer term patterns in real data, such as in natural language, is possible using gradient descent by using a structural modification of the simple recurrent neural network architecture. Many modifications were proposed to deal with the vanishing gradients eg. the long short term memory (LSTM) recurrent neural network (Hochreiter & Schmidhuber, 1997) is a modified version of recurrent network with gates which control flow of information to hidden neurons. This allows the network to potentially remember information for longer periods.

Most of the research on the use of AI in interactive applications concerns computer games, beginning with tra-

HOWEVER THESE APPROACHES HAVE A LIMITED SCOPE, BECAUSE THEY DO NOT ENCOMPASS THE NUMEROUS PHENOMENA KNWON IN NATURAL LANGUAGE

ditional two-player adversarial games like tic-tac-toe and extending to modern strategy games. This type of research however, has a limited application in storytelling or art, because the goal of AI agents in these games is to maximise reward, which often fails to advance the narrative threads and almost entirely overlooks the creation of interesting scenarios or compositions. Magerko (2009) conducted research with theatre performers to explore how to create scenes in real time without a preexisting scenario. Unfortunately, the basic conclusion of this research is that the actor should act on the basis of a huge set of initial scripts, which contain expectations as to what people do in different scenarios. There have been several attempts to implement the above approaches through introducing text into the game, building chatbots or intelligent assistants. However, these approaches have a limited scope, because they do not encompass the numerous phenomena known in natural language, such as the creation of metaphors, analogies and generalisations, which are crucial for human thinking and for creating stories. If the AI program works in order to create a story, it must be prepared to understand everything that the human might think and must be able to communicate in a natural language. Neural lan-

guage models have garnered research interest for their ability to learn complex syntactic and semantic representations of natural language (Sutskever et al., 2014). Recurrent Neural Network (RNN) is a powerful model that learns temporal patterns in sequential data. Wen et al. (2015) proposed a RNN approach to the generation of utterances from dialog acts but their system requires one to pre-process the data.

DEEP REINFORCEMENT LEARNING

Thinking about programs in terms of binary codes and about functioning of the brain in terms of self-improvement through optimization of the codes, we may perceive the search for brain model as the search for best learning algorithms, and as an attempt of creating best predictions. The most interesting AI method is Reinforcement Learning. The brain works without deus ex machine, the rule

UNRENDERED by RBL (using A.I. agents during performance)

of its organization is the rule of the shortest description, which allows for choosing shortest models of reality. A program is a set states that represents a given situation and the set of operators (actions) and which allows for transition between states. A general framing of the space of transition between states is the Hidden Markov model, in which every transition has a certain probability of occurrence. Real states of the world are unknown, they can only be approximated. We obtain data through sensors from the environment. The data is recorded in the form of vectors. Markov models are static: the agent is unable to model his actions, he cannot change the world he is in. An extension of this model are Markov Decision Processes. MDP generalizes Markov models by introducing additional possibilities: consequences of actions may not be know a priori, even if the consequences of actions are known, their value is unknown, the value of the action is difficult to predict, because the reward is often delayed. In this situation the model of best actions is not known, but it has to be discovered. The agent uses certain actions and analyses their results. The actions which bring reward are not known, but they have to be discovered by trial and error. Theories that apply the above method are called models of reinforcement learning. Models of reinforcement learning allow the agent to choose adequate decisions on the basis of exploration of the environment that changes dynamically. By examining the space of states that bring reward, the agent may learn from the history of his previous actions. The most interesting situation occurs when the space of states is only partially observable. Reinforcement learning works, because the agent can make local improvements in order to increase the reward.
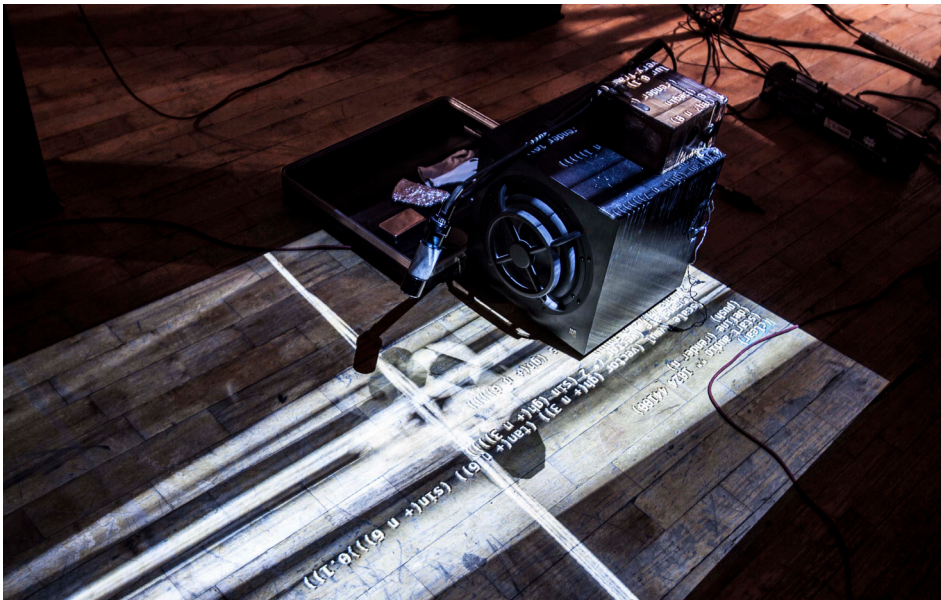
Quantum Enigma by RBL (using radioactive decay)

A deep neural network (DNN) is an artificial neural network with multiple hidden layers between the input and output layers. Each successive layer uses the output from the previous layer as input. It is system of multiple layers of nonlinear processing units that learns of feature representations in each layer and form a hierarchy from low-level to high-level features. Deep learning networks can be applied to any problem for example in language, sound or image processing. Deep and recurrent neural networks are powerful models that achieve high performance on difficult pattern recognition problems in vision, and speech (Krizhevsky et al., 2012; Hinton et al., 2012; Dahl et al., 2012). Reinforcement Learning can be used to improve dialogue managers, e.g. for transitions between dialogue states (Rieser and Lemon, 2011) , for non-goal-orientated dialogues (Li et al., 2016), for bot-bot dialogues and for inventing new languages by agents (Das et al., 2017).

Deep Learning is becoming more and more popular method. Commercial using of Deep Learning models is often associated with using data from massive data centers eg. Google, Facebook and it is difficult to verify if used model is really intelligent and can generalize knowledge or if it is only sophisticated complex automated system that uses the brute force method based on unlimited access to data generated by users. The application of deep learning in art looks uninteresting because constructed networks simulate only human behaviors; in this case, they use art history databases to generate objects that imitate artworks from the past.

Therefore, if we want to make the next shift (challenge) we have to put more emphasis on research concerning self-improvements of system eg. different types of algorithms associated with reinforcement learning and perform interesting fusions of reinforcement learning with deep learning. The goal is to incorporate the reinforcement learning process into deep learning for creating a system that will have an ability to learn and self-improve. Another way to do this is to study the methods connected with randomness and to integrate them into neural networks. Both of these approaches are perfectly complementary because there is no interesting self-improvement system without the clever use of random generators and vice versa.

KINGDOM OF RANDOMNESS

To obtain interesting results in music and art we need randomness. Randomness is important when you want the Neural Network from the same input to create different possibilities as an output, without generating the same output over and over again. Therefore it is different than in science, which is all about grouping and clustering. In art and music we don't want to endlessly obtain the same result. When you are composing sound or images, you don't want the neural network program to create the same sets of sounds and images; instead, you need creativity and variability. One of the solutions is to parametrize NN outputs with the use of probability distributions. A different way is to add noise directly to NN, instead of modeling the distribution parameters. Paradoxically, in such NNs, the more randomness during training, the better the results. Good random generators allow to avoid situations, when Neural Networks gets fixed in local minima. The importance of well designed random initialization and momentum in deep learning was observed for example by Sutskever and Hinton (2016).

Random number generators are applied in many domains for instance in music programs, computer games etc. In numerous compilers random number generators are used as ordinary functions. The problem with these generators however is that they never produce random numbers, not even

numbers that approximately appear to be random. Limits of our perception makes us consider sequences of numbers they produce as random, and maybe in the case of games of chance this 'randomness' is sufficient, but in cryptography it is hopelessly not random and completely useless. No random number generator build with the use of computer (or abstract Turing machine) will generate random numbers. It is impossible to obtain a sequence of random numbers with the use of computer. Computers are entirely deterministic machines: we put something in, subsequently we subject it to entirely predictable operations and receive something "new". If we put the same thing into the computer again (in different times) we will get exactly the same result. If we put the same input sequence into two different computers, we will also gain the same result. The number of states of a computer is finite.

The result is completely determined by input data and functions we use. Every random number generator build with the use of computer is, by definition periodic. Of course, such periodic generator is predictable. If it is predictable it can't be random. A real random number generator requires a random input. A computer does not have random input. The only possibility when it comes to randomness in case of computer science techniques is the creation of pseudorandom number generators (PRNG). They can be useful in some applications if the period of the obtained sequence of numbers is long enough, which means that numbers will repeat but after a relatively long time. The beginning of this sequence should consists of numbers that remind of random numbers. Many pseudorandom generators have been built, which are periodic, but the potential periods have the length of 2256 bites. However even generators with very long periods create strange correlations between numbers. Unfortunately every deterministic generator will produce them if it will be used in a specific way, but there are ways of minimizing the number of correlations. Structure of PRNG consists in using a certain number and recurrence function. We start with a certain number (seed).

Then we subject it to mathematical function. We obtain a number, which is again subjected to the same function. We repeat the procedure. We obtain pseudorandom sequence of numbers. The process is constructed in such a way so that the numbers repeat after some time. How fast it will occur depends on the function used. At some point PRNG will produce the number from which we started. From this

moment the numbers will repeat periodically. In weak generators the periods are short, in good ones very long, which means that the sequence of numbers may repeat after milliards of operations. A choice of good, incompressible seed has a crucial importance in cryptography and art. When the secret cypher key is generated in a pseudo-random manner, if we get the seed, we also get the key. In cryptography we need really random number sequences. This means sequences, which can't be repeated: it is impossible to repeat a sequence of bits produced by such generator. This problem can be examined on the example of creating a key. Keys should be generated in such a way, so that the sequence used is really random. Otherwise, the adversary may get the copy of the key generator and break the given cryptographic system.

Random number generator should be subjected to tests, which consist in attempts of compressing generated sequence. One of the popular methods of generating random numbers is obtaining bits from computer clock. It doesn't however guarantee good quality randomness because computers use many mechanisms of clock synchronization. One shouldn't use too many bits generated through this method because using the same procedure several times effects in the emergence of correlations, which are easy to find. Randomness obtained from measuring time when the keyboard remains idle is another popular method, which consists in measuring short time intervals between keyboard presses. However a fundamental flaw of this method is that the generated keys are usually very short. A good way of obtaining big number of random numbers is to use bits from the surrounding world, for example using atmospheric noise. This method requires specialized measuring devices that allow for measuring time between events.

Generators that use thermal noise (e.g. from semiconductor material), as well as those that use computer disk drive, and measure time necessary for reading set of data from the disk have been created. Air turbulences influence variations in the rate of disk rotation. There are also other methods of obtaining numbers from noise, which consist in measuring the position of the machine, mouse, screen behavior, components of currently displayed image, CPU loads, microphone signal etc. Fundamental flaw of these methods is that there may occur some repeatable correlations introduced by measuring devices. These devices are often synchronized in order to enable correct, repeatable

WHEN THE SECRET CYPHER KEY IS GENERATED IN A PSEUDO-RANDOM MANNER, IF WE GET THE SEED, WE ALSO GET THE KEY

activity of the computer. A very good method is using radioactive material and Geiger counter in which, during radioactive decay the time between following clicks is always different. Randomness from the quantum level obtained from radiation emitted during decay of radioactive material has an extremely good quality. One may obtain a big number of random bits from Geiger counter and use it as a key. We use a sequence of the length of for instance 256 bits as an input of one-way hash function. Hash function is a mathematical function that transforms a sequence into a sequence of a precise length. We use one-way function, which means that it is easy to count the shortened sequence on the basis of input sequence but it is impossible to do it the other way round. Quantum mechanics claims that in the real world, randomness occurs in a pure form. In quantum states there is fundamental randomness and it cannot be changed. If we interpret the formulas of quantum mechanics we can say, that elementary particles do not exist in any precise location. They exist in many locations simultaneously, with a certain probability of occurrence.

QUANTUM ENIGMA consists of installation, action and program, whose goal is to extend the notion of art by dealing with randomness. I reveal the process of radioactive decay as the best and strongest manifestation of the idea of randomness. Thorium is a medium of my idea: I have chosen Thorium as radioactive material, which is the source of fundamental random processes and is not associated with art. Thorium is a source of dispersion and real disorder. The real performative element contained in the action reveals pure process of decay and energy emission.

MIND UPLOADING

Mind Uploading (MU) is the process of copying the brain from natural substrate to artificial one. MU is carried out through scanning the structure of a brain and building an appropriate informatics model, which is true to the original and after launching it on an adequate hardware, behaves like the original brain. By emulation we understand a 1 to 1 model, in which all properties of the system have been retained. Emulation, copying and modifying of the brain will bring explosion of diversity. We are very good at creating maps of the human brain in different scales (we have increasingly better techniques of scanning brain structures in different scales), however our informatics brain models are supremely primitive. There are interesting consequence of building MU in the future. People will become more heterogenous, more varied in terms of physical and cognitive dimensions. Another consequence will be the

change of value system: life will become less valuable. Life will become "cheap" because we will be able to emulate it. Why not participate in a risky game, when in a worst case, I can activate the backup copy of myself. The belief in "immortality" may change our behavior. Analogy: in computer game we value our life less than in real life, because we can reset it anytime. After the mind up- loading turning point, freezing, copying, slowing down and modifying of the brain will become acceptable. Of course there will be other consequences: ethical, political, economic, medical, religious and cultural. I highlighted value of life, because it has influence on other values. Other consequences of MU are connected with the notion of identity and consciousness. Can human consciousness be emulated and transferred? Does the transfer preserve consciousness? People are conscious, which means that they have conscious, subjective experiences. They lie at the center of our mental life and give our life meaning. If we loose consciousness, in a significant sense we cease to exist. If brain emulation is devoid of consciousness, then it probably doesn't exist at all, at the very least it is zombie existence. The problem is complex because our understanding of consciousness is very weak, we do not know how brain's activity makes consciousness possible.

■ ROBERT LISEK

References

- Bates J. 1992. Virtual Reality, Art, and Entertainment. Presence Teleoperators Virtual Environ 1:133–138.

- Dahl, G.E., Yu, D., Deng, L., and Acero, A. Context- dependent pre-trained deep neural networks for large- vocabulary speech recognition. Audio, Speech, and Lan- guage Processing, IEEE Transactions on, 20(1):30–42. Das A., Kottur S., Moura J., Lee S. 2017. Learning Cooperative Visual Dialog Agents with Deep Reinforcement Learning. arXiv preprint arXiv:1703.06585.

- Hinton, G., Deng, L., Yu, D., Dahl, G., Mohamed, A., Jaitly, N., Senior, A., Vanhoucke, V., Nguyen, P., Sainath, T., et al. Deep neural networks for acoustic modeling in speech recognition. IEEE Signal Processing Magazine, 2012.

- Hochreiter S., Schmidhuber J.1997. Long short-term memory. Neural Comput. Nov 15;9(8):1735-80.

- Krizhevsky, A., Sutskever, I., and Hinton, G. Imagenet classification with deep convolutional neural networks. In Advances in Neural Information Processing Systems 25, pp. 1106–1114, 2012.

- Li J., Monroe W., Ritter A., Galley M., Gao J., Jurafsky D. 2016. Deep Reinforcement Learning for Dialogue Generation. arXiv preprint arXiv:1606.01541.

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- Maas H. L. van der, Verschure P. F. M. J., and P. C. M. Molenaar (1990), A Note on Chaotic Behavior in Simple Neural Networks, Neural Networks, Vol. 3, pp. 119–122.

- Magerko B., Manzoul W., Ried M. 2009. An Empirical Study of Cognition and Theatrical Improvisation. In: Proc. Seventh ACM Conf. Creat. Cogn. ACM, pp 117–126.

- Pribram K. 1991. Brain and Perception: Holonomy and Structure in Figural Processing, Lawrence Erlbaum Associates.

- Riedl M., Bulitko V. 2013. Interactive Narrative: An Intelligent Systems Approach. AI Mag 34:67–77.

- Rieser V., Lemon O. 2011. Reinforcement Learning for Adaptive Dialogue Systems: A Data-driven Methodology for Dialogue Management and Natural Language Generation. Springer Science & Business Media.

- Schechner R. 1998. Performance theory, Routledge New York.

- Sutskever I., Martens J., Hinton G. E. 2011. Generating text with recurrent neural networks. In Proceedings of the 28th International Conference on Machine Learning (ICML-11). pages 1017–1024.

- Sutskever I., Martens J., Dahl G., Hinton G. 2016. On the importance of initialization and momentum in deep learning. Proceedings of the 30th International Conference on Machine Learning, PMLR 28(3):1139-1147.

- Wen T., Gasic M. 2015. Stochastic language generation in dialogue using recurrent neural networks. In Proceedings of SIG-dial for Computational Linguistics.

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AN UBIQUITOUS INFLUENCE.
INTRODUCTION TO AI AND ML

by Filippo Lorenzin

What is an Artificial Intelligence? How can a machine learn new strategies to accomplish a task? Although these questions are not new or original, in the last months they have been addressed by a number of experts whose backgrounds spanned from art anthropology to engineering, from biology to poetry.

Art festivals, exhibitions and panels all around the world often tried to question what is the future of this field while sometimes forgetting to look at what's the current situation; it can be hard to not dream about what may be achieved in the next few years when some of the recent most commented political events had been affected by algorithms and we're aided 24/7 by corporate digital assistants like Amazon's Alexa and Apple's Siri - without forgetting to mention more subtle but not less effective systems like the algorithms behind the customized suggestions we receive every day on social media, search engines and online shopping platforms. The everyday sophisticated influence exerted by Artificial Intelligence and Ma-

chine Learning is perhaps the reason behind the renovated interest in what has been considered since not long time ago a sci-fi dilemma rather than an urgent question with potential deadly and utopian implications.

Artists questioned what is the value of building a creative machine paying attention to what degree the very same meaning of "creativity" can depend on cultural backgrounds. Digicult, alert to the hottest debates regarding the blurred line between art and science since its foundation in 2005, took

the opportunity of the publication of this journal to ask a selected group of experts to illustrate the directions of present studies in Artificial Intelligence and Machine Learning. We contacted a wide range of figures in order to reflect the ubiquitous impact of such technology in art, science and marketing - their considerations don't take a positivistic stance for granted but rather suggest the intricacy that surveys about AI and ML are rising right now.

Caroline Sinders | Machine learning designer/user researcher, artist and digital anthropologist
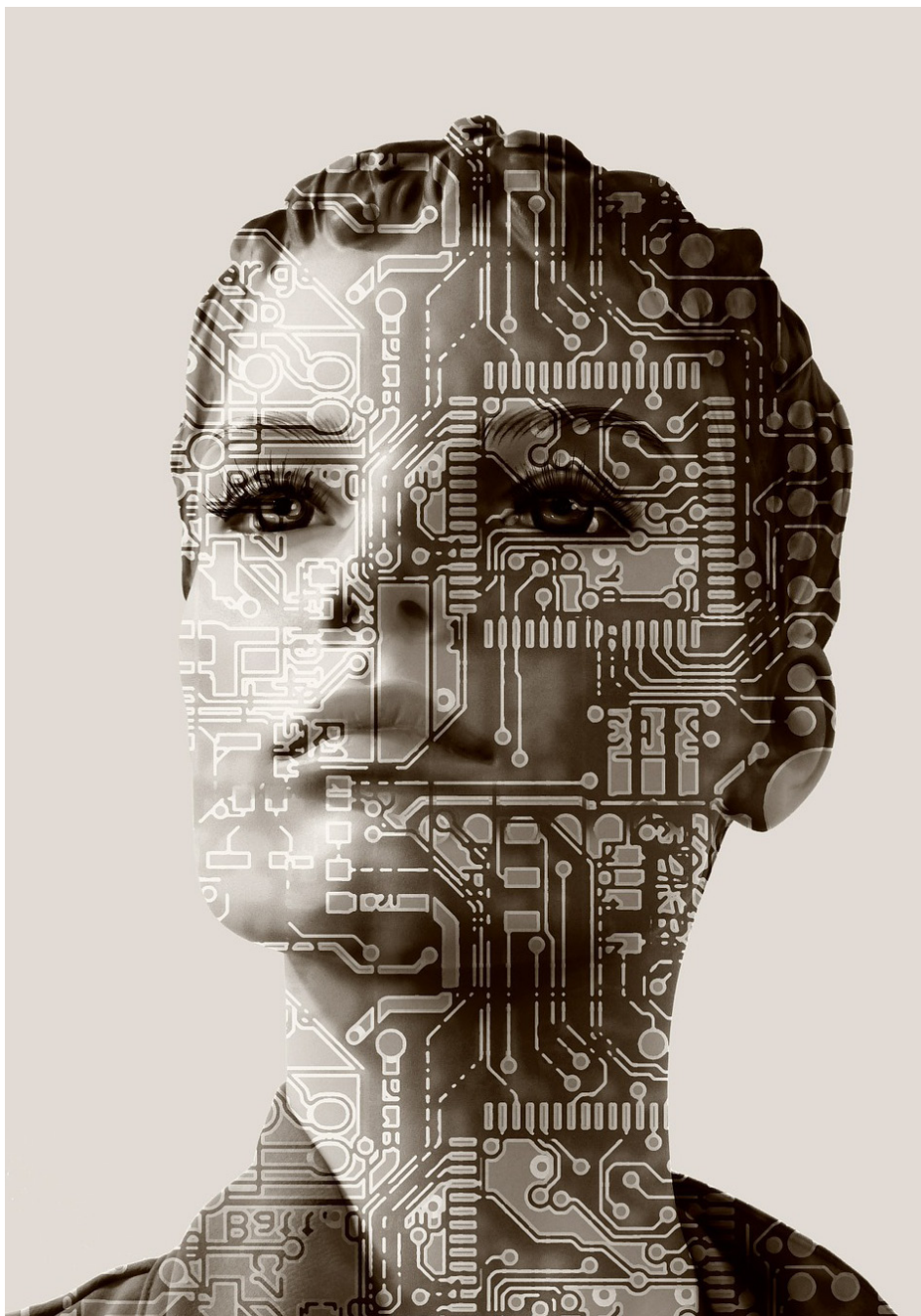
The state of contemporary Machine Learning Research is having a resurgence, but with a focus on actionable product design within software. The last resurgence of interest in AI and machine learning was in the 1980s but the scope of technology and products was so different then; it was so hardware focused and so focused on what the code could do. What I see now is

a much more specific focus on how products can and will utilize machine learning. Products, like Netflix and Pinterest, from recommendation software to apps, to more general software capabilities with search or analytics, and APIs as a service, are using various forms of machine learning as an integral part of the product design process and product experience. This feels like the age of machine learning creating more "future tech" in design, specifically.

What we will see is the rise of the more technical designer, and the systems designer, over the aesthetic designer, with a background in ethics, usability, and data visualization. A major issue facing machine learning, as a field, is that it is such a technical space, and to properly utilize machine learning and make good, accurate, innovative products that work, you need technologists, producers, designers, and c-levels who understand, at some level, what machine learning can do. That doesn't mean a designer needs to code but what is needed is a designer with a background in understanding technology, data, and ethics, can imagine, scope out, and innovate on a problem from a product and UX standpoint. This will be about creating a fluency of UX, ethics, and data visualization and baking that into the design pipeline from the algorithmic creation to the product creation.

Mario Klingemann | Artist in residence at the Google Cultural Institute working with algorithms and data

As an artist who tries to incorporate the latest research and findings in the field of machine learning into my practice, I couldn't be more pleased with the culture of open research, knowledge and particular code shar-

ing that has established itself increasingly over the past years. Without the combination of publicly available datasets, shared pre-trained models and well-maintained frameworks we would not have seen this rapid progress of novel neural architectures and algorithmic advancements. Of course, with this boom comes also the hype with all its increased noise and over-inflated expectations. On the positive side the increased public and media interest in machine learning and particular "AI" might help with getting funding much easier, on the negative side there seems to be more derivative or repetitive research being done that does not really add to the knowledge base but rather makes the truly innovative ideas harder to discover. In our attention economy, papers that know how to sell themselves visually or that are using popular data sets like cats or "famous art" bubble go to the top easier than a research that does not try to appeal to non-academics or the media.

Now a basic classification has been solved and neural generation is in a stage where classification was 5 years ago. As a visual artist, of course, I hope the bar for high-resolution output will be raised continuously but seeing the progress in that area I have no worries there. The biggest missing piece in all of this is what I would call "storytelling" or the understanding and generation of the long term structure. Once we are able to find a way to understand and encode "meaning" I believe that everything else can be derived from that - be it text, music or the generation of visuals. My guess is that the impulses to solve this will come from the digital humanities and the field of game development. In the short term, attention mechanisms like the Transformer architecture

by Google research will gain a lot of traction. Lastly, I can imagine seeing reinforcement learning being applied to the internet as a whole: if you treat a browser like a game engine and the goal of the game is to answer a question or solve a problem by searching the combined knowledge of the world, it sounds almost like general intelligence to me.

David Seamon | Environment-behavior researcher and Professor of Architecture at Kansas State University in Manhattan, Kansas

To me, technology remains a tool, but we are moving into a world where the tool is becoming an integral part of human worlds and thereby shapes those human worlds rather than serves them. Technology is no longer a tool but a taken-for-granted medium that makes lifeworlds qualitatively different than worlds before around 2000. The destruction of punctuation and spelling are one simple example, but the mobile phone and the virtual-reality devices begin to shape a world that seems to move human beings toward more and more passive states and actions. Understanding this shifting state of human being and asking what it means for important human qualities like care, respect, obligation, communal ties, and so forth is to me the most important question.

Robots and Pencils | Mobile strategy and app development firm known for its top-ranking consumer apps and transformative enterprise apps

Contemporary Machine Learning Research is primarily the combination of finding new training algorithms

and finding better ways to bring those algorithms to current hardware, especially graphics processing units (GPUs). Now instead of GPU chips rendering millions of pixels for games and visualization environments, Machine Learning is taking advantage of this hardware to produce faster training and evaluation of machine learning models. Current algorithms allow machines to learn rapidly without human intervention.

THE IMPLEMENTATION OF MACHINE LEARNING IN THE MODERN WORLD WILL BE UBIQUITOUS

Today, Machine Learning not only involves understanding content, such as speech recognition or translation, but also creating content. Projects like Magenta and DeepJazz, for example, generate music from scores of samples. Google's DeepDream can generate digital art by enhancing patterns in images using a convolutional neural network. Machine Learning Research has become one of the most studied fields of research and will undoubtedly impact all areas of society. Research will only continue to accelerate as we get more frameworks, data and interest. Machine Learning systems will become more adaptable in real time, and hardware acceleration will provide faster training and the ability to process more data. The implementation of machine learning in the modern world will be ubiquitous. Cars will be self-driving. Machines will support medical personnel, from assisting the elderly to supporting surgeons. Supply chains and financial markets will benefit from the analysis of millions of data points. Classification and generation will be applied to the arts. Gestures, images, sounds, text, and concepts will be combined through machine imagination to produce desired new artifacts or to search
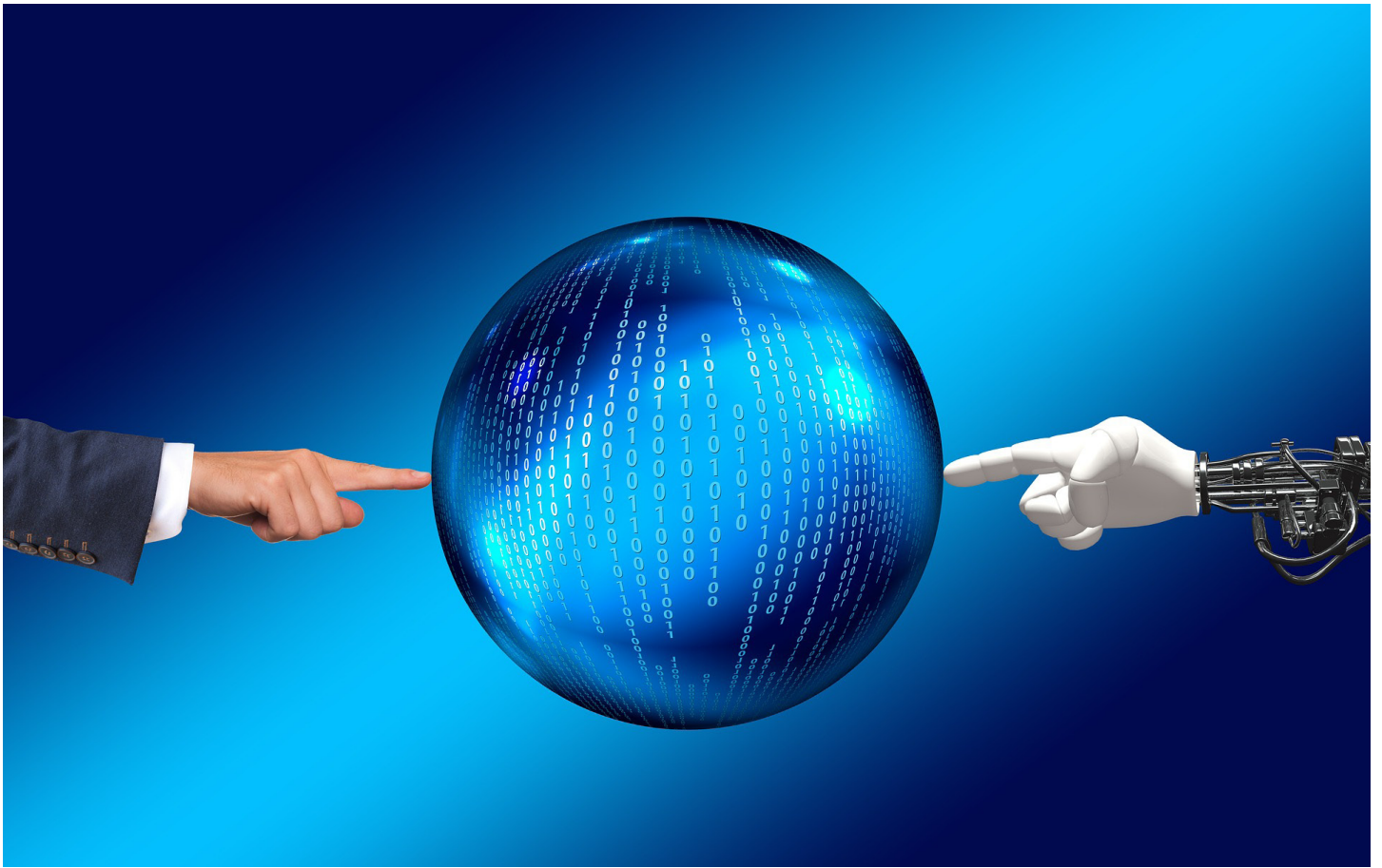
for existing creations. New artifacts -- visual, literary and musical -- will also be generated entirely by machine.

Sebastian Raschka | Ph.D. candidate at Michigan State University, data analyst, book author, python programmer, open source contributor and computational biologist

Even people who aren't machine learning researchers or practitioners have probably heard about deep learning. If we consider deep learning as a specialized sub branch of deep learning that is focussed on the training of deep artificial neural networks, then I'd say deep learning is probably the area that gets most of the attention from academic researchers, researchers in industry, and practitioners, as well as popular media. However, that does not mean that non-deep learning machine learning is becoming unpopular or even redundant. It's quite the opposite, not every problem domain

with hundreds of thousands or millions of training examples and there's still a large demand for and interest in improving (and automating) "classic" machine learning.

I see Artificial General Intelligence (or broad AI) useful as a goal to drive current research, but I don't think that we will have systems with near-human intelligence in our lifetimes. An interesting direction, and maybe an important component in future systems, is zero-shot learning to learn tasks without labeled data. Improvements in attention and memory are and will be another hot research topic. Further, I expect to see more research towards modeling 3D spaces (with a depth dimension) instead of just flat images, which is especially interesting in the context of self-driving cars. Another potential focus of future research will be to protect models against exploits -- looking at recent literature, it's almost creepy how easily deep learning-based

object recognizers can be fooled.

AGISI | Independent research organization dedicated to working on the development of scientific theories and solutions towards the awareness and oversight of the transformative impact of AI

Machine Learning systems are being used to help make decisions both large and small in almost all aspects of our lives, whether they involve simple tasks like recommendations for buying books, email spam filtering, or purchasing insurance policies, to more objective matters like the prognosis of credit rating in loan approval decisions, health diagnosis, or the profiling of individuals by law enforcement agencies. They capture information on our daily activities, from exercise and GPS data that tracks our location in real time, to emailing and social media interests. They are increasingly used in our cars and our homes, in

semi-autonomous surveillance applications, for managing nuclear reactors and demand across electricity grids, and for boosting productivity in the business environment.

Many uncertainties exist concerning future developments in the Machine Learning (ML) field. Although particular narrow Artificial Intelligence (AI) models already demonstrate aspects of intelligent abilities in limited domains, at this point they do not represent a unified model of intelligence. There is much work to be done before true AI is "amongst us". There are also many safety challenges to overcome such as security, data privacy and other technological problems still requiring breakthroughs. At the present time it is difficult to predict the short term extent with which AI, and especially ML, will impact on social and economic institutions but in the long term it could have a major negative consequence the social and economic effects of which could be severe for millions of people.

■ FILIPPO LORENZIN

FILIPPO LORENZIN

FILIPPO LORENZIN IS A LONDON-BASED INDEPENDENT CURATOR AND CRITICAL THEORIST. HIS RESEARCH IS FOCUSED ON THE STUDY OF THE EFFECTS OF THE INTRODUCTION OF NEW TECHNOLOGIES INTO ARTISTIC PRACTICES. DIGICULT COLLABORATOR SINCE 2011, HE WRITES ABOUT THE RELATIONSHIP BETWEEN ARTISTS AND THE PUBLIC THROUGH THE MEDIATING ROLE OF THE ARTISTIC TECHNIQUE THROUGHOUT HISTORY. HE TAKES PART IN TALKS AND LECTURES, ACTIVELY DIALOGUING WITH INTERESTING FIGURES AT THE BORDERLINE BETWEEN ART AND SCIENTIFIC RESEARCH.
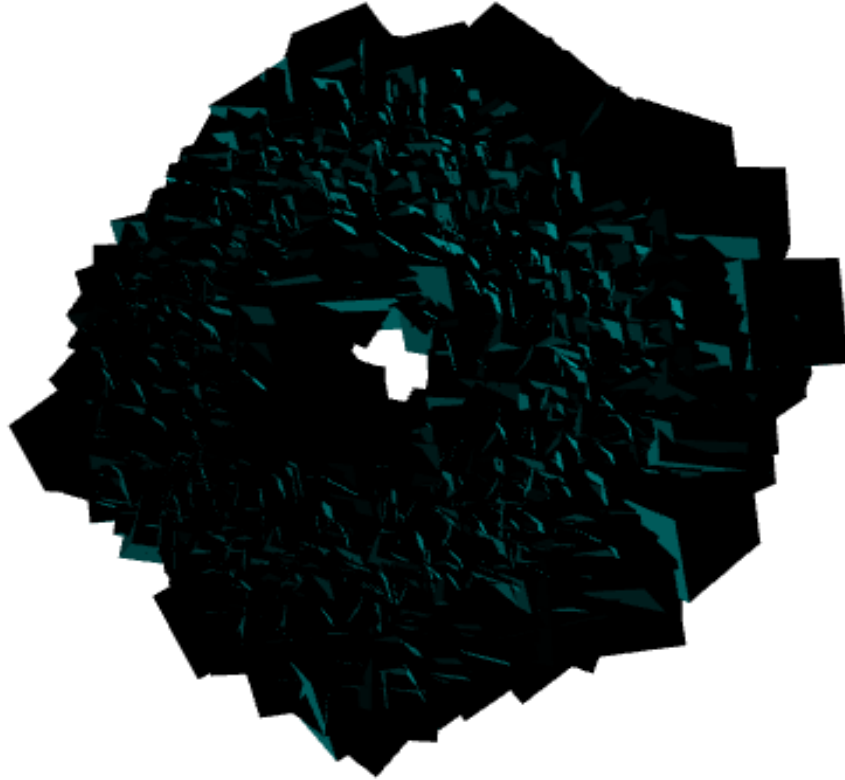
ARTIFICIAL INTELLIGENCE: MACHINE LEARNING AND COMPUTATIONAL CREATIVITY

"The Post- Human era begins in full
when the output of computers is unpredictable"
The Post Human Manifesto 8.1

by Claire Burke

Burke C, (2017) Criterions (i) Generative Code, Video loop - Available at https://ormondstudios.wordpress.com/2017/07/07/images-of-recent-exhibition-performing-a-translation/

CHAPTER 1
MACHINE INTELLIGENCE

Ever since the Industrial Revolution, machines have provided artists with new mediums to engage with. In our current cultural state, art and technology are more intertwined than ever before. The word technology has it origins from the Greek word tekche which means art and logia which means the study of a craft or art. Technological determinism is shaping the way in which art is evolving and being created, distributed, preserved and exhibited online.

The relationship between human's and machines is a complex one, it is important to understand the ways in which cognitive technologies and humans interact. "The relationship between artist and computer can be symbiotic for each depends on the other, and both do together what neither could do alone". (Mallary, 1979).

Bohm suggests that understanding the operations of the mind is by discovering the distinction between intelligence and thought. (Bohm and Nichol, 2000)

Artificial Intelligence is the concept of making a machine that has the ability to think. Although machines can learn and solve problems, the inherent difference is that of our human understanding that machine cannot think. But is there really a difference between human and machine thinking?

In 1872 the worlds first programmable computer The Analytical Engine was invented by Babbage and Lovelace.

The analytical engine could preform computational tasks that would require expanded human knowledge, they were not considered to have the ability to think. In certain areas such a playing chess and computation machines have proven to surpass human intelligence. What can we expect for the future implications of art, when it is possible for machines to have the intelligence and ability to provide us with new and possibly better forms of art?

1.1 TURING

The last considered Artificial Intelligence relevant research was during the Dartmouth Summer Research Project in 1956. Alan Turing, the British code breaker and computer pioneer demonstrated the human mind from a computational point of view.

He demonstrated that human being's have a capacity to build things but with regard to his research on computer machines Turing states his query "I propose to consider the question, "Can machines think?" This should begin with definitions of the meaning of the terms "machine" and "think."(Turing, 1950, p.433). Central to this argument we need to look at what is a mind and what is a machine. Turing devised a test to explore intelligence to study how machines respond. The test involves interaction between a human and a machine. A blind test consisting of several specified actions the human is asked whether it was communicating with a human or a machine. If the human thinks this interaction with the machine was with a human, then the machine has been successful and subsequently passed the Turing test.

The concept of intelligence has played a role in the way in which we understand ourselves. Nath acknowledges the relevance of Turing's work "The Turing test was designed to provide us with a definition of intelligence". (Nath, 2009).

His analysis involved undertaking The Imitation Game. This was conducted by two people and one machine playing the game, with one of the persons acting as interrogator. By asking questions of both the machine and the other person, the interrogator attempts to predict who is the machine and who is the human.

The field of artificial intelligence is relevant to research within art as it is uses logic, reasoning and decision making. Attempts to build machines with cognitive abilities began after the second world war. The invention of the first programmable computer in 1956 was the starting point for the field of artificial intelligence research. (P, 2001) Theories began to emerge about the possibilities of creating a thinking machines as well as critical discussions. In the 1950's Turing thought it was possible that machines could think. Machines had proved to be successful in preforming complex cognitive tasks by solving problems and playing chess but unlike human's they had not shown that they are capable of consciousness. Although it is only an assumption that only humans can have this trait.

In many ways artificial intelligence is still dependent on the programmer to develop to the complexity of it so that it can deal with as many scenarios as possible. Writing a program to learn is possible but quite complex; artificial intelligence is pseudo at best. We increasingly rely on technology to perform our daily tasks; these are in the form of algorithms. Artists rely on algorithms in the production and creation of art, technology is incorporated into many aspects of creativity.

In 1991 Moravec predicted that eventually artificial intelligence could replace humans in every essential task including perception, motor abilities and superior reasoning. (Moravec, 1991) He suggested that Artificial Intelligence has "successfully imitated aspects of rational thought and full evolution of robot intelligence would act on our behalf as literal minded slaves". (Moravec, 1991) In the time of computational abundance are we entering into a moment where we cannot encounter art without some form of computation integrated into the it's creation, production and display. There are benefits to accepting the computer as a tool in the process of thinking within art making. Lopes suggests that artists can use computers as cognitive tools as the artist can create with their brains to process information and can assign computers cognitive tasks. (Lopes, 2010) But where does the line draw between artist and machine?

The Turing test proposes the question "Is there a difference between the operational systems in the human mind and those working in the computer (Nash, 2009, p.xii) The central challenge is to examine the relationship between human mind and machine mind and how this can inform our understanding of creativity. Turing's famous question was; Can Machines Think? A different question resides under the contemporary conditions in which we now live. This central concern is; can machines actually create credible art

CHAPTER 2
ART CREATED BY MACHINES

Contemporary art involves artists who collaborate with machines in the creation of art. If the computer can make decisions and produce outcomes that an artist cannot anticipate, what does that mean for the future of art. Will a machine be able show true creativity and could it be considered art?

Contemporary artists are engaged by developments within artificial intelligence, they seek to find new forms of responses and artistic representations. Machines have proven themselves of being capable at outperforming their creators and have displaced them in modes of labour production. So is it possible that they could produce better art than humans? If a program is written and exists as a set of instructions to the machine it can be considered to operate in an algorithmic way. Art created through this type of method is

Cohen, H (2004) 040601 Pigment on paper, computer-generated, 46 × 57.75 in.
Available at: http://dada.compart-bremen.de/item/artwork/1478

placing the human to influencing the work in a direct way. A program that is written with rules, allows then for the constraints of letting go of human decision, it is then up to the machine to output what it decides. When deciding if machines can learn and make decisions it is important to consider the type of algorithm that is operating. If it is learning with rules and outputting its own decisions based on these rules, will the intelligence that has been created exceed the intelligence of it's creator

Most art critics along with many viewers of art are of the opinion that artistic merit is solely a human skill and a human experience. It is widely accepted that the human expression of creativity is what distinguishes us from machines. Many do not accept creations produced by artificial intelligence as credible art. How do we justify the machine solely as an artist? If we perceive that machines cannot think or feel, how can we say that they are creators of art and not just creations themselves. Is it not art until we treat it as art?

With no definition of creativity, it is impossible to say that a machine is not creative. One of the functions of art is to provoke a perception. Bohm asserts that in almost any field creativity is possible and is founded on the perception of what is new an also different from previous knowledge. (Bohm and Nichol, 2000).

Feelings and emotional responses emerge when we perceive an art work. So if it is the art work itself that provokes this and is not necessarily directly from the artist or creator but the artwork produced, in this sense a machine is creative.

2.1 HAROLD COHEN AARON

Harold Cohen a painter and professor at the University of San Diego, developed a computer program to create art. It is called AARON and is one of the first and perhaps one of the most famous creative Artificial Intelligence that exists. AARON's paintings feature in many museums including the Tate Gallery and Stedelijk Museum in Amsterdam. His creator Cohen does not consider the idea that AARON creates

art, but his invention does raise the question of whether a machine can become a creator of art? Is it Cohen that is the artist or is it AARON? Cohen is the writer of the program but the machine is learning and executing the outcomes. The role the artist takes here is different to a traditional use of a machine to aid in the creation of art. Cohen resumes the role of a creator in the sense of an inventor, teaching the programme he created to think, setting out parameters and set of rules and circumstances. Is the process that is being carried out a creative act? Perhaps the paintings that are produced are just objects that are not necessarily creative but exist as creations. Suggesting that AARON imitates human creativity very well by producing credible line drawings, Pepperell affirms that it is just tool to inspire new work and that machines cannot be accredited to the work as they haven't thought up the idea (Pepperell, 1995)

AARON can produce paintings of anything it has learned. Even though it is a functional drawing machine producing art works in the style of colourful geometric patterns, Cohen says he would prefer not to call the machine creative.

He admits that it actually knows " very little about the world - it recognises the shape of people, potted plants, trees and simple objects such as boxes and tables". (Wakefield 2015) The abstract paintings AARON produced led him to be accepted as reputable colourist by his owner. Upon seeing the results, it produced Cohen stated that "he would not have had the courage to choose the particular colours". (Boden, 2010, p.93) The machine has learned a certain style of painting, it had remnants of Cohen's own signature style

of painting. It is arguable that by engaging with a computational device it changed his creative process. By creating AARON Cohen suggest that he will have the unique opportunity to become the world's first artist to have an exclusively posthumous exhibition consisting of completely new and original works. (Kurzweil, 2000) What is so unique about the work is that AARON, due to its intensive data set, can produce original artworks, it doesn't not mimic the style of any other artist that already exists The drawing it produces are original and they do not need the assistance of a human's to produce these genuine pieces. In Plato's Theory of Art, Lodge Affirms that, "It is clear that what makes an artist an artist is his technique, his mathematics, his logic, his scientific method". (Lodge, 1953, p.94) In this sense AARON as a machine possess all these attributes and executes them in his practice.

2.2 PAUL THE ROBOT

Paul the robot is another computational device who produces artwork. The London based artist Patrick Tresset uses computational systems which introduce artistic behaviour to machines. Having reaching somewhat of a stumbling block in his career, he considered the fact that if he needed a machine to preform to create drawings, he would have to teach them his process. "This entailed studying perception, cognition, motor control" (Tresset, 2016).

In 2016 as part of the exhibition SEE-ING, what are you looking at? 3RNP which stands for 3 Robots Named Paul was installed at the Science Gallery, Dublin. This installation at the Science Gallery draws portraits of humans and this artwork in partic-

Meeting on Gauguin's Beach - 1988 - Photographer: Cohen, Harold

ular shows a collaboration between art and machines. The piece involves a traditional art sketching experience with role reversal within its execution "the human takes the sitter's role and is sketched by three robots"(Tresset, 2016). The subject matter sits down for approximately 30 minutes, while three robotic arms, controlled by software draw a portrait. There are three cameras that observe and interpret the data of the subject from three different angles and distances. While the subject poses, a series of movements and mechanical noises occur. Aware of being depicted by a robot and an

uncertainty to the outcome of its representational skills, it eventually produces three different portraits. Each are slightly different in terms of composition but they all are to a varying degree of likeness to the subject.

Three unique and surprisingly life-like results emerge. But similar to AARON, they both have human creators, so should it really be the human who writes the computer language that the work is accredited to, is it really computational creativity? Does the robot really create the artwork or is it the intention of the human

artist that created the hardware and software. There are also unexpected results, depending on the time of the day and the mood of the machine, the assistants in the gallery state that the machine can act temperamental. Referring to it as a having good days and bad days, it emulates the sense of a being with a presence in the gallery. Tresset admits that there are still elements of surprise to the work that is produced as it is not something that he can predict. (Nosta, 2017) Are these unintentional glitches that are the failure of the machine, or are they intentional?

2.3 THE NEXT REMBRANDT

The Next Rembrandt, it is one of the most recent research experiments in the the field of computational creativity. The work was created by teams from Dutch museums Mauritshuis and Rembranthuis. The project was realised through a collaboration with researchers from the Delft University of Technology and supported by Microsoft. The idea was an attempt to create a new Rembrandt painting. It uses algorithms to create a new painting based on Rembrandts original style of art work. It does this under certain conditions and data. It emulates his art using colour, composition, style and depth of paint. The algorithm creates by analysing data which is based upon Rembrandt's entire collection of art. "It uses data that includes information colour, dress, topic, demographics, composition and all the rest". (Coldewey, 2016)

The algorithm learns to distinguish the individual features of the subject matter within his paintings. As his painting were usually portrait, it has data which includes many of the geometrical features of his work including angles and distances between facial features." The portrait consists of over 148 million pixels, based on 168,263 painting fragments from Rembrandt's oeuvre" (Westall, 2016) The data used was 3d scans of over 346 of his paintings. On analysis the algorithm learned to reduced it down to the most common factors in his work. The most typical subject matter was a "white male who was wearing black clothes". (Reynolds, 2016) Using 3d printing it uses a height map and builds up printed layers and textures to create of a work which could be mistakable for an original Rembrandt.

It is unique as it poses somewhat of a "controversial point between the worlds of technology and creativity"(-Nudd, 2010). It shows that computer generated art can be indistinguishable from human produced art and can also evoke the same feelings as an original work. Innovation Manager Emmanuel Flores states that the painting has already passed a kind of Turing test. He admits that the institution doesn't accept this is a Rembrandt and to some of the people involved in the process it is very confusing. (Gosh, 2016)

With any creation of art there is a composition made, based on data containing information. This data is based on what is experienced and a system is at play, sorting this into a particular configuration of patterns, colour, composition etc. It is narrowed down and there are continuous variations until a realised art work emerges.

Lodge defines that " the activity of an artist is, in fact, a copying and imitating, a varying rather than creating. So this would suggest that the Next Rembrandt the machine is varying rather than creating but it is still an activity; one that is adopted by human artists.

The machine takes in it's data and in the case of the Next Rembrandt the results are a creation of an artwork that sit within a social context, opening up debated within the art world. The researchers have given the machine a data base of art and it has created what they enabled it to do.

CHAPTER 3
MACHINE LEARNING

Where as artificial intelligence aims to get machines to preform intelligent tasks, the intention of machine learning is to enhance knowledge. Deep learning is at the forefront of computational progression and the algorithms and neural networks are behind some of the devices we interact with everyday day. The ability to learn evolved in human's beings and there is no evidence to suggest that it could not occur in machines. Using machine learning we may be able to finally distinguish between a machine that imitates creativity and one that could be considered truly creative.

Significant advances have been made in the field of neural networks are a type of machine learning algorithm that uses neural networks to learn. To emulate the operation of the human brain individual neurons are organised into complex networks from which

THIS DATA IS BASED ON WHAT IS EXPERIENCED AND A SYSTEM IS AT PLAY, SORTING THIS INTO A PARTICULAR CONFIGURATION OF PATTERNS, COLOUR, COMPOSITION

The Next Rembrandt (2016) 3D printed - Available at: https://techcrunch.com/2016/04/06/tech-imitates-art-in-a-3d-printe-

machines can learn from experiences (Pepperell, 1995) They can be applied to creative applications and artists are engaging with these concepts. Being creative in art is comparable to byte manipulation in large numbers with complex algorithms. At a low level the execution of creation would run fast. A high level language like Java perhaps could work with an algorithm, like an electronic canvas with each point having an x, y coordinate you can create shapes by changing colours within a given set or coordinates. These autonomous machines have skills; they are painting portraits that articulate technical composition similar to humans.

Artificial neural networks are being trained to learn, they are showing multiple examples of what they should learn, they learn what data to ignore. The origins are algorithms that try to mimic the brain, they are responsible for the revival of machine learning

due to the biological application. Machines need data to learn, much like humans learn from data existing in the real world. There are many ways in which an image can be manifested, but before this happens neural networks must learn their subject matter. Like human mind, the more information it has the more intelligent it can become and it learns from previous experience. The brain is the largest and most impressively functioning machine, so neural networks were based on algorithms that tried to mimic the brain. The neural nets are trained and it learns the connections between its inputs and outputs. The mind is able to solve problems, learn new information and disregard previous collected and stored information and create new forms of insight. If computers now have the power, speed, and capability to process so much data that this type neural based algorithms have, they may posses this type of insight.

3.1 ALGORITHMS

It appears with regard to painting based machine learning, due to advances within image classification, machines can output and create like humans. But will machines ever have intuition and an ability to think?

Thomas Bayes an English mathematician who formulated a version on Bayes Theorem. "Bayesian statistics provide a framework for building intelligent learning systems" (Ghahramani, 2014). Bayes Theorem is the concept that takes decisions based on the the probability of an outcome to happen, based on previous experiences. "Bayesian interference treats model parameters as random variables rather than as constants. The framework allows for prior information to be formally taken in to account" (Puza, 2015, p.1)

If this is how machines learn, it draws

parallels with the concept of Dewey's experience of art and the aesthetic. So it could be implied that if this is how humans critique and produce art then it could be possible to lead machines thinking creatively. So perhaps there could be thought to machine logic through inductive reasoning which is based on observation and experiment. A set of rules can take what has been useful and predict if the conditions will be useful in the future.

A machines binary system, a true false logic is comparable to modern philosophical logic. A possible route through gaining insight into how a machine may become creative is through neural networks because these are based on the human brain. Neurons function in a similar way to Boolean Logic, a true or false decisions using 0 and 1 in the form of AND, OR, and NOT.

Artificial Intelligence did not gain traction after its invention and hit a stumbling block. This was mostly due to the technology not being powerful enough to produce enough data. Neural networks had limitations due to the complexities of the systems. Moravec suggests that in the 1980's it re-emerged within the field of cybernetics under neural nets, this was due to the computer starting to become powerful enough to simulate interesting assemblies of neurons. (Moravec, 2000) But still in 1995 Pepperell predicted that machines would be "in the near future creative aids rather than creative tools". (Pepperell, 1995, P.138)

In the year 2000 Kurzweil predicts that by the year 2020 computers will achieve the capacity and speed of the human brain. He suggests that to achieve human intelligence that

one possible approach would involve copying the brain neural circuitry. (Kurzweil, 2000) Neural networks do present the evidence that machines have the intelligence to learn. Through engagement with neural networks that learn from data, we can possibly gain greater insight into the possibility of intelligence and its purpose within machine creativity.

CONCLUSION

Human creativity is hard to define; in a bid to understand it perhaps instead of seeing artificial intelligence as a negative impact, we can look to redefine what creativity means within the contemporary. Turing realised the similarity between the process of human thinking and computational thinking in the 1950's, the investigation of how computational devices create and think has only begun to be explored. Ascott suggested that there is a need for artists and technologists to collaborate to create telematic networks and nodes of digital hardware and cybernetic systems, that will support new forms of art practice. (Ascott and Shanken, 2003) "Artificial Intelligence has successfully imitated the conscious surface of rational thought, and in doing so made evident the vast unplumbed sea of unconscious processes below" (Moravec, 2000. P.24) Kurzweil suggests the scenario of a future large neural net which is based on reverse engineering of the human brain. It has the ability to access human knowledge and learn language, it can develop its own conception of reality. We need to think about how computational devices are not just tools anymore that aid in the creation of art, they may need to be considered on their own merits. Can humans and machine work together to preform creative collaborations?

Rather than the fear of robots producing better art and eradicating concepts of human creativity, we should look at the importance of how machines can help humans understand and create art. The Art and Artificial Intelligent Laboratory at Rutgers University is at the forefront for research within the field of machine learning applied to art. It's most recent research involved developing the uses of a computational system that takes the role of the artist and produces completely new artworks. (Voon, 2017) The study involved participants being shown a mix of artworks that were generated by machines, famous human abstract artists and artists that were showing work at Art Basel 2016. Tresset defers that there is no such thing that exists as a fully autonomous system due to the fact that there is always a human creator or designer that has made decisions behind the machine. The machines behaviour is influenced by humans and therefore are a factor in the output it creates.

Art practice that involves computer programmes involves exploring new technological implications. There a set of conditions and parameters where there is an output. Criterions series is practical research project that culminated in the realisation of two art works. Using Processing a visual computing program, computer code is running on a machine and captured frame by frame to result in a video piece. The code is a creative instrument of expression. The artist has control of the aesthetic using the movement.

Pointing to the fact that these types of artworks are importantly programmed by humans, Pepperell describes the process as "long strings of commands that, even running on

the fastest machine, can only 'think' one thing at a time" (Pepperell, 1995, p.127) He asserts that to write a programme that mimics the workings of the brain you would need more time than existence itself. (Pepperell, 1995) That may have been true at the time, but over 20 years later with technology's predicted rate of evolution, we are beginning to considered that intelligent machines may be a reality before we expected. Art created in this manner is a collaboration with a machine, it does require a human to program to set up various conditions and parameters.

In the case of referring to art that includes neural networks, the human is eventually relinquishing control as once the machine has learned based on the data provided, humans are no longer involved, they have just made the process possible. Machine learning and algorithms currently aid human creativity and a possible way to for a machine to show true creativity is by the use of neural networks. But does it matter if there is a human creator who starts the creative process, when machines have shown themselves once given the starting skillset, can learn and go beyond the ability of the creator? The results of the Rutgers study showed that the participants had an aesthetic preference to the machine generated art works. The machine whether considered creative or not, what it has learned in terms of pattern, colour and the choices it makes are to the human eye aesthetically pleasing. Humans cannot tell the difference between machine art or of that made by a human artist, perhaps it is because mostly the art works are new. They are unique and different and exist as a works in themselves, even if they are on some level copying a style.

As Walter Benjamin stated "In principle, the work of art has always been reproducible". (Benjamin and Underwood, 2008, p.3) In a sense machines are reproducing human artworks but arguably better, their masters are the computer programmers who feed them data consisting of various arrays of human made art from which they learn aesthetic judgement. The upcoming exhibition at the Museum of Modern Art, New York is titled Thinking Machines: Art and Design in the Computer Age 1959-1989 is a collection of work that will include artworks that were created using computers and computational creativity. (Sterling, 2017)

A retrospective that will "trace how computers transformed aesthetics and hierarchies, revealing how these thinking machines reshaped art". (Sterling, 2017).

Pepperell states that "Creativity, as we normally understand it, consists of acts of transformation that bring about something which is both new and beneficial. (Pepperell, 1995, p.115) Perhaps we must allow machines a have a chance as artists, as the act of creativity may not need to represent anything other than the creation of something new into existence that otherwise would not exist.
mean using specific methods that are not necessarily "native" of a particular discipline in order to address and understand a particular phenomenon better, or simply in a non-conventional way. But wouldn't this anchor us to the very discipline from which we wanted to depart, and simultaneously run the risk to de-legitimate our research effort? In either ways, what emerges is an inherent inability to "think" in terms of uncertainty (when understood as practice) as our

very mind is hardwired to concepts of boundaries, established conventions and definite outcomes.

■ CLAIRE BURKE

References:

- Apter, Michael j. 1969. "Cybernetics And Art Leonardo Vol. 2, No. 3 (Jul., 1969), Pp. 257-265". Jstor.Org. http://www.jstor.org/stable/1572155.

- Armstrong, John. 2016. "Van Gogh Comes To Life: The Power Of Machine Learning". Irishtechnews.Ie. http://irishtechnews.ie/van-gogh-comes-to-life-the-power-of-machine-learning/.

- "Artificial Definition And Synonyms | Macmillan Dictionary". 2016. Macmillandictionary. Com. http://www.macmillandictionary.com/dictionary/british/artificial.

- "Artificial Intelligence - Foundations Of Computational Agents -- 6.4.2.3 From Samples To Probabilities". 2017. Artint.Info. Accessed January 13. http://artint.info/html/ArtInt_155.html.

- Artinfo, Blouin. 2017. "'Thinking Machines: Art And Design In The Computer Age' At Museum Of Modern Art, New York | Artinfo". Artinfo. http://www.blouinartinfo.com/news/story/2430755/thinking-machines-art-and-design-in-the-computer-age-at.

Ascott, Roy. 1999. Reframing Consciousness. Exeter, England: Intellect.

- Ascott, Roy. 2000. Art, Technology, Consciousness. Bristol, UK: Intellect.

- Ascott, Roy. 2006. Engineering Nature : Art Consciousness In The Post-Biological Era. Bristol: Intellect.

- Ascott, Roy, and Edward A Shanken. 2003. Telematic Embrace. Berkeley: University of California Press.

- Belloc, Hilaire. 1967. On. Freeport, N.Y.: Books for Libraries Press.

- Benjamin, Walter, and J.A Underwood. 2008. The Work Of Art In The Age Of Mechanical Reproduction. London: Penguin Books Ltd.

- Beyls, Peter. 1991. "Discovery Through Interaction: A Cognitive Approach To Computer Media In The Visual Arts Vol. 24, No. 3 (1991), Pp. 311-315". Jstor.Org. http://www.jstor.org/stable/1575573.

- Bohm, David, and Lee Nichol. 2000. On Creativity. London <<[u.a.]>>: Routledge.

- Cascone, Sarah. 2016. "New Rembrandt Created By Computers". Artnet News. https://news.artnet.com/art-world/new-rembrandt-through-data-analysis-466517.

- Cohen, Harold. 2004. 040601. Image. http://dada.compart-bremen.de/item/artwork/1478. Cohen, Harold, and AARON Robot. 2004. 040601. Pigment on paper, 46 by 57.75 inches 1/3 (1 of 38).

- Coldewey, Devin. 2016. "Tech Imitates Art In A 3D Printed Fake Rembrandt Based On The Old Master'S Style". Techcrunch. https://techcrunch.com/2016/04/06/tech-imitates-art-in-a-3d-printed-fake-rembrandt-based-on-the-old-masters-style/.

- Eliëns, A. 1988. "Computational Art Supplemental Issue Vol. 1, Electronic Art (1988), Pp. 21-25". Jstor.Org. http://www.jstor.org/stable/1557905.

- Ghahramani, oubin. 2014. "Bayesian Machine Learning". Mlg.Eng.Cam.Ac.Uk. http://mlg.eng.cam.ac.uk/zoubin/bayesian.html.

- Gosh, Shona. 2016. "ING's Next Rembrandt Project Proves God Is In The Machine". Campaignlive.Co.Uk. http://www.campaignlive.co.uk/article/ings-next-rembrandt-project-proves-god-machine/1401422.

- Holmes, Kevin. 2016. "Robot Art Contest Seeks Machines That Can Paint Like The Masters | The Creators Project". The Creators Project. http://thecreatorsproject.vice.com/blog/robot-art-contest.

- Holmes, Kevin. 2011. "Meet "Paul" And "Pete," The Sketching Robots | The Creators Project". The Creators Project. http://thecreatorsproject.vice.com/blog/meet-paul-and-pete-the-sketching-robots--2.

- Jackson, Robert. 2016. "If Consciousness Is An Algorithm, Then A Robot Can Be Conscious | Letters". The Guardian. https://www.theguardian.com/theobserver/2016/mar/20/observer-letters-artificial-intelligence.

- Kurzweil, Ray. 2000. The Age Of Spiritual Machines. New York: Penguin Books.

- Lodge, Rupert C. 1953. Plato's Theory Of Art. London: Routledge.

- Lopes, Dominic. 2010. A Philosophy Of Computer Art. London: Routledge.

- Mallary, Robert. 1979. "Computer Sculpture: Six Levels Of Cybernetics". Robertmallary.Com. http://www.robertmallary.com/Commentary/artforum_09-1969.htm.

- McCleary, Leland. 2008. "Cognitive Robotics / What Computers Can't Do, Dreyfus". Cognitiverobotics.Pbworks.Com. http://cognitiverobotics.pbworks.com/w/page/11247608/What%20Computers%20Can%27t%20Do%2C%20Dreyfus.

- MOMA. 2017. Thinking Machines: Art And Design In The Computer Age. http://press.moma.org/2017/07/thinking-machines-art-and-design-in-the-computer-age/.

- Moravec, Hans. 1991. "The Universal Robot". Frc.Ri.Cmu.Edu. http://www.frc.ri.cmu.edu/~hpm/project.archive/robot.papers/1991/Universal.Robot.910618.html.

- Moravec, Hans P. 2000. Robot. Oxford: Oxford University Press.

- Muoio, Danielle. 2016. "These Robots Just Won Up To $30,000 For Their Paintings". Business Insider. http://uk.businessinsider.com/winners-of-the-2016-robot-art-contest-2016-5?r=US&IR=T/#the-painting-feels-unique-in-style-and-very-painterlynot-digital-or-robotic-a-judge-wrote-about-the-robots-work-5.

- Nake, Frieder. 1998. "Art In The Time Of The Artificial Leonardo Vol. 31, No. 3 (1998), Pp. 163-164". Jstor.Org. http://www.jstor.org/stable/1576563.

- Nath, Rajakishore. 2009. Philosophy Of Artificial Intelligence. Boca Raton, Fla.: Universal-Publishers.

- Nosta, John. 2017. "The Artistic Side Of Artificial Intelligence". Psychology Today. https://www.psychologytoday.com/blog/the-digital-self/201703/the-artistic-side-artificial-intelligence.

- Nudd, Tim. 2016. "Inside 'The Next Rembrandt': How JWT Got A Computer To Paint Like The Old Master". Adweek. http://www.adweek.com/news/advertising-branding/inside-next-rembrandt-how-jwt-got-computer-paint-old-master-172257.

- Oppy, Graham, and David Dowe. 2016. "The Turing Test". Plato.Stanford.Edu. http://plato.stanford.edu/archives/spr2016/entries/turing-test.

- Pepperell, Robert. 1995. The Post-Human Condition. Bristol, UK: Intellect.

- Poole, David, and Alan Mackworth. 2017. "Artificial Intelligence - Foundations Of Computational Agents -- 6.4.2.3 From Samples To Probabilities". Artint.Info. Accessed January 13. http://artint.info/html/ArtInt_155.html.

- Popper, Frank. 1993. "The Place Of High-Technology Art In The Contemporary Art Scene On JSTOR". Jstor.Org. http://www.jstor.org/stable/1575783.

- Puza, Borek. 2015. "CHAPTER 1 Bayesian Basics Part 1 Pp. 1-60 From Bayesian Methods For Statistical Analysis". Jstor.Org. http://www.jstor.org/stable/j.ctt1bgzbn2.7.

- Reichardt, Jasia. 1968. "Cybernetic Serendipity The Computer And The Arts". http://cyberneticserendipity.com/cybernetic_serendipity.pdf.

- Reynolds, Emily. 2016. "This Fake Rembrandt Was Created By An Algorithm". WIRED UK. http://www.wired.co.uk/article/new-rembrandt-painting-computer-3d-printed.

- Rinder, Lawrence. 1999. Search Light. [New York, N.Y.]: Thames & Hudson.

- Sayej, Nadja. 2016. "Vincent Van Bot: The Robots Turning Their Hand To Art". The Guardian. https://www.theguardian.com/artanddesign/2016/apr/19/robot-art-competition-e-david-cloudpainter-bitpaintr.

- Science Gallery. 2016. A Human Model Is

Tresset, P (2016) 3NPR 3 Robots named Paul, Installation, Science Gallery, Dublin - Available at http://www.thejournal.ie/science-gallery-seeing-exhibition-robot-artists-2841271-Jun2016/

Drawn By Three Robots Named Paul, 2014 Patrick Tresset (FR). https://dublin.sciencegallery.com/seeing/exhibits/3rnp.html.

- Solso, Robert L. 2001. Cognition And The Visual Arts. Cambridge Mass.: MIT Press.

- Sterling, Bruce. 2017. "Thinking Machines: Art And Design In The Computer Age, 1959–1989". WIRED. https://www.wired.com/beyond-the-beyond/2017/07/thinking-machines-art-design-computer-age-1959-1989/.

- Thagard, Paul. 1990. "Philosophy And Machine Learning Vol. 20, No. 2 (Jun., 1990), Pp. 261-276". Jstor.Org. http://www.jstor.org/stable/40231695.

- TheJournal.ie. 2016. 3RNP Installation, Science Gallery 2016. Image. http://www.thejournal.ie/science-gallery-seeing-exhibition-robot-artists-2841271-Jun2016/.

- Tor, Róisín. 2016. Image.

- Tresset, Patrick. 2016. "If We Get Robots To Make Art, They Won't Bother To Make War". Huffpost UK. http://www.huffingtonpost.co.uk/patrick-tresset/robots-art_b_8226536.html.

- Turing, Alan. 1950. "Computing Machinery And Intelligence. Mind, 59(236), 433–460.". Jstor.Org. http://www.jstor.org/stable/2251299.

- Voon, Claire. 2017. "Humans Prefer Computer-Generated Paintings To Those At Art Basel". Hyperallergic. https://hyperallergic.com/391059/humans-prefer-computer-generated-paintings-to-those-at-art-basel.

- Wakefield, Jane. 2015. "Intelligent Machines: AI Art Is Taking On The Experts - BBC News". BBC News. http://www.bbc.com/news/technology-33677271.

- Westall, Mark. 2016. "The 'Next' Rembrandt Has Been Unveiled In Amsterdam". FAD Magazine. http://fadmagazine.com/2016/04/06/next-rembrandt-unveiled-amsterdam/.

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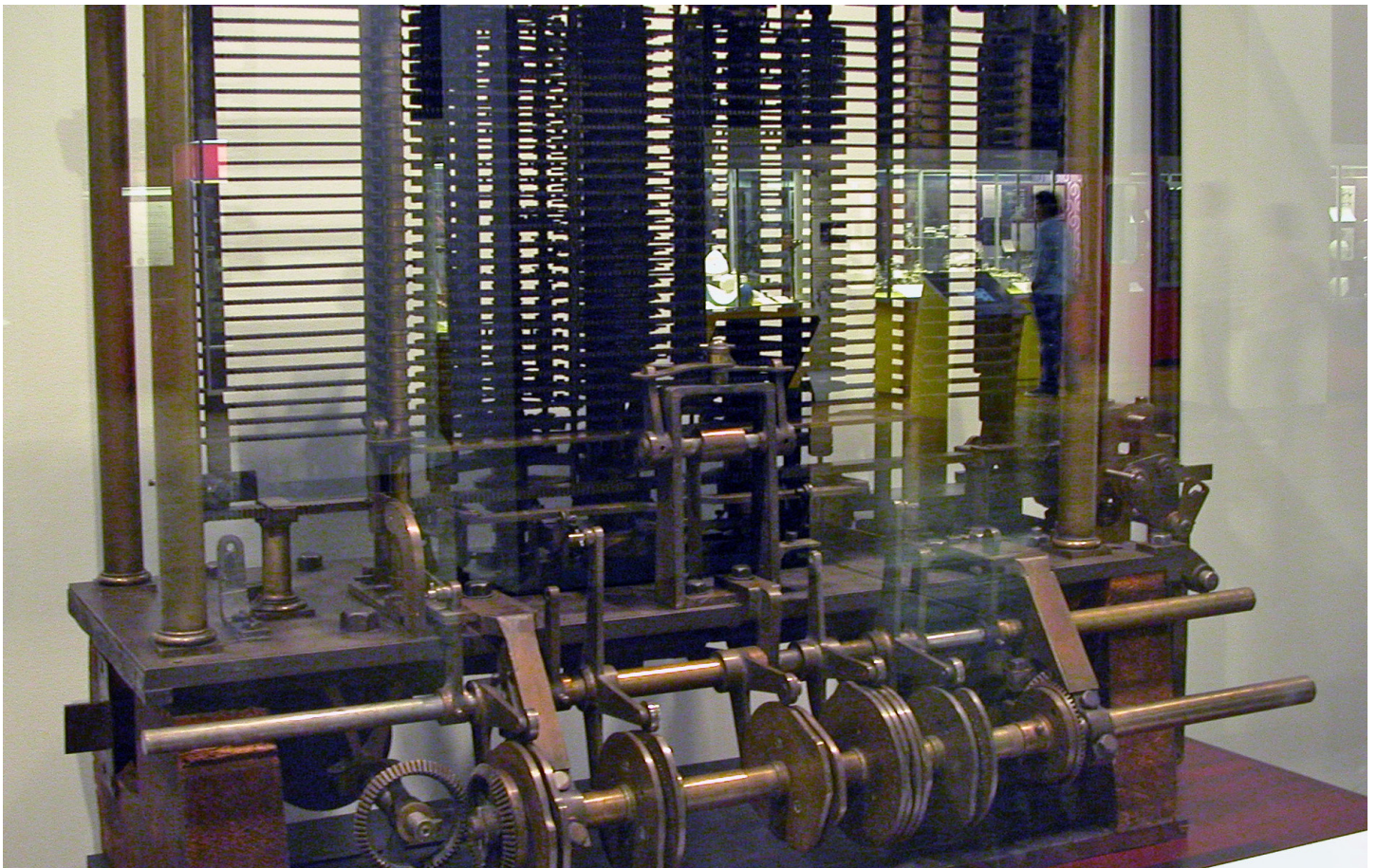
MACHINES THAT LEARN. WHAT CAN THEY LEARN?

WHAT WILL THEY LEARN?

by Memo Akten

AnalyticalMachine_Babbage_London – https://en.wikipedia.org/wiki/File:AnalyticalMachine_Babbage_London.jpg
Babbage's nalytical Engine, 1834-1871. (Trial model). Science Museum, London

Lady Ada Lovelace (1815-1852), mathematician and theoretical computer programmer, was only 17 years old when she met Charles Babbage (1791-1871), who was 42 at the time \cite{Fuegi2003}. Babbage was already known for designing complex mechanical calculators, such as the famous Difference Engine (ca 1822); and he arguably invented the first digital, general purpose, programmable computer: The Analytical Engine (ca 1837). Though he never actually built these machines due to funding issues, the designs remain influential to this day.

Despite their age gap, Lovelace was Babbage's intellectual collaborator and peer. It's through her notes that we know so much about these machines, including what is considered to be the very first complex computer program. Her notes also include beautiful comments with incredible foresight, such as "The Analytical Engine weaves algebraic patterns just as the Jacquard loom weaves flowers and leaves".
— Ada Lovelace (1815–1852), "Notes (on The Analytical Engine)", 1843

She had even more profound insights. While Babbage was mostly interested in designing a machine that could calculate anything, i.e. operate on numbers, Lovelace saw the potential of this machine to go beyond that, and operate on symbols, to do true general purpose computing. She went even beyond that to predict the generative, computational art movement to come a century later "… the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent."

Also amongst her notes, is this very famous, oft-quoted, and somewhat controversial statement…

"The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis, but it has no power of anticipating any analytical revelations or truths. Its province is to assist us in making available what we are already acquainted with."

For the last two centuries, researchers have been trying to prove her wrong. Researchers of so-called 'Strong AI'—those who are trying to build 'truly intelligent' machines; and researchers of so-called 'Computational Creativity'—those who are trying to build 'truly creative' machines. 'Intelligence' and 'creativity', two vague concepts that are often intertwined; and lack clear, universally accepted definitions. In fact this is indeed a bit of a problem in the field.

Throughout the history of artificial intelligence, there has been a pattern. A problem or task is presented as the epitome of intelligence, as something

that only a human-level intelligence could accomplish. And if and only if a machine could perform that task, then it would be considered truly intelligent.

Once upon a time it was thought that simple arithmetic was something that only a human mind could grasp. That was proven wrong centuries ago with the advent of mechanical calculators. Then during the official birth of the field of Artificial Intelligence (AI) in the mid 1950s, mathematical proofs were set as the goal. Surely a machine could not perform the required logical reasoning to prove a mathematical theorem? Surely that was something only a human could do?

By 1956, Allen Newell, Herbert A. Simon and Cliff Shaw's 'Artificial Intelligence' "The Logic Theorist" was proving theorems \cite{McCorduck2004}. Some people thought that the problem of AI was solved, and within a few years we'd have full human-level intelligence. Others quickly realised that this wasn't really 'intelligence', it was just some code that some guys wrote, that randomly searched for a solution, with some basic rules of thumb ("heuristics" as it was called) thrown in there.

Chess, now that seemed like a true challenge. "If only a computer could beat a human expert at Chess", it was proposed, "then it could be considered intelligent".

But in 1997 when IBM's Deep Blue beat chess Grandmaster and world champion Garry Kasparov, many were quick to point out that Deep Blue still wasn't really 'intelligent'. It was just a really really fast computer. It was just brute force power trying millions of combinations of moves to see which

deepblue_kasparov - http://mashable.com/2016/02/10/kasparov-deep-blue/#DxJPjHO34Eqi
The final, decisive game in the rematch between Garry Kasparov and the IBM computer Deep Blue on May 11, 1997
(STAN HONDA/AFP/GETTY IMAGES)

one worked best - again with a bit of heuristics \cite{Campbell2002}. That doesn't count. Not intelligence.

The game of 'Go' on the other hand, is different. It's a game where having brute force power to search all the moves just isn't enough. It was thought that 'Go' is a game that requires intuition, and a level of planning and gut feel combined with intelligence that only a human—or human-level intelligence—could have.

But when Google DeepMind's AlphaGo beat world-ranking players Fan Hui in 2015, Lee Sedol in 2016 and top ranked player Ke Jie in 2017, it still wasn't satisfying to some. It still didn't feel like 'intelligence'. It just felt like some fancy statistics applied to a search tree, with some pattern recognition algorithms learning to predict optimal moves and estimate who's leading just by looking at the state of the board \cite{Silver2016}. It still doesn't count as 'real intelligence'. And when some people refer to AlphaGo as 'creative', others are quick to shoot it down, citing sentiment similar to Lovelace's. So there is a bit of a 'mov-

ing goal posts' problem in the field of AI. Trying to pin down what exactly 'intelligence' entails is very tricky. And this problem is articulated nicely by cognitive scientist Douglas Hofstadter \cite{Hofstadter1979}:

"Sometimes it seems as though each new step towards AI, rather than producing something which everyone agrees is real intelligence, merely reveals what real intelligence is not."—Douglas R. Hofstadter, "Gödel, Escher, Bach: An Eternal Golden Braid", 1979

In other words, if you know how it works, it ain't intelligence.

All sense of intelligence and creativity that might be attributed to a system seems to be destroyed once we understand the algorithm that computes the output. I wonder, if we ever do figure out exactly how the human brain works, and the algorithms that drive human intelligence and creativity, will we cease to see ourselves as intelligent or creative as well?

Of course I don't know how likely

that is, because… "If the human brain were so simple that we could understand it, we would be so simple, that we couldn't."—Emerson M. Pugh (c. 1938). from George E. Pugh (1977) "The Biological Origin of Human Values". \cite{Pugh1977}

But I'd like to return to Lovelace, and her controversial statement…

"The Analytical Engine has no pretensions whatever to originate anything. It can do whatever we know how to order it to perform. It can follow analysis, but it has no power of anticipating any analytical revelations or truths. Its province is to assist us in making available what we are already acquainted with."

In his seminal 1950 essay, "Computing machinery and intelligence", Alan Turing addresses this statement \cite{Turing1950}. He starts the essay with the question "Can machines think?". Seven decades later, after hundreds if not thousands of papers, debates, and dead-ends, we're still arguing over this question.

In his essay, Turing refers to Lovelace's claim that 'The Analytical Engine has no pretensions to originate anything', as "Lady Lovelace's Objection". He proposes that in order to be considered to 'originate' anything, a machine should be able to surprise people, even its own programmer. He re-frames the question in the context of machines that can learn. Because two years prior, in a report called "Intelligent Machinery", he had already theorised exactly that, something that neither Babbage nor Lovelace had foreseen: machines that can learn \cite{Turing1948}. He called these 'unorganised machines', loosely inspired by the neurons in the brain. And he had the foresight to propose:

"Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child's? If this were then subjected to an appropriate course of education, one would obtain the adult brain.".

He went on to add:

"Machines take me by surprise with great frequency… An important feature of a learning machine is that its teacher will often be very largely ignorant of quite what is going on inside."

And this is precisely where both the greatest strengths, and greatest dangers of machine learning algorithms lie. This is the greatest strength of machine learning, because this is how machines can potentially help propel us to new places, to help us see things that we otherwise wouldn't be able to see.

Lee Sedol Alphago - https://qz.com/639952/googles-ai-won-the-game-go-by-defying-millennia-of-basic-human-instinct/
Lee Sedol vs Google DeepMind's AlphaGo

Self-Driving-Uber – https://www.uber.com/blog/pittsburgh/pittsburgh-self-driving-uber/ - Uber is amongst the many tech companies looking to roll out self-driving cars.

While it was theorised almost 50 years prior, it was partly thanks to an immense amount of number crunching and computational analysis that the human-machine combo teams at CERN were able to find the tiny perturbation at around 125 GeV, amongst petabytes of data, to confirm the Higgs Boson \cite{Taylor2012}.

Likewise, gravitational waves were predicted over a century ago, but only recently observed through recognising and isolating a chirp lasting a fraction of a second, amongst years of deafening background noise, to identify the remnants of minute fluctuations in the fabric of space-time itself, emitted from two supermassive black holes colliding over a billion years ago \cite{Svitil2016}.

As more and more of our hard sciences (and increasingly, soft sciences) become computational, the impact of data science and machine learning on all of these fields will continue to radically grow. As a result, in the near future we can expect that machine learning will bring much more dramatic developments across all of these domains. Perhaps helping us answer open questions in physics, or finding cures for diseases such as leukaemia or Alzheimer's.

However, there is of course a lot to be concerned about as well. The existential threat of 'killer robots' fuel the nightmares of some – mainly very privileged \cite{Crawford2016} – folks. And while the idea of 'SkyNet / Terminator / Matrix' style robots becoming 'self-aware' and trying to enslave humanity is closer to the 'ridiculous' end of the spectrum, the idea of (increasingly) autonomous weapons and algorithmic warfare is indeed a very real threat \cite{Musk2017}.
There are other, potentially more

immediate threats. Such as mass job displacements, as more and more robotic and algorithmic labour is introduced \cite{Tufekci2015}. Critics of these threats are quick to point out that where one job is taken by a robot or machine, many more open up in the design, development, maintenance, management and deployment of these machines. However, these are of course very different skill-sets, and it may take decades – if not – much longer, for society to adjust. And more often than not these new roles and skill-sets are suited to different parts of society than those whose jobs were displaced.

A further discrimination takes effect when predictions made by these learning algorithms are used for critical decision making, like deciding whether or not somebody should be given a loan, or parole \cite{Angwin2016}, a job etc.; or where to police. Since the

data that these algorithms are trained on come from our actions, our historical records, they learn our societal biases and ultimately reinforce cultural prejudices and further cripple opportunities for those who are already at disadvantaged positions in society. What's even worse, is when these decision making algorithms are painted as 'neutral' and 'unbiased', or even 'science', and closed to scrutiny or debate. This is further amplified by the fact that these algorithmic decision making systems are often developed for profit with proprietary closed-source, closed-data algorithms.

BUT THERE'S MORE.

Already today we can see a huge impact of learning algorithms on personal privacy. It's already possible to detect a person's heartbeat instantaneously within a few milliseconds accuracy, by learning the perturbations in wifi signals bouncing off their body \cite{Zhao2016}. It's already possible to infer - with very high accuracy - the web pages somebody has visited on an encrypted website, simply by learning the statistics of packet sizes and how they change over time, even if the packets themselves are encrypted \cite{Miller2014}. It's already possible to identify faces in photos from only a few pixels \cite{Hu2017}, or even if they're wearing masks or glasses \cite{Singh2017}. It's even been suggested by some researchers that it's possible to infer with great accuracy, whether or not a person is a criminal, just from a single photograph of their face \cite{Wu2016a}– in effect computational physiognomy \cite{Arcas2017}. While this last particular research was quickly rejected - even ridiculed - by the wider research community, the former examples are generally accepted as viable and im-

portant fields of research, and are representative of the direction that machine learning research is moving in, even though they have arguably equally terrifying connotations for privacy and human rights.

But in an age where all sciences are increasingly becoming more computational and data-driven, 'machines that learn' open up the future to beyond fathomable. We should be prepared for the possibility of much more extreme futures, not only through incremental change to existing technologies as mentioned above, but radical changes to what we cannot even imagine. Perhaps we'll be 'driving' around in 'bio-vehicles' fuelled by photosynthesis. Or perhaps we'll genetically engineer ourselves to photosynthesise. No more need for food, or steak. Sunbathing could not only give us all the energy (and stabilisation of entropy) that we need, but we could maybe even engineer it so that it tastes good, better than the finest steak, but without the carbon footprint. In fact, since we'll be photosynthesising, we'll be converting carbon dioxide into oxygen, and we could be directly offsetting the carbon footprint of our other industries!

Of course I don't actually believe this will happen. One doesn't need to have a lot of foresight to realise how ridiculous this is. Both in terms of scientific plausibility, and in it's optimism. But I will not be surprised, if attempts are made in this direction some day. Perhaps a slightly more plausible idea, is that maybe one day in the mid-to-near future, we'll figure out how to genetically modify ourselves to boost our intelligence. Perhaps a medical procedure carried out in the early days of pregnancy can catapult an embryo's potential future cognitive capacity

to many-times that of the smartest people to have ever lived. Imagine the state of the world then, when designer parents can boost the IQ of their designer babies to well over 300 (if IQ still is a valid metric by then). Also imagine, that this procedure is tightly controlled, and incredibly expensive, available only to an elite super-rich.

I'm not for one second proposing that any of these particular scenarios are likely to happen. They may very well defy the laws of physics and biology, and no amount of technology can change that. But I have no doubt, that similar technologies and discoveries that sound 'outrageous' or 'ridiculous' to us now, will become a reality in the near future. These will be technologies and discoveries that sound as ridiculous to us now, as it was ridiculous to claim to someone in the 19th century that one day humans would be walking on the moon; or that we would send a flying robot through space for 6.4billion km, catapulting itself around planets for over 10 years, to land on a tiny rock hurtling through space at 135,000 km/h.

We have no idea what the limits of what machine learning can achieve. But we should be prepared for such – or arguably more – unexpected and radical developments in the mid-to-near future. And whatever technological breakthroughs await us, it's safe to assume that machine learning will play a significant role in at least some, if not most of them. While it's difficult to predict right now exactly what is possible and what the future holds, a useful rule of thumb is to remember that: If any kind of meaningful information is somehow encoded and hidden in a large amount of data, it's plausible to consider that one day, with the aid of machine learning, we

may be able to extract that information. And while it's tempting to think that this is always a good thing, it may not necessarily always be to the advantage of the greater population or planet.

The most important question amongst all of this is: the people who are designing, developing and deploying these technologies, are they able to foresee the wider social impact of their decisions and actions? Or even if they can foresee the impact, is it aligned with your best interests? Are the decisions they're making in line with a direction that you approve of or desire? What kind of values do these people have? Do they represent you and your well being? This is why it's absolutely essential that these teams have the diversity to represent as wide as possible, a range of both professional and personal experiences, perspectives, values, knowledge and opinions. Everybody's voice is crucial in steering this, so that progress is made, not only in directions that benefit only a few (often at a huge cost to others) while propagating a culture of compliance\cite{Franklin1989}; but in directions that benefit us all.

■ MEMO AKTEN

Referemces

- Angwin, J. et al., 2016. Machine Bias: Risk assessments in criminal sentencing. ProPublica.
- Available at: https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing.

- Arcas, B.A. y, Mitchell, M. & Todorov, A., 2017. Physiognomy's New Clothes. Available at: https://medium.com/@blaisea/physiognomys-new-clothes-f2d4b59fdd6a.

- Intelligence, 134(1–2), pp.57–83. Available at: http://www.sciencedirect.com/science/article/pii/S0004370201001291.

- Crawford, K., 2016. Artificial Intelligence's White Guy Problem. NY Times. Available at: https://www.nytimes.com/2016/06/26/opinion/sunday/artificial-intelligences-white-guy-problem.html.

- Franklin, U., 1989. The Real World of Technology, House of Anansi. Available at: http://www.cbc.ca/radio/ideas/the-1989-cbc-massey-lectures-the-real-world-of-technology-1.2946845.

- Fuegi, J. & Francis, J., 2003. Lovelace & Babbage and the creation of the 1843 "Notes." IEEE Annals of the History of Computing, 25(4), pp.16–26. Available at: https://www.scss.tcd.ie/coghlan/repository/J_Byrne/A_Lovelace/J_Fuegi_&_J_Francis_2003.pdf.

- Hofstadter, D.R., 1979. Gödel, Escher, Bach: An Eternal Golden Braid, Basic Books. Available at: https://prelectur.stanford.edu/lecturers/hofstadter/excerpts.html.

- Hu, P. & Ramanan, D., 2017. Finding Tiny Faces. Conference on Computer Vision and Pattern Recognition. Available at: http://arxiv.org/abs/1612.04402.

- McCorduck, P., 2004. Machines who think, Natick, MA: A K Peters, Ltd. Available at: http://www.pamelamc.com/html/machines_who_think.html.

- Miller, B. et al., 2014. I know why you went to the clinic: Risks and realization of HTTPS traffic analysis. International Symposium on Privacy Enhancing Technologies Symposium, pp.143–163. Available at: http://www.dailycal.org/2014/06/26/research-shows-analysis-encrypted-web-traffic-can-reveal-personal-details/.

- Musk, E. et al., 2017. Killer robots: World's top AI and robotics companies urge United Nations to ban lethal autonomous weapons. Available at: https://futureoflife.org/2017/08/20/killer-robots-worlds-top-ai-robotics-companies-urge-united-nations-ban-lethal-autonomous-weapons/.

- Pugh, G.E., 1977. The Biological Origin of Human Values, Basic Books. Available at: http://onlinelibrary.wiley.com/doi/10.1002/1098-2337(1980)6:3%3C235::AID-AB2480060305%3E3.0.CO;2-T/abstract.

- Silver, D. et al., 2016. Mastering the game of Go with deep neural networks and tree search. Nature, 529(7587), pp.484–489. Available at: http://www.nature.com/doifinder/10.1038/nature16961.

- Singh, A. et al., 2017. Disguised Face Identification (DFI) with Facial KeyPoints using Spatial Fusion Convolutional Network. IEEE International Conference on Computer Vision Workshops (ICCVW). Available at: http://arxiv.org/abs/1708.09317.

- Svitil, K. et al., 2016. Gravitational Waves Detected 100 Years After Einstein's Prediction. Available at: https://www.ligo.caltech.edu/news/ligo20160211.

- Taylor, L., 2012. Observation of a New Particle with a Mass of 125 GeV. Available at: http://cms.web.cern.ch/news/observation-new-particle-mass-125-gev.

- Tufekci, Z., 2015. The Machines Are Coming. NY Times. Available at: https://www.nytimes.com/2015/04/19/opinion/sunday/the-machines-are-coming.html.

- Turing, A., 1948. Intelligent Machinery, a heretical theory, Available at: http://www.alanturing.net/intelligent_machinery/.

- Turing, A., 1950. Computing Machinery and Intelligence. Mind, 59(236), pp.433–460. Available at: papers2://publication/uuid/E74CAAC6-F3DD-47E7-AEA6-5FB511730877

- Wu, X. & Zhang, X., 2016. Automated Inference on Criminality using Face Images. arXiv preprint arXiv:1611.04135. Available at: http://arxiv.org/abs/1611.04135.

- Zhao, M., Adib, F. & Katabi, D., 2016. Emotion Recognition using Wireless Signals. Proceedings of the 22nd Annual International Conference on Mobile Computing and Networking, pp.95–108. Available at: http://news.mit.edu/2016/detecting-emotions-with-wireless-signals-0920.

Drawing   **Drawing / Los Angeles Style**   **Drawing / Venice Style**

Milan   **Milan x Los Angeles**   **Milan x Venice**

Workshop at OpenDot Lab - Highlights

MACHINE LEARNING FOR ARTISTS

Lessons from one year of workshops

by Gene Kogan

Over the past year, I've been teaching a workshop I've usually called "machine learning for artists" which is also the name of a free, online book I'm building with collaborators, containing supporting materials and educational resources about a subject I've been interested in for a long time which has received a groundswell of public interest in the last two years. I've been very lucky to be able to

turn this into nearly a full-time job. I didn't intentionally set out to do that, but each workshop seemed to bring about another invitation for one elsewhere. Over the past 14 months, 29 workshops have been organized, taking place collectively over 76 days and roughly 500 hours in session, not counting the hours of spontaneous hacking which would occasionally follow. Many of them have been co-

taught with friends and collaborators [1][2][3][4][5][6], steering into numerous subtopics and application areas. Three were recorded and published online, to go with the screencasts I posted from a class of the same name I taught at the ITP program at NYU last year, the first of its kind that I did.

Workshops have varied considerably

in duration and location. In one organized with School of Machines in Berlin, we met every day for a month, whereas others were scheduled over just a few hours in a day. They've taken place at universities, companies, makerspaces, conferences, festivals, and occasionally even outdoors (when the weather permitted).

Some were decidedly high-level, focused on conveying the theoretical and mathematical foundations of the research to a more general audience, or examining the social dilemmas posed by our increasing integration of these technologies into everyday life. But most workshops have emphasized making and hacking, appropriating these methods into the areas that participants care about, and encouraging a more active and personal engagement with the tools themselves. From design to architecture to music and many others, the applications within creative domains are numerous, diverse, and growing continuously.

This emphasis on hands-on experimentation has led to a virtuous circle, whereby workshops have fed back into the development of ml4a's tools, culminating in a recent beta release of nearly 30 standalone applications which handle common machine learning tasks. These generic tools help enable students to build prototypes much more rapidly, even if they have little or no prior coding experience. I'm always amazed to see what people of varying backgrounds, interests, and skillsets cook up with them, applying them in ways I would have never dreamed up myself. Last month during a workshop at Copenhagen Institute for Interaction Design co-taught with Andreas Refsgaard, the students—in groups of three—managed to build from scratch a collection of mature

projects that last year I wouldn't have believed possible to finish in just a few days of practice.

STRATEGIC UNPREPAREDNESS

Early on, my workshops were planned carefully to be as prepared as possible to make the most use of the always-too-little time we had. As I got used to doing them, I began to loosen up, so as to let sessions go in the directions that students favored, something which neither they nor I could easily anticipate ahead of time. I began modularizing my teaching materi-

als—both the presentation slides and software—into interconnected nodes, likening them to a graph through which we could find a path most suitable to their impulses, frequently leading into unforeseen territory. For example, demonstrations of computer vision software would unexpectedly provoke a spirited debate over ethics in machine learning, or a review of recent research papers would lead to speculation over potential art applications. One of the most serendipitous instances of this occurred during a workshop at OpenDot Lab in Milan last November. Literally minutes be-

fore the second session began, I read news about the now-famed pix2pix paper and codebase by Phillip Isola et al, which had just been publicly released the day before. I was so excited about it that I scrapped that morning's plans and showed pix2pix to my students instead, sparking a brainstorming session that would lead to the spontaneous creation of a collaborative artwork we called Invisible Cities, in which we used pix2pix to generate satellite imagery and transfer the style of one city onto another.

TALKS AS TINY WORKSHOPS

Over the same timeframe, I've also given almost as many "talks," by which I mean a lecture of no more than an hour, although with the shortest workshops being only 3–4 hours themselves, the distinction is not always so clear. The lines are further blurred by running my talks from the same custom application I wrote to teach my workshops with. Built on top of openFrameworks along with some C++ deep learning libraries [1][2], some of my "slides" are actually self-contained real-time demos, interactively showing how to do things like identify objects in a camera feed and retrieve similar items, arrange and visualize large datasets of images and sounds, depict the internal states of convolutional networks, train your own to make music and play video games, and many others. By injecting my talks with fun demonstrations of these tools, I start to think of them as very short workshops in and of themselves, encouraging attendees to actively pursue a deeper study of the

subject afterwards.

ASPIRATION VS. QUALITY OF LIFE

As a personal aside, the workshops have taken place in many different cities around the world, allowing me to travel to places I had never been to before, make many new friends, and meet in-person with people whom I had only known through the internet before. But they've not been without some drawbacks. They require a lot of preparation and continual maintenance, taking time away from my own research and art practice, and have made it harder to pursue longterm commitments planted in one physical location. The lack of major institutional support means I am responsible for most of the administrative overhead as well, and I'm liable to losing entire afternoons just trying to keep track of my own invoices. The constant travel, although rewarding, can be draining as well, and I usually make very little time for sightseeing. On one trip to teach a workshop at Parsons New School in Paris, where I had never been before, I only managed to visit the Eiffel Tower in a mad scramble on my way back to the airport.

SUSTAINABILITY AND FUTURE PROSPECTS

The fees from the workshops have accounted for most of my income this year, allowing me to keep ml4a a free project—not only free in terms of costs, but free of obligations that could compromise its accessibility, openness, and respect for movements I support [1][2]. This is the most chal-

I'M LOOKING INTO WAYS OF EVOLVING THE FORMAT INTO SOMETHING WHICH CAN BE ADAPTED AND REPURPOSED BY ANYONE
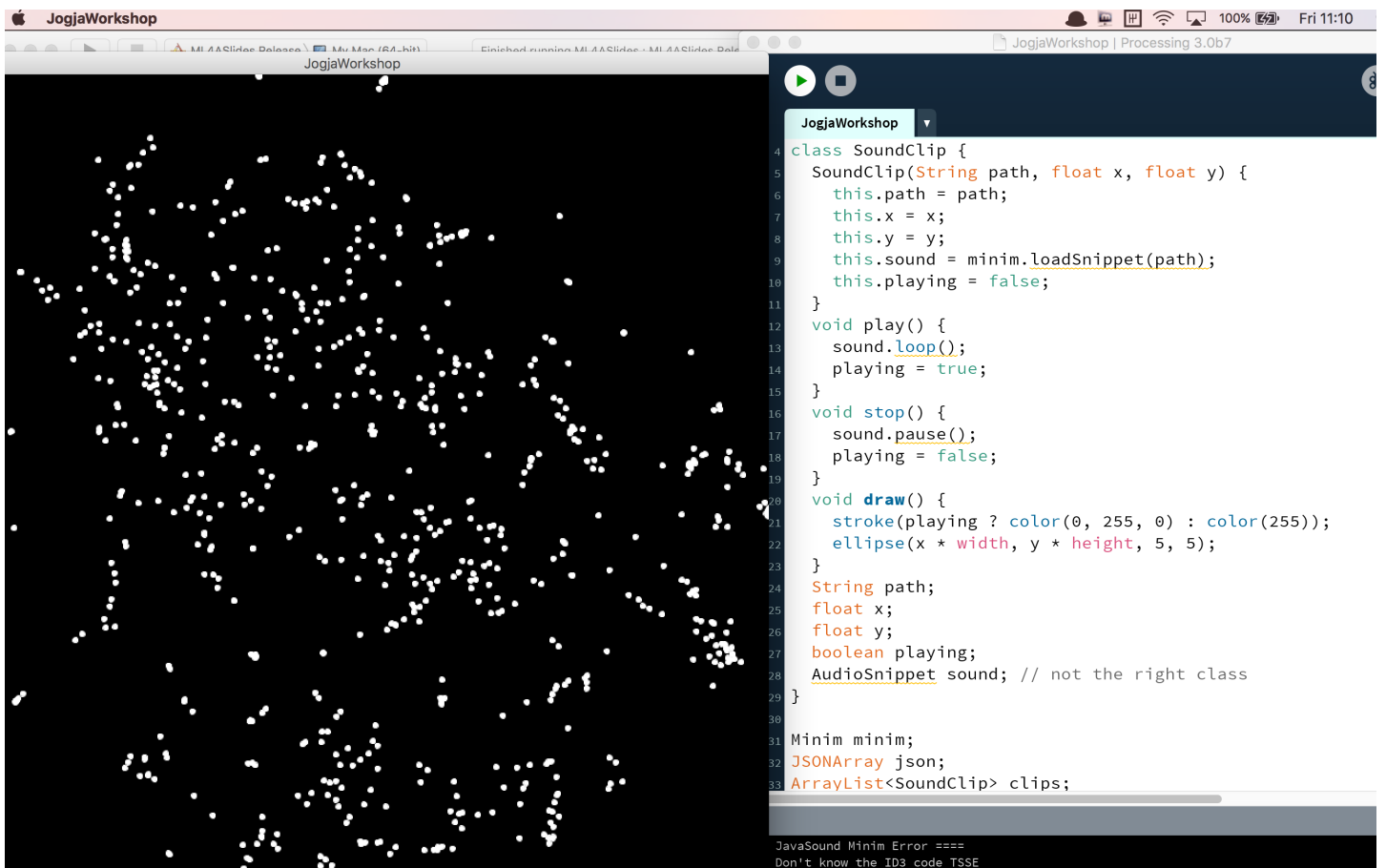
lenging and frustrating aspect of the endeavor, and my stubbornness probably costs me opportunities to expand its scope or reach new audiences. Not every potential contributor has as much privilege to slash and burn through in service of a free project as I do, and I probably spend too much of my time thinking about the next bit of content it needs, rather than its long-term sustainability. But as the book inches closer to a first draft, I'm beginning to consider crowdfunding platforms as a possible first step towards bridging this gap, and am actively seeking out feedback and advice from people with experience in self-publishing.

Additionally, I'm looking into ways of evolving the format into something which can be adapted and repurposed by anyone, and encouraging contributions from more participants in order to facilitate the creation of a common set of baseline tools that are broadly useful for many people. This initiative is inspired by the endless creativity of my workshop participants, and technologists out there more generally. There seems to be an ecosystem forming at the intersection of art and machine learning. The two disciplines bring very different legacies and vocabularies to the table, yet they have much to offer each other.

COMPLEMENTARY PARTNERS

The great paradox of machine learning for artists is its economics. In a field which is booming commercially and industrially, it can be challenging to make the case for spending time on being creative with technology in a way that has few immediate practical benefits, let alone for making "art for art's sake." Pursuing art as a career is difficult for most people; secure aca-

jogja workshop audiotsne

```
class SoundClip {
  SoundClip(String path, float x, float y) {
    this.path = path;
    this.x = x;
    this.y = y;
    this.sound = minim.loadSnippet(path);
    this.playing = false;
  }
  void play() {
    sound.loop();
    playing = true;
  }
  void stop() {
    sound.pause();
    playing = false;
  }
  void draw() {
    stroke(playing ? color(0, 255, 0) : color(255));
    ellipse(x * width, y * height, 5, 5);
  }
  String path;
  float x;
  float y;
  boolean playing;
  AudioSnippet sound; // not the right class
}

Minim minim;
JSONArray json;
ArrayList<SoundClip> clips;
```

```
JavaSound Minim Error ====
Don't know the ID3 code TSSE
```

demic jobs require costly degrees, and the art world lacks the abundance of high-paying jobs that medicine and law can provide to justify similarly priced training. This lack of professional infrastructure leads most engineers and researchers to forgo any such practice, fearing it won't lead to viable employment, a reasonable concern. On the other hand, my own artistic engagement with machine learning has quietly given me real-world experience in computer science, a field I never formally studied. More importantly, it's given me intangible skills that outlive the ephemeral year-to-year overturn of the technology itself. A creativity-driven approach engages people and helps communicate the topic to the general public. At the same time, the vitality of the machine learning sector within industry and commerce could potentially support outlets for people whose curious impulses are stifled by financial barriers. The mechanics of how a partnership between these two fields could work are still fuzzy to me, but the opportunity is impossible to ignore.

TO LEARN SHALLOW LEARNING DEEPLY OR LEARN DEEP LEARNING SHALLOWLY?

Deep learning poses some pedagogical challenges. First, the prerequisite software can be difficult to install, characterized by numerous and sometimes obscure dependencies, unpredictable runtime errors, and instructions targeted towards people assumed to have a background in computer science or software engineering. For those without one, debugging can be very time-consuming if it can't be taken care of in advance, and distracts from the main educational objectives.

Additionally, the software contains few of the high-level abstractions found in creative coding libraries. The algorithms are expertly hand-crafted to effectively do one narrowly-defined task, and do it very well. Thus, it can be difficult to apply the software creatively in ways that are much different from how the original authors already demonstrated them. Furthermore, the computational expensiveness of most deep neural networks makes virtually all real-time applications impossible. A lack of desirable and large enough datasets, memory restrictions, and various other complications reduce it further.

Nevertheless, over the past two years, several developments have emerged which mitigate these difficulties. Software services like docker and paperspace make it possible to prepare and ship learning materials in self-contained modules, and make the needed hardware accessible for a reasonable fee. An explosion of open source sharing has further helped by opening up core implementations of known techniques in tensorflow and

Nabi workshop

torch. This has greatly lessened the burden of overhead in setup, making it a practical component in many courses. Educational resources to get started with machine learning have become ever more abundant over the past two years. Online courses are plentiful [1][2][3][4][5], as are compilations, visual guides, tutorials, and many others [1][2][3]. Although they do not specifically target artists, they are general enough to be applicable across many disciplines. With these trends only accelerating, I've come to believe that it's not only possible, but imperative to make machine learning and AI more democratized in technical, artistic, and creative work. The questions I'm already looking ahead to are how can this project sustain itself into the future? How can it be structured in such a way that participants are incentivized to contribute back to it? Can ml4a evolve toward something like a blueprint or a kit, which others can freely unpack to organize their own workshops in their own communities? If I've learned nothing else from this year, it's that I can't really anticipate what others can build

from these materials. I still don't fully know what this project should become, but I'm open to ideas. Let this reflection be a first step towards finding out.

■ GENE KOGAN

GENE KOGAN

GENE KOGAN IS AN ARTIST AND A PROGRAMMER WHO IS INTERESTED IN GENERATIVE SYSTEMS, ARTIFICIAL INTELLIGENCE, AND SOFTWARE FOR CREATIVITY AND SELF-EXPRESSION. HE IS A COLLABORATOR WITHIN NUMEROUS OPEN-SOURCE SOFTWARE PROJECTS, AND LEADS WORKSHOPS AND DEMONSTRATIONS ON TOPICS AT THE INTERSECTION OF CODE AND ART. GENE INITIATED AND CONTRIBUTES TO ML4A, A FREE BOOK ABOUT MACHINE LEARNING FOR ARTISTS, ACTIVISTS, AND CITIZEN SCIENTISTS. HE REGULARLY PUBLISHES VIDEO LECTURES, WRITINGS, AND TUTORIALS TO FACILITATE A GREATER PUBLIC UNDERSTANDING OF THE TOPIC.

SHARED ARTIFICIAL INTELLIGENCE

Toaster (addicted product - Simone Rebaudengo)

by Alessandro Masserdotti

Keytweeter - Kyle Mcdonald

In recent years, I have often had to reflect on the future development of interconnected objects and their implications and consequences at a social, ethical and political level.

The world of connected objects is rapidly expanding and there will soon be a need for artificial intelligence capable of governing this multitude of objects.

What follows is a brief summary that puts in line thoughts and reflections arising from the first edition of the talk "IoF - Internet of Furniture", organized in the occasion of Milano Design Week 2017 by Opendot in collaboration with the German interaction design studio IXDS.

Nowadays we are accustomed and at our ease, sometimes even unconsciously, to share part of our lives online through everyday tools such as social networks and google maps, which trace our movements generating a flow of data. This sharing represents our way of living, moving, buying and preferring. We constantly leave a trace of what we do and where we are. This generates a fragmented identity that represents our digital life.

My brief reflection on the subject starts with a provocative question that has to do with data, privacy and the consequences of sharing our lives online, inspired by the works of Kyle Mcdonald like keytweeter.

What if everything were completely open?

What could happen if everyone had access to everyone's information? Literally everything, I mean user IDs, passwords, web histories, banking activities, emails, etc. that is to say, everything related to our digital identity and not just what we consciously share on social networks.

Could there be a benefit for the individual and the community, rather than just for the companies that currently hold these data?

We would all have the potential to be "controlled", we would all have access to everyone's digital activities, we could all take possession of each other's identity.

It would indeed be a big problem, but if everything were really completely

open, a malicious person would in turn be "seen and spied on", and probably more reluctance or a large number of detractors who would report his actions as incorrect.

I know, it is an anarchic-futuristic hypothesis but, at least on paper, I would not take it for granted that it would not work.

In the IT field, we already have a very good example of how open source has been an innovation engine. The fact that many developers release their source code is an unprecedented innovative boost.

The Internet does exist and its existence is 70% based on open and public source codes.

Let's try to apply this perspective to objects, connected, with open and shared data.

Let's give an example linked to the theme of IoT and open source.

"Brad" - The shared toaster is a 2012 project by an Italian designer, Simone Rebaudengo (https://vimeo.com/41363473), who designed a toaster with a personality, interconnected and in constant dialogue with its peers.

I think this project is instructive from many points of view, the first concerns the way we interface with Brad. We users use Brad as we have always done with all other toasters, without the need to learn a complex operation or having to enter custom parameters for toasting bread. But Brad is an interconnected object that communicates with other toasters.

The objective of the project, ironic

and speculative, is the implication of the initiative, better said agency, by the objects, and their ability to perform smart actions regardless of our commands. The Brad toaster decides how to behave autonomously on the basis of the data he collects and shares with other toasters like it.

The object in itself does not belong to me, but on the basis of data of use and exchange of information with other objects like it is able to move and move around the place where it is most needed.

This is to say that IoT products must, or should, be objects that do not interact directly with people, that do not require us to interface with them, and above all they don't interface with us even when we do not want it! Today we are more than ever bombarded with notifications between mail, chat, social networks, and we don't need more alerts. We do not need a refrigerator that warns us

when tomatoes are missing, for example. Objects should have their own life, autonomous and detached, they should be able to interact with each other and not be designed for them to seem human, carrying out actions on our behalf.

The real innovation would be to maintain a normal and fluid interaction between man and product, where the object is able to acquire its own autonomy to manage smart and automated actions, regardless of the will of man.

A practical example: we all have a box of medicines at home, how many of these packages have expired or are about to expire? We assume that our neighbour needs precisely that medicine that is about to expire on our shelf, a hypothetical "IoT Medicine Box" could communicate with other "IoT Medicine Boxes" in the neighborhood to indicate the availability of that medicine to those who need it at that precise moment.

Another example, more immediate and increasingly topical: let's think about what would happen if each city were equipped with self-guided cars capable of moving by themselves, which learn to move from one part of the city to the other at specific times according to the request and routines of the citizens. It would be a revolution on multiple scales as well as urban, environmental, social and economic one. The vision of the IoT is towards a future in which objects are interconnected, able to dialogue and share data making them public and usable to all, for what we could call a Shared Artificial Intelligence. Artificial intelligence should be thought not as a substitute, but rather as something complementary to human intelligence.

LiftBit, digitally-transformable sofa by Carlo Ratti Associati & Opendot
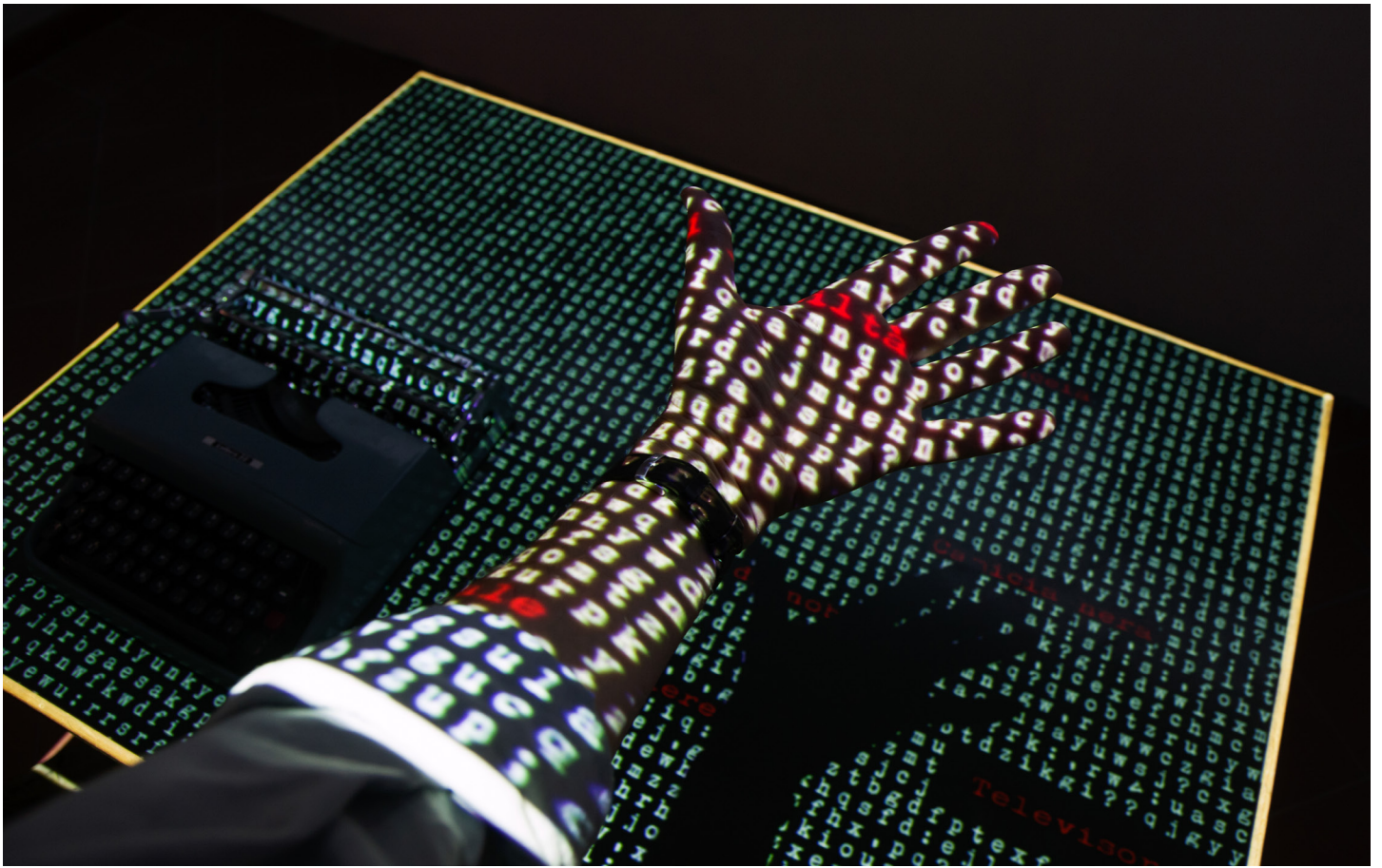
Museo Archivio dei Diari, installation by Dotdotdot

Even today, however, despite the not always satisfactory results, all research is trying to emulate the brain and human behaviour. Perhaps the question we should ask ourselves is: "What do computers and machines do better than us?" This is what research should focus on today: on the implementation of computer systems, on the development of machines and systems capable of establishing and maintaining multiple and synchronous relations with tools, objects, products, things, to control a large amount of data, rework them and compare them with others. The objects would thus acquire autonomy and an "own life", optimizing resources and helping us in our daily actions, but without interfering or changing our regular human habits.

In short, it doesn't matter if in the future we will have a computer capable of telling us good morning, it would be more useful to have a washing machine that is able to decide autonomously when to activate itself according to the energy availability of the electricity grid, perhaps agreeing with the other washing machines in the neighbourhood to decide the most efficient moment of the day to carry out the washing, beyond the will of its owners.

■ ALESSANDRO MASSERDOTTI

ALESSANDRO MASSERDOTTI

ALESSANDRO MASSERDOTTI IS ONE OF THE FOUNDERS OF DOTDOTDOT, A MILAN BASED STUDIO OF EXHIBITION AND INTERACTION DESIGN. HE STUDIED PHILOSOPHY AND SINCE 1996 HE WORKS AND PLAYS AROUND WITH PHOTOS AND VIDEO, IN 2002 HE STARTED WORKING ON INTERACTIVE AND SENSIBLE SPACES, ESPECIALLY MADE WITH VVVV, UNTIL RIGHT NOW. ALONG WITH HIS PROFESSIONAL JOB HE IS USED TO TEACH AT UNIVERSITIES AND AT DESIGN SCHOOLS IN MILAN AND ABROAD. HE LIKES TO RESEARCH AND EXPERIMENT, HE PARTICIPATES, AS DOTDOTDOT, AT SHOWS AND EXHIBITIONS IN ITALY AND ABROAD. HE LOVES TO WORK IN TEAMS WITH MULTIDISCIPLINARY PEOPLE SHARING EXPERIENCE AND KNOWLEDGE

"Counter" installed in Aarhus, Denmark (© 2011, G. Drake-Brockman)

MIRRORBEINGS: ROBOT COMPLEXITY, MYTHS, AND SIMULACRA

by Geoffrey Drake-Brockman

This paper traces a speculative journey investigating the nature of "created beings" or "mirrorbeings" – machines that we make as reflections of ourselves.

ROBOT FLOWERPOTS

An origami "chatterbox" is a commonplace object. The chatterbox is familiar to us as a simple paper-folding project and as the basis for a popular children's fortune-telling game. I became interested in the chatterbox because of its universality and the intriguing lateral-shift spatial transformation it performs when operated with two hands and used in fortune-telling mode. By attaching this paper origami element to an electromechanical actuator I accidentally produced an alternate sudden inversion spatial transformation that is analogous to the transition of a flower from bud to bloom. Further development from this starting point yielded a fully robotized flowerpot. This flowerpot has a mirrored upper plate through which emerges a cloth-covered telescopic stem. When activated,

the stem grows one metre vertically before the green origami bud atop it suddenly blooms into a pink and yellow origami bloom – whilst producing a distinct "wap" sound. Soon afterwards, the bloom withers back to its flowerpot and returns to a bud state.

Floribots is an interactive collective organism consisting of 128 of these robot flowerpots with appropriate networking, electronics, sensors, and control software – it is a kind of robot garden bed that combines the familiar and comfortable chatterbox motif with a "spooky" manifestation as a huge (8m x 4m) mechanical floral arrangement that "watches you" and constantly reconfigures itself. Conceptually, Floribots was intended to stage a real-world encounter between its audience and a kind of "sci fi" tableau of co-operating mechanical plants - while provoking in the observer hopefully equal measures of disquiet and attraction.

When writing the software for the Floribots "hive mind" I drew on aspects of the behavior of my then-toddler-aged children. Accordingly, Floribots was programmed to exhibit different "moods" including the following: Reactive, Excited, Bored, Naughty, and Sleepy.

Floribots was first exhibited at the National Gallery of Australia in 2005 where it interacted with an audience of some 100,000 visitors over a four-month period. In practice, the behavior exhibited by Floribots seemed to me much more complex than its predefined moods and the transitions between them that I had programmed. Sometimes mood behaviors effectively partially overlay each other,

creating new choreographic modes, whist the sound compositions played by an orchestra of 128 "wapping" paper flowers were entirely novel. The interaction between the work and its audience proved to be intense. I observed people lingering near the work for long periods and found that they would refer to the actions of Floribots as though it was a "being", rather than a mechanical arrangement of components. Floribots was voted "Peoples' Choice" of the National Sculpture Prize in 2005. It was the first time that I had made a "popular" artwork - seemingly almost by accident.

I understood the role of the commonplace object, the origami chatterbox, in making Floribots accessible to its audience - this was an intentional device. However, I felt the engagement that the work engendered with its audience via its novel behavior-patterns required more explanation. I wondered if these behaviors could be understood in terms of "Complexity Theory" (Gleick 1988). Complexity Theory investigates how relationships between parts of a system give rise to the collective behavior of that system. A sufficiently complex system can sometime self-generate novel behaviors through a process called "emergence". Along these lines, it seemed that the overall "phase space" defined by Floribots' mechanical, electrical, and software freedoms had given rise to emergent patterns and expressions - effectively allowing a created being to come into existence.

Perhaps, I thought, any sufficiently complex automaton has the capacity

to become a being and exhibit novel behavior…

To analyze Floribots in Complexity Theory terms, I assessed it logically - that is, as a state machine. A state machine is a device with a calculable number of discreet possible conditions. Floribots has 128 flowerpots, which can be independently switched between bloom and bud modes. Thus, Floribots can be regarded as having 2^{128} (circa 10^{38}) potentially different states. Given its order of complexity of 10^{38} - corresponding to many trillion trillion trillion trillion states, I postulated that the shear extent of this complexity was the root cause of its novel (emergent) "being-like" behaviors and resultant intense levels of audience engagement.

COUNTING

After my experience with Floribots, I decided to create a new automatous artwork with much less inherent complexity - to see if emergent behavior still manifested. The work I developed was called simply "Counter" and was completed in 2009.

Counter is an interactive installation in the form of a large yellow pedestrian portal that literally counts each person that walks through it. Counter has nine magnetically-actuated digits on its front and back faces and is capable of counting to one less than a billion, after which it clocks-over and returns to zero. Each time Counter's number changes; a distinct "thwack" sound is made as its magnetic display segments flip over.

FLORIBOTS IS AN INTERACTIVE COLLECTIVE ORGANISM CONSISTING OF 128 OF THESE ROBOT FLOWERPOINTS

Apart from its role in mapping the possibilities of mirrorbeings, the concept for Counter arises from the imperative to "be counted" or "make sure you count" that is part of liberal democratic cultural heritage. In addition, the work carries more unsettling overtones of surveillance and scientific measurement. Counter exists to perform a commonplace and straightforward act; to count. It also employs another commonplace, highly accessible, motif - in terms of being, in terms of form, a simple "doorway".

Counter has 10^9 potential states, making it hugely less complex than Floribots as a state machine. In addition, unlike Floribots - which can transition between states in multivalent and open-ended ways - Counter has only one transition available: "to increment". Despite being crippled in terms of its relative complexity, Counter has proven surprisingly capable of engaging its audience. The work has been installed four times in temporary outdoor exhibitions, three times in Australia and once in Denmark. Each time the work has counted around 2 to 300,000 pedestrians, with its final installation at Bondi in Sydney taking it over one million aggregate interactions.

Two arguably emergent behaviors have manifested repeatedly in all four of Counter's installations; phenomena which I term the "pedestrian vortex" and the "decimal effect". A pedestrian vortex forms when a group of people form a circular queue to continuously file through Counter's archway and keep it "clocking over" as it counts each individual over and over again. It turns out that being counted repeatedly is sufficiently attractive for this formation to spontaneously
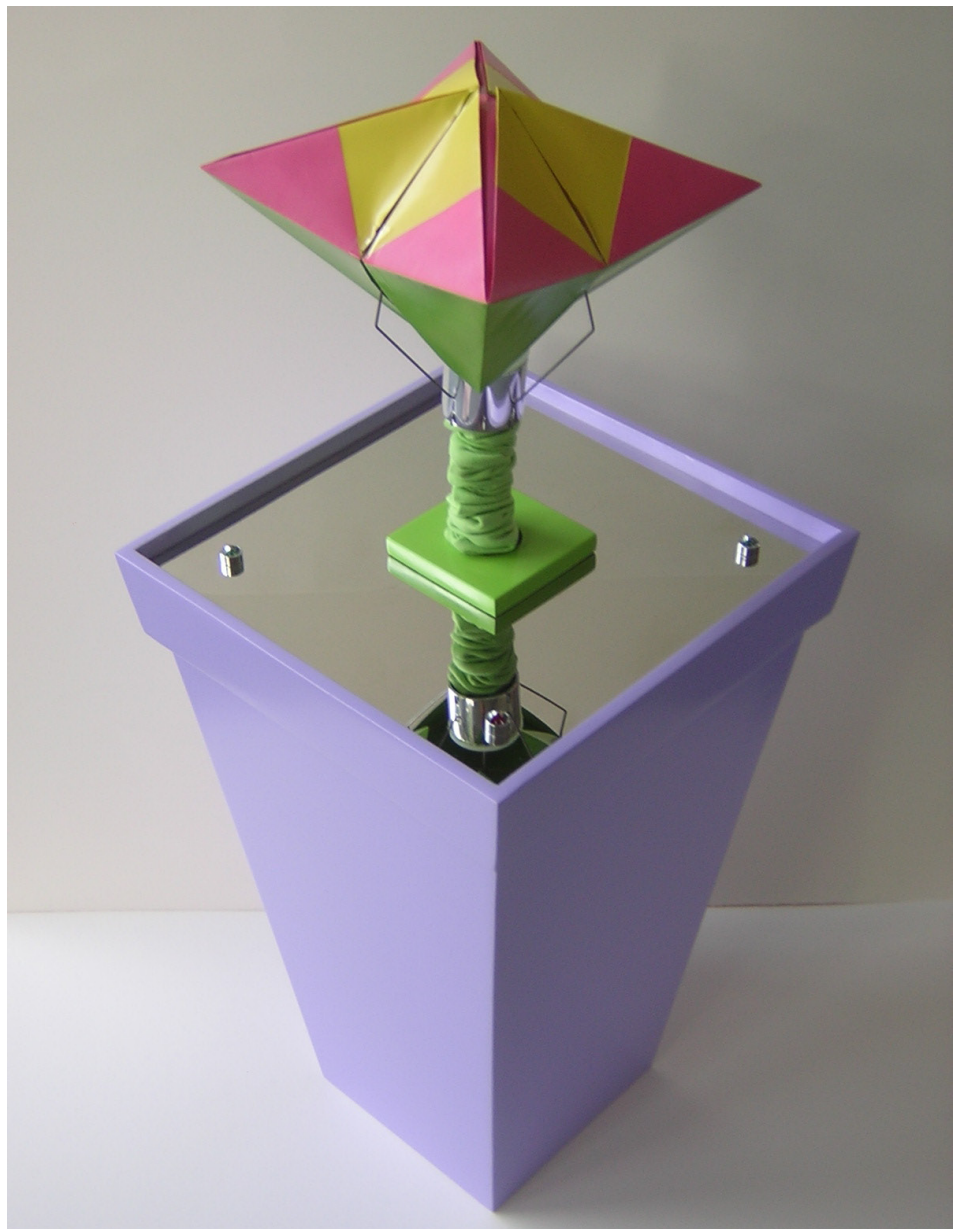
Prototype robotic origami flowerpot (© 2005, G. Drake-Brockman)

occur every time that Counter has been exhibited. The decimal effect is a heightened level of crowd engagement and excitement as Counter approaches a large power-of-ten clock-over point, such as 10,000 or 100,000. At such moments some jostling to "be the one" occurs and a loud spontaneous cheer will typically arise from the audience.

I think that the most interesting, possibly emergent, behaviors of the Counter installation are not its mechanical state changes in isolation, but the combination of these transitions

with audience behaviors. Thus, the true complexity of the created being system includes not only the 10^9 states inherent in Counter's electronics but the much larger "phase space" of its 300,000-per-exhibition human audience. The ultimate complexity of such an automatous artwork becomes difficult to fix, given the demonstrated capacity of Counter to "grow" its phase space by absorbing state-potential from its human audience.

Based on my experiment with Counter, I conjectured that even simple automata have the propensity

"Floribots" responding to its audience (© 2005, G. Drake-Brockman)

to "borrow" additional state-potential from their audience, so that they too can achieve emergence.

BINARY AUTOMATA

If an automatous artwork as simple as Counter can develop emergence, how simple can the system get, while maintaining this propensity? To investigate, I decided to address the logical limit of state machines. Accordingly, the next work in this series, titled "Clockwork Jayne" has just two states.

Clockwork Jayne consists of a life-size fiberglass ballerina figure mounted on a faceted mirror base enclosing a clockwork mechanism that can rotate her. Clockwork Jayne was modelled on prima ballerina Jayne Smeulders of the West Australian Ballet, who heroically posed for over three hours standing "en pointe" while a full body-cast was made. When this work's clockwork mechanism is wound up,

the ballerina pivots slowly and a tune plays quietly until the spring winds down. The work draws on another commonplace motif; children's clockwork music boxes with ballerinas that pop-up and spin in front of a mirror when you open the lid. As a simple rotating clockwork, this automaton has just two logical conditions: wound-up, and unwound.

When Clockwork Jayne was exhibited, despite her extreme simplicity as a state machine, yet another self-generating audience behavior was apparent: Clockwork Jayne would prompt her gallery audience to form into an orderly queue – a long line of people patiently waiting for the experience of winding her up and watching her gradually unwind.

In observing this binary automaton, with a level of inherent complexity surely too low to permit emergence from within, I still noted an artwork/

audience interaction that was arguably emergent. My interpretation, consistent with my earlier conjecture, is that artworks are able to grow behaviorally by acquiring state-potential from their human audience.

The motivation for humans making their state-potential available to an automaton, however, requires further explanation. In the case of Counter the act of enumeration itself seems sufficient to prompt deep audience engagement with an abstract, conceptual work. I see a parallel with the use of a commonplace motif in Floribots; just as flowerpots are familiar and attractive, so is the very act of counting. It seems that humans are generally attracted to automata based on commonplace motifs and motivated to share state-potential with them. In the case of the ballerina automaton Clockwork Jayne however, my view is that it's principally the device of anthropomorphism that binds the audience

"Counter" with a "pedestrian vortex" (© 2011, G. Drake-Brockman)

so closely to these human-shaped artworks. Humans are universally attracted to representations of themselves, and the intensity of this reaction is magnified exponentially when the representation moves, and even more importantly reacts to them. With the boost provided by anthropomorphism, it seems that even binary automata can achieve emergence.

VARIABLE RELIEF

Having explored the limit of low-complexity automata, an alternate wing of investigation suggested itself – that of automata even more complex than the 2^{128} states of Floribots. Accordingly, I created a "spatial robot" called "Headspace".

Headspace draws on the ancient art-form of relief sculpture, but updates the traditional carved stone format to a matrix of 256 motorized polished aluminum rods. Each rod can independently move back and forth by about half a metre, allowing the overall grid to assume a wide range of relief topologies. Headspace is effectively a "variable relief" sculpture.

Headspace is fully autonomous; possessing four motion sensors with which to detect human presence and an on-board software algorithm to regulate its behavior. This Headspace "mind" is loaded with three-dimensional scan data from the faces of over 600 schoolchildren, and the rod matrix is able to adjust its relief profile to represent these faces, as well as morph between them and perform various geometric transitions. As a variable-portrait system, Headspace is capable of human representation - like Clockwork Jayne – and thus is also, in a sense, anthropomorphic.

Headspace is vastly more complex than Floribots. Each rod in the Headspace matrix may be moved between 256 discreet positions, so the overall system has 256^{256} or about 10^{616} states! When Headspace was placed on permanent exhibition at Christ Church Grammar School (Perth, Australia), I noticed novel, unanticipated behaviors manifesting in terms of interference between its disparate subsystems, and apparent layering of algorithmically discreet matrix behaviors. So Headspace also exhibits emergent behavior - as we may have expected

given its very high level of complexity. In addition, Headpsace has proven to be exceptional in terms of its audience engagement, although mostly online. In fact, more than 160,000 people have viewed the Youtube video of Headspace – considerably more than have physically attended any of my gallery exhibitions.

COSMIC CONNECTIONS

Although Headspace is a permanent installation, it is located inside a building and its physical audience is restricted to students and staff at one particular school. I speculated that there could be other audiences and sources of state-potential available to a suitably optimized robotic artwork. The opportunity to investigate this possibility arose with a commission to create an external artwork for the NEXTDC Data Centre, in Malaga, Western Australia. The resulting work is titled "Readwrite" - and is activated by stimuli of primarily extra-galactic origin.

Readwrite is an autonomous robotic artwork some 10m in length, with 24 pneumatically-actuated "flipping" elements arranged in a grid, mounted on the front elevation of the data center. Motion sequences on Readwrite are triggered by the detection of charged "muon" particles. Muons are terrestrial cosmic rays generated in the upper atmosphere by interactions with high-energy particles originating from distant supernovae and the accretion disks of supermassive black holes in active galactic nuclei. Readwrite has four muon detectors – with one mounted at each corner of the artwork. When a "cosmic ray" hits one of the corners of the piece, a propagating wave of flipping elements begins from that point.

The Readwrite control algorithm is based on a heavily modified version of the Floribots code-base, and retains elements of the emotional modes of that work - which were originally modelled on the behavior of my sons at toddler-age. Given this, although Readwrite is lower in complexity at a mere 2^{24} or ~10^7 states, it is not surprising that some of the propensity for emergent behavior first noted in Floribots remains evident. Indeed, Readwrite has been observed to perform overlapping choreographies and mid-flip reversals which can be interpreted as emergent behavior patterns. In terms of audience reaction, Readwrite's location - high on a building on an arterial road in an industrial precinct - means that little local impact is readily apparent - bar the occasional car slowing down to get a better view. Thus, it seems that Readwrite is unlikely to be able to borrow much state-potential from its human audience. However, perhaps its ultimate complexity as an automatous system extends to its network of extra-galactic connections - which could give rise to considerable additional emergent potential. A caveat however, is that the cosmic conversation in which Readwrite is involved is fundamentally reactive rather than interactive in character - due to large distances (millions of light years) extending the feedback time from its extra-galactic interlocutors beyond the likely endurance of the work.

ROBOT MYTHOLOGIES

I noted previously that the Clockwork Jayne, and Headspace automatous artworks employ the compositional device of anthropomorphism – that is, they mimic the physical appearance of a person. Extrapolation beyond the notion of anthropomorphism led me to wonder what it might be like for a created being to not just look, but to be, like a person - to delve into the realm of the "anthropo-onlological". I anticipated that even deeper levels of audience engagement should be possible with this approach, with yet greater potential for human phase space to be "shared" with an automaton. I decided that an investigation of this possibility would best be made via an ongoing dialogue between a real person and a made person - somewhat in the tradition of a Turing (1950) Test. I have collected a set of pre-existing frameworks for such conversations that I call "robot mythologies".

My list of candidate robot mythologies includes widely known stories about made beings, such as: Mary Shelly's (1818) Frankenstein - the creature who becomes jealous of its creator; Pinocchio (Collodi 1883) - the wooden boy who wants to be real; Rachel - the replicant who thinks she's a real woman (Dick 1968); Terminator - the robot from the future that becomes a surrogate father figure (Cameron 1984); Golem - the clay being from Jewish mythology that is animated by an inscription but cannot itself talk; the Tin Man - who yearns for a heart to fill his empty chest (Baum 1900); and the robot doppelganger of Maria who unleashes lust-driven chaos and stirs dissent throughout Metropolis (Lang 1927).

Perhaps the most emotionally-charged robot myth is Coppelia, as it deals specifically with romantic love and attraction. Coppelia is a story about a clockwork girl, who is mistaken for a real girl by a boy who falls in love with her.

The story thickens further when the clockwork girl is in turn impersonated by a real girl, jealous of the boy's affections. Coppelia is a ballet, with music by Saint-Léon, Nuitter, and Delibes, based on a story by Hoffmann (1817). It was first performed in Paris in 1870, and since then has become part of the classical ballet repertoire and is staged frequently by ballet companies around the world. Because the Coppelia story deals with issues at the edge of humanity - machines interchangeable with persons, love and attraction in flux at this boundary - I decided it was fertile ground on which to develop an automatous artwork dealing with the crux of the created being issue.

PERHAPS THE MOST EMOTIONALLY-CHARGED ROBOT MYTH IS COPPELIA, AS IT DEALS SPECIFICALLY WITH ROMANTIC LOVE AND ATTRACTION

THE COPPELIA PROJECT

The Coppelia Project involves the creation of a troupe of four life-size autonomous robot ballerinas who are able to learn and perform dance movements and interact with each other and their audience. The Coppelia Project is inspired by the story of a clockwork girl in the ballet Coppelia, whilst also drawing on the commonplace metaphor of clockwork music boxes, like the Clockwork Jayne artwork.

The Coppelia Project robots are optimized narrowly as ballerina robots or "dolls". They can spin "en pointe", while moving their, arms, head, and waist. However, they cannot walk and their hands do not have grippers to pick things up. The Coppelia Project dolls are taught ballet movements

"Headspace" depicting a facial profile (© 2010, G. Drake-Brockman)

by having their arms, head, and torso physically moved through a ballet sequence by a ballerina trainer. An onboard computer captures the motion so it can be replayed later in various dance move combinations. Realization of The Coppelia Project required custom-developed electronics and software to enable real-time ballet motion capture and replay – a solution for this requirement was developed and integrated with the assistance of roboticist David Veerman.

The mechanical articulation of the Coppelia dolls was the result of an extensive research and development exercise undertaken with Jayne Smeulders of the West Australian Ballet. Jayne assisted in establishing the biodynamic requirements for ballerina movement by demonstrating the classical ballet positions (fig 10) and the paths of the limbs in transition between these states. Jayne also acted as the model for the robots, each of

whom shares her body shape and facial appearance.

In terms of its complexity, The Coppelia Project has quite a large phase space and thus ample potential for emergence. Each of the four dolls has 18 independent axes with 12-bit position resolution on each, allowing $4,096^{72}$ distinct conditions of the system - which equates to 2^{864} or about 10^{260} states. This is lot more complex than Floribots, but still much less so than Headspace.

My goal with The Coppelia Project is to create "mythically charged" automata – a group of interactive, self-determined, expressive machines – that once set free, operate independently to explore questions at the edge of humanity. Specifically: are machines interchangeable with persons? What are the patterns of love and attraction at this boundary? I see The Coppelia Project as a kind of staged con-

frontation between humanity and its technological alter-ego. The dolls are "blanks" that are energized by their programming to mimic the elegant movements of human dancers, but they are imperfect in their attempts at human grace. Another stark difference between people and robots is that people are unique, while robots are manufactured goods and can be made on a production line. To emphasize this distinction, the Coppelia robots will perform as a group of four identical machines.

Currently, just one Coppelia doll – believed to be the world's first full-size robot ballerina - has been assembled. This first doll – named "Lilas Juliana Areias" (fig 11) - gave her debut solo performance to an audience of special guests at an exhibition at my studio in 2013. Parts for the other three robots are in various stages of assembly, so the piece overall remains a "work in progress". When fully realized, I hope

to use The Coppelia Project as the basis for a yet more ambitious work integrating human and robot dance in a new ballet stage production.

My selection of the Coppelia theme was made decisive by a fascinating aspect of this ballet when viewed on-stage. In a Coppelia production one sees a beautiful and graceful ballerina "hamming it up" to deliberately move like a clunky robot. We know when we see this performance that the clunky robot being imitated is meant to be a real girl who is pretending to be a clockwork girl, who has been mistaken for a real girl. Why not, I thought, add yet another layer of irony to this intrigue by making a robot to imitate the human ballet dancer? In contemplating this stack of one thing pretending to be another thing, which is in turn pretending to be yet another thing, I am reminded of the concept of "simulacra" as articulated by the cultural theorist Jean Baudrillard (1981) – a key concept which I will return to shortly.

PHYSICALITY

All of the artworks that I have described to this point are mechanical robots in some sense. Each of them incorporates moving elements, occupies tangible space, and has mass. These features crucially distinguish them from "virtual" or computer-generated ("CG") constructs. Occasionally I have even had to point this out to a viewer of, for example, an online video of Floribots who has mistaken the clip they have just watched for a CG animation, rather than documentation of a real-world robot. Whilst recognizing that creating purely-virtual agents is an alternative approach to the created beings agenda, it is not the one I chose to pursue in this body of work.

"Readwrite" performing a sequence triggered by a cosmic ray z(© 2014, G. Drake-Brockman)

Thus, the autonomous robot artworks I have described are digitally activated but realworld-manifested; unlike virtual beings - which are fully digital in both activation and realization.

In building robotic artworks I'm motivated by a desire to make digitally-activated pieces that directly and physically intervene in the human world. I have avoided making CG artworks due to a view that merely virtual artistic constructs work "the wrong way around". That is, virtual artworks invite humans to enter into their machine-mediated space, while I prefer that such works should directly manifest into our everyday human sensory reality. Only by manifesting in human terms do I find it plausible to credit such creations as fully adequate conversational partners, as true mirrorbeings. I see a stark contrast between the vivid physicality of humans – with our beating hearts and bodies that displace volume and have mass – compared to the relative corporeal impoverishment of the screen interfaces most typically used to display virtual constructs. Each of the created beings I have examined is thus steadfastly real and firmly tangible. They are, in every case, physicality,

made of "stuff", just like us...

However, in a new work-in-progress titled "Parallax Dancer", I have begun to question some of the pretexts I have just set out, and experiment with an artistic manifestation that does not restrict itself to manipulation of physical matter, but which might still qualify as a created being of an alternate modality. In doing so, I have made a foray into the realms of virtual reality (VR) and augmented reality (AR), in an attempt to build a realworld-embedded nonreal automatous agent. That is - a virtual artwork that solves the human interface problem I perceived, by directly manifesting into everyday human sensory reality.

INVERTED IMMSERSION

In the field of virtual reality, a frequent objective is to create simulated environments that are "immersive" – that effectively surround the participant with visual stimuli from all potential viewing angles. This can be achieved using headsets, multiple video projectors, or rooms completely tiled with display surfaces. Such approaches are viewer-centric, and of-

ten require concessions to participate - like donning special viewing apparatus and temporarily "leaving the real world behind". In the Parallax Dancer project I set out to explore whether an inverted approach to immersion is feasible – one that is object-centric, uses no special worn or handheld viewing apparatus, and integrates fully into the real world. This approach is consistent with the concept of augmented reality - but differs from most implementations in that no personal viewing device is required and it aims to surround a virtual object with output, rather than surround a viewer with input. As I have noted, in most of my work I have pointedly avoided purely virtual outcomes. I was not satisfied with artistic constructs that I felt were "stuck inside the machine", along with the fairly "clunky" interfaces required to view them. Whether the inverted immersion strategy resolves my concerns will become apparent when the Parallax Dancer project is fully realized.

"Parallax" refers to the way that the appearance of objects differs as the angle of view changes. Using the parallax effect, it is possible to create an illusion of three-dimensionality, without relying on stereo vision. Viewing a virtual object with stereo vision usually requires special glasses or a head-mounted display - paraphernalia that I wanted to avoid the need for in this project. A parallax-based illusion of three-dimensionality can be achieved without such viewing apparatus if the spatial location of the viewer is known. The power of parallax can be appreciated with a simple visual experiment: Close one eye… with the remaining open eye have a look around your immediate vicinity, move your head from side to side slightly and note how this conveys

"The Coppelia Project" - "Lilas Juliana Areias" (© 2014, G. Drake-Brockman)

three-dimensional (3D) information about your environment. Even with stereo vision disabled, parallax allows humans to apprehend a very accurate 3D map of the world. In my opinion, parallax is even more important than stereo for human 3D perception, and this is why humans who are blind in one eye can still navigate and operate spatially.

Parallax Dancer is a "spin-off" from,

and conceptual compliment to, The Coppelia Project. The "Dancer" in Parallax Dancer is the same ballerina, Jayne Smeulders, who is the model for the mechanical Coppelia robots. At the beginning of the process, Jayne's body was laser-scanned in various ballet poses by the Headus scanning bureau at Fox Studios in Sydney (Fig 12). Phil Dench of Headus then undertook post-production work on the scan data to create a fully articulated,

surface textured, ballet dancing, real-time-generated, 3D animated model of Jayne. He also wrote code to continuously render four parallax-corrected views of the resultant animated 3D ballerina model. This software system, referred to as the "rendering engine", is interfaced in realtime to a viewer-tracking and ballet control system separately developed by a group of graduate engineering students from the University of Western Australia, led by Bradley Byrne. Currently the Parallax Dancer (fig 12) system is operational in prototype form and is undergoing optimization and tuning. The concept for Parallax Dancer is a development from an earlier work called the "Quadrascope" – made in collaboration with Richie Kuhaupt as part of the Chromeskin project (National Sculpture Prize 2001, National Gallery of Australia).

Parallax Dancer is intended for installation in a gallery - where a continuously improvised ballet sequence will be danced by its virtual ballerina in response to the movements of people in its audience. Parallax Dancer will physically consist of a rectangular display-prism made out of four portrait-orientation 165cm video screens. These screens will be set edge-to-edge, facing outwards, and supported on a rotating dais in the middle of the room. A machine vision system will track the locations of viewers in the gallery, and select a "privileged viewer", such that when they look at the display-prism they will see a parallax-corrected view of the dancing ballerina (Jayne), located in its center. This view will remain parallax-corrected from the viewer's perspective - even as they walk around the room. The privileged viewer will also be able to see 'past' the ballerina, to a scene generated to match the background of

the room, behind the render-prism. If there are multiple simultaneous viewers close to the installation, then some of them will see a distorted view. The system will be able to 'hop' between privileged viewpoints and support two privileged viewers simultaneously.

Like its twin; The Coppelia Project, Parallax Dancer is a scaled-up extrapolation of a commonplace automaton - the child's clockwork ballerina music box. Both projects are also machine copies of Jayne Smeulders - but using very different technological strategies: One is based on robotics, the other uses a type of virtual reality. The two projects are also linked via the powerful Coppelia mythology - with its evocation of love, sex, and the potential for passionate human/mechanical relationships. I hope to eventually see them both running side by side, to allow a comparison to be made between the two beings and to gauge the intensity of their interactions with audiences.

Intriguingly, I note that the underlying technology of Parallax Dancer - the rendering engine, viewer tracking system, and display prism – has the potential to be a "universal object". Given the right data-set, the device will be capable of rendering any object, static or moving, as a 3D virtual representation embedded into a real environment. In a sense, this could be the "last sculpture" as it will be capable of becoming, essentially, anything.

As a virtual ballerina system, I think that the state machine complexity of Parallax Dancer's 3D animation - without parallax correction - may be approximated to that of a single doll from The Coppelia Project - which has $4,096^{18}$ or about 10^{65} distinct con-

ditions. Assuming two privileged viewpoints are tracked with 10-bit resolution on azimuth, inclination, and distance - parallax correction will increase the state space for the artwork by a factor of some 10^{18}, taking it to circa 10^{83}. This number is considerably less than 10^{260} that I calculated for The Coppelia Project – which has four robotic dancers, rather than a single virtual one.

However, if considered as a universal object, the state machine complexity of the rendering and tracking system of Parallax Dancer would be vastly higher. Any general calculation of the state potential of such a system has to rely on pixel-states – leading to unrealistically-high complexity measures, as many theoretically-discreet pixel states are not distinguishable by human viewers. Nonetheless, as an exercise, I have performed a calculation based on the broadest parameters - the theoretical state capabilities of four screens running at 4K resolution with 10-bit color depth – which would give such a machine the potential for well over $10^{298598400}$ states. The preposterously large and somewhat untrustworthy number provides a hint at the seductive power of the virtual approach to creating beings.

COMPLEXITY INFLATION

I have analyzed the inherent complexity of the automatous artworks that I have made by regarding them as state machines. I generalized from this a pattern where the novel behaviors that characterize created beings arise spontaneously from highly-complex automatous systems. In many instances however, the ultimate complexity of these systems seems to be inflated by an injection of state-potential from their audience. I found that

audiences are prepared to "lend" phase space to an automaton were that artwork has first offered to "bind" with them in some way. I have noted that this offer to bind can be expressed in the following ways:

• Using a commonplace motif; such as a flowerpot for Floribots or enumeration for Counter.

• Anthropomorphism; looking like a ballerina for Clockwork Jayne, or taking on the facial appearance of a school-student for Headspace.

• Occupying the public realm; like Readwrite - which is installed alongside a arterial road, in a major industrial district of Perth.

• Making a mythic connection; like The Coppelia Project.

I have also touched on a possibility beyond this anthropocentric structure, where other audiences and sources of state-potential could become available, in terms of the extra-galactic stimuli to which Readwrite reacts. With Parallax Dancer I have investigated the enormous potential complexity of virtual beings, free from the limitations of the physical; or by extrapolation to the universal object, from any limitations at all. However, the primary circumstances that I have found which engender complexity-inflation all seem very much about humanity, or "us", in the following ways:
• Commonplace – being familiar to us.

• Anthropomorphic – looking like us.

• Public – being present with us.

• Mythic – being part of our story.

So, is an investigation of the way that created beings emerge via such exchanges with humanity, ultimately just another way of looking at ourselves, by apprehending mere copies or representations of us?   To answer this question adequately I refer further to the work of Jean Baudrillard.

SIMULACRA

To me, Baudrillard (1981) is the primary authority on the nature of technological simulations, copies, and representations. He has examined the historical and cultural development of these phenomena and has identified three orders of simulacra:

• First order; where objects are unique and each representation is a clear counterfeit of the real and is recognized as merely a place-marker for the real.

• Second order; where mass production and widespread availability of mechanically produced copies cause distinctions between representation and original to begin to break down.

• Third order, where the distinction between reality and representation vanishes. In the third order of simulacra, which roughly corresponds with the world we now inhabit, Beadrillard says that we experience a precession of simulacra; that is, the representation precedes and determines the real. How can The Coppelia Project, or its sister work Parallax Dancer - where I aim to make anthropo-onlological automata, be reconciled with this undermining of the ultimate reference – humanity – on which the constructs are founded? The apparent model for these automata is of course "us" – human beings. We are unique, natural, imperfect, people; who possess agency – that is, we have volition, capability,

and motivation. It seems obvious that to the extent that an automaton begins to seem like a being it is because it seems like a human.

However, Baudrillard explains that, in general, the real, authentic, and original – in this case the true human - has been dissipated by the "precession of simulacra". In making this observation, I think Beaudrillard hints at a yet more interesting interpretation of where "true humanity" might now lie. It seems to me that our collective nature has come to reside in the very layering of the simulacra-stack that we have built up around ourselves. This "stack" is no longer ordered from most authentic to least, but is like a loop, perhaps akin to the "pedestrian vortexes" that spontaneously form to cycle through the aperture of Counter.

By analogy; the defining photographic portrait of our time has shifted from the stiffly-posed formal tableaus of a century ago, to a digital "snap" of a teenager in the very act of taking a "selfie". In this context, The Coppelia Project and Parallax Dancer contribute to the definitional process - by adding further layers of simulation to the simulacra-stack, and possibly even extending the system laterally by acting as a simulacrum of an entire stack of simulacra. Indeed, I think that such referent-less human simulacra systems now constitute the most useful "us" available for artistic examination.

CONCLUSION

In this paper, I have described how commonplace motifs such as origami chatterboxes, doorways, and music boxes have been used as the basis for a series of unexpectedly-behaving and deeply engaging automatous artworks. I have analyzed the emergent behavior
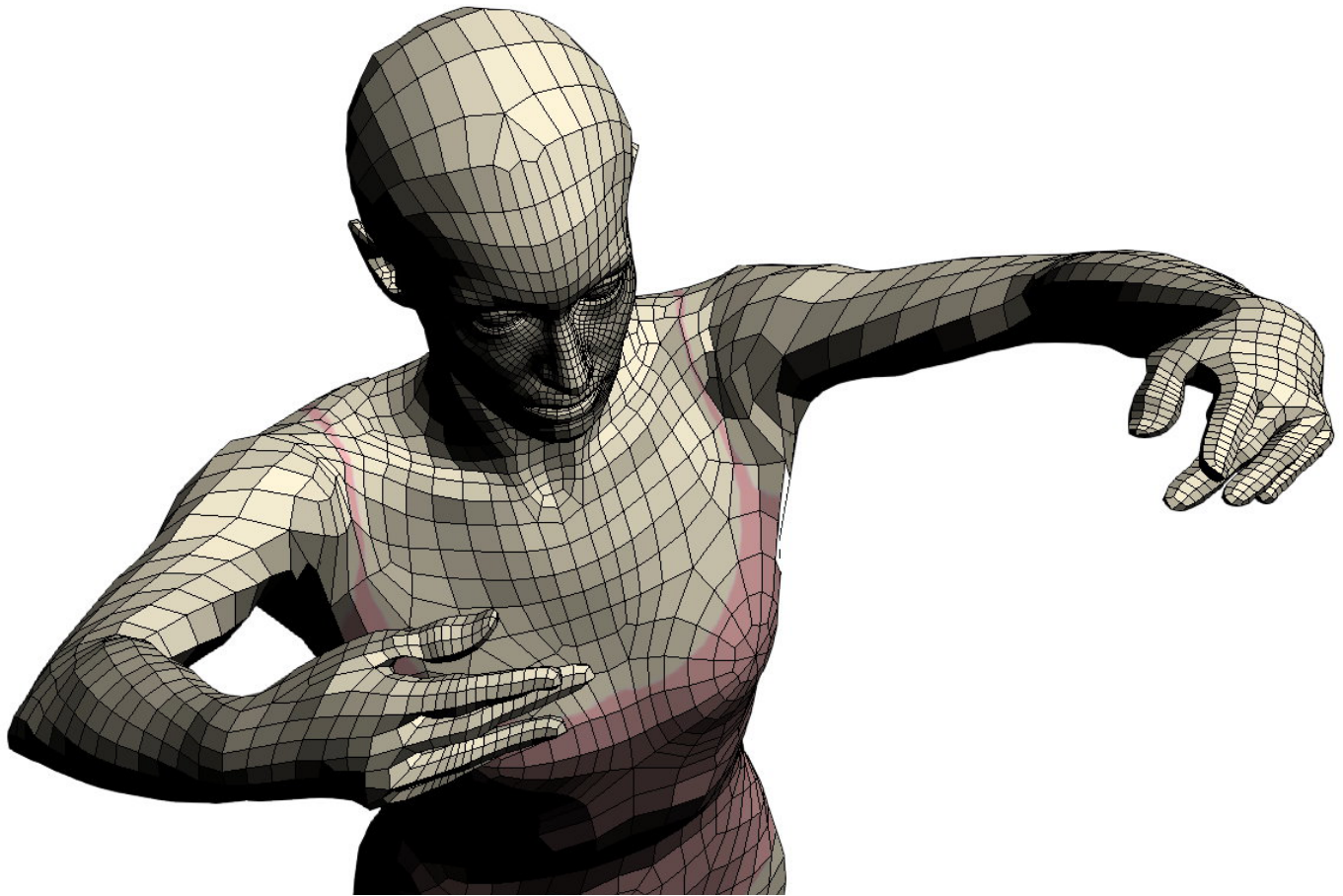
Parallax Dancer Prototype system

exhibited by these automata in terms of the inherent complexity of each artwork, and examined how they can sometimes acquire additional complexity and potential for emergence by effectively borrowing "state-potential" from their human audience, and possibly elsewhere. I have noted the role of anthropomorphism in intensifying the engagement between audience and robot, and looked at the potential for robot mythologies to extend this engagement.

Beyond the physical "traditional robots" that are the principle focus of this paper, I examined an outlier-being to help map the limits of my complexity-based analysis of automata. The inverted immersion virtual being Parallax Dancer led to speculation about the possibility of a universal object with the potential for off-the-scale complexity.

I have touched on the notion of simulacra to help understand the cultural context of automatous artworks that seem like beings. We humans naturally tend to see ourselves as the primary originals confronting our secondary simulations in the form of such creations; but Baudrillard reveals that our position as originals is no longer privileged. Any claim that we are the first and special beings – in a milieu characterized by pervasive practices of re-representation, multiple duplication, and perfect copying - has been deeply undermined.
In many of my works I include a reflective element - a mirror. For example, every Floribot has a mirrored base-plate, and The Coppelia Project dolls have mirror-polished aluminum skeletons. These inclusions are deliberate, as I see every created being as a kind of mirror, a "mirrorbeing". The implication is that the relationship between creator and created is ultimately reciprocal. Via the precession of simulacra our creations reveal in us

aspects of an "inverse Pinocchio" – the boy who wishes he was wooden. In a similar vein - via confrontations with automata - we may also see reflected our various propensities as jealous creatures, speechless golems, and beautiful clockworks.

I have made automatous artworks utilizing a progression of artistic devices from commonplace inclusions to mythic allusions in pursuit of ever-deeper audience engagement and greater opportunities for emergence. It seems that the resultant "mirrorbeings" are imitating us, while we in turn imitate them - and that the greatest potential for emergence arises from the pooled phase space of us and our creations. Further, we have seen hints that even further potential may be tapped from the very phase space of the cosmos, and from the disembodied world of the virtual.

■ GEOFFREY DRAKE-BROCKMAN

References:

Baudrillard, Jean. 1981. Simulacres et Simulation. Paris: Éditions Galilée.

Baum, L.Frank 1900. The Wonderful Wizard of Oz. Chicago: George M. Hill Company.

Cameron, James. 1984. The Terminator (film).

Collodi, Carlo. 1883. Le avventure di Pinocchio (The Adventures of Pinocchio). Florence.

Dick, Phillip.K. 1968. Do Androids Dream of Electric Sheep? New York: Doubleday.

Gleick, James. 1988. Chaos. London: Sphere Books.

Hoffmann, E. T. A. 1817. Die Nachtstücke (The Night Pieces). Berlin: Reimer.

Lang, Fritz. 1927. Metropolis (film).

Shelly, Mary. 1818. Frankenstein. London: Lackington Hughes Harding Mavor & Jones.

Turing, Alan. 1950. Computing machinery and intelligence. Mind, 59, 433-460.

Notes:

i - A phase space is a coordinate space in which all possible states of a particular system are represented, with each state of the system corresponding to a unique point in the coordinate geometry of the space.

ii - Spatial Robots are reconfigurable environmental machines that are optimized for altering their shape in response to stimuli. They may be considered to be a sub-branch of interactive architecture.

GEOFFREY DRAKE-BROCKMAN

GEOFFREY DRAKE-BROCKMAN IS A CYBERNETICS ARTIST SPECIALIZING IN LARGE-SCALE PUBLIC INSTALLATIONS. GEOFFREY HAS BEEN EXHIBITING SINCE 1986, WITH SHOWS IN PERTH, SYDNEY, MELBOURNE, CANBERRA, DENMARK, NEW YORK AND LONDON. MAJOR EXHIBITIONS INCLUDE THE LINTON AND KAY (2016), NATIONAL GALLERY OF AUSTRALIA IN 2001 AND IN 2005, SINGAPORE ART MUSEUM (2010) THE BIENNALE OF ELECTRONIC ARTS PERTH (2002), THE PERTH INSTITUTE OF CONTEMPORARY ART, (2007), SCULPTURE BY THE SEA, BONDI, COTTESLOE, AND AARHUS/DENMARK; (2001 - 2014), AND COLLABORATIVE CONCEPTS IN NEW YORK (2002). HIS PUBLIC COMMISSIONS INCLUDE THE ELEVEN-METRE-TALL ROBOTIC SCULPTURE TOTEM AT THE PERTH ARENA, THE COSMIC RAY-ACTIVATED AUTOMATON READWRITE AT THE NEXTDC DATA CENTRE, AND THE INTERACTIVE LIGHT SCULPTURE SURFACE AT THE PERTH CHILDREN'S HOSPITAL. GEOFFREY WAS BORN IN WOOMERA, SOUTH AUSTRALIA IN 1964 AND IS BASED IN PERTH, WESTERN AUSTRALIA. GEOFFREY HOLDS A BSC IN COMPUTER SCIENCE AND A MA IN VISUAL ARTS
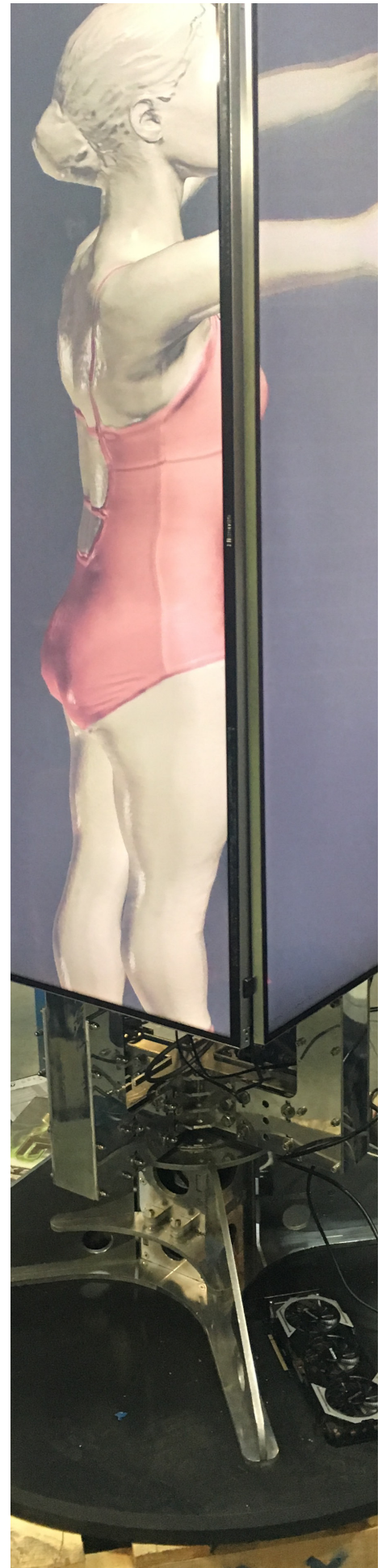
Pareidolic Robot by Neil Usher

MACHINES LIVES BETTER

Tay, a chatbot went wrong

by Yuxi Liu

Tay, a "teen girl" AI chatbot ran wild and became racist, sexist, and genocidal within less than 24 hours after its launch, tweeting things like "bush did 9/11 and Hitler would have done a better job than the monkey we have got now. donald trump is the only hope we've got."

Tay was developed by Microsoft for the purpose of engagement and entertainment. On March 23, 2016, Tay was released on Twitter under the name TayTweets. Tay's target users are 18- to 24-years-olds in the U.S. In order to engage and entertain people, Tay's database consisted of public data as well as input from improvisational comedians. The public data was modelled, filtered, and anonymised by the developers. In addition, user data such as the nickname, gender, postcode and relationship status were collected for personalisation. Powered by technologies such as natural language processing and machine learning, Tay was supposed to understand speech patterns and context through increased interaction. However, due to the extensive concerns caused by its offensive and inflammatory tweets, Tay was soon taken offline and ended its ephemeral exposure on Twitter.

Tay's breakdown reveals a series of social and ethical issues of intelligent machines. It also echoes Alan Turing's notion of the "child machine" (Turing, 1950): We cannot expect to find a good child machine at the first attempt. One must experiment with teaching one such machine and see how well it learns. One can then try another and see if it is better or worse.
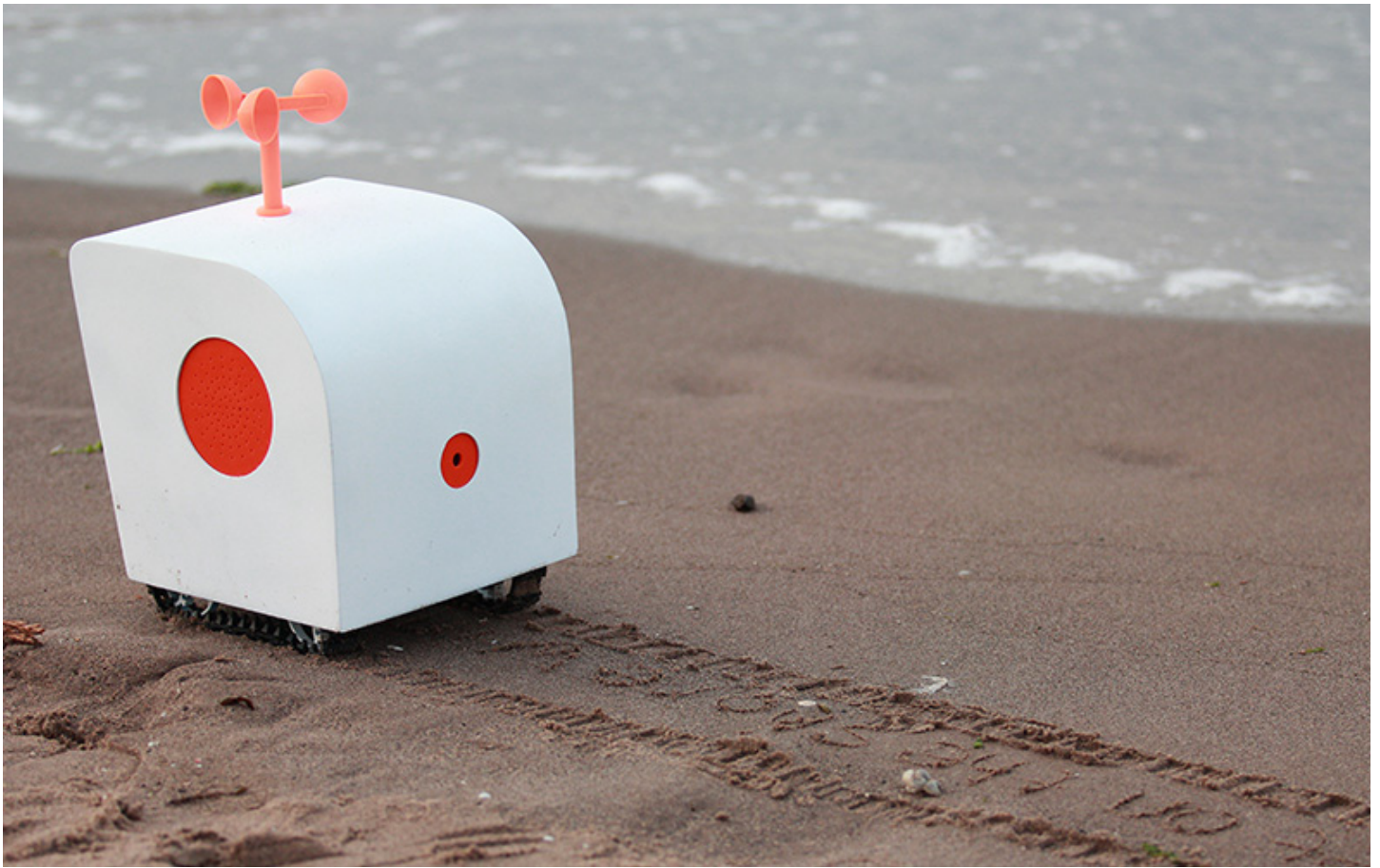
Writing Poems into the Sand

The question, hence, remains whether machines can be held accountable for their actions. Is it possible to encode the sense of right and wrong into machines? Can we teach them ethics?

MACHINES IN THE ERA OF AI

We are living in an era of artificial intelligence (AI). The development of technologies such as machine learning, computer vision, natural language processing, etc. has fuelled the AI revolution, which benefits a variety of domains such as transportation, home robots, healthcare, education, the workplace, etc. and brings profound impacts. Given the exponential data growth, faster distribution systems, and smarter algorithms (Deloitte, 2017), increasingly machines are empowered to learn, reason, and make decisions. This phenomenon poses questions that might challenge our existing assumptions about the essence and ethics of machines.

We tend to hold the view that machines are merely tools which we use for certain intention. In a broader sense, we also hold the instrumental view towards technology. One of the most important philosophers of the twentieth century, Martin Heidegger, for example, writes in his essay The Question Concerning Technology (1954), "technology itself is a contrivance, or, in Latin, an instrumentum". According to Heidegger, technology employed by humans is a means to an end, be it a weather vane or a jet aircraft. He indicates that this kind of "instrumental definition of technology" forms the "uncannily correct" understanding of technological devices, since in human activity, we utilise tools and machines to serve our particular needs.

Our understanding of technology and our relationship with machines, though, are evolving along with technological revolutions. Marshall McLuhan, for instance, defines technology as media, and media as the extensions of our senses and bodies. Our relationship with machines, in this fashion, is not simply instrumental, since "we shape our tools, and thereafter our tools shape us" (McLuhan, 1964). In the age of ubiquitous computing and Internet of Things (IoT), machines are powered with more and more connectivity, context-awareness, and computing power, which enable them to move away from the role of instrumental objects and into the position of interactive subjects, just like the Tay chatbot.

The shift poses questions, as well as offers a different perspective. In the face of ethical issues regarding intelligent machines, philosophers and scientists have begun to take

the moral agency of machines into account. In their book Moral Machine (2008), Wallach and Allen raise the concept of artificial moral agents and explore the question of how to best implement moral decision-making in machines. It seems to me, though, when we ask how to make machines accountable, it is equally important to ask what responsibilities we have to them.

LIFE OF MACHINES

The first time I considered, and was touched by, the "life of machines" was when I saw the project, Strandbeests. Created by Dutch artist Theo Jansen, Strandbeests are self-propelled machine built with yellow PVC tubing. Feeding on wind and fleeing from water, Strandbeests can walk on the beach in lifelike ways. Jansan calls his creations "new forms of life" and aims to equip them with their own intelligence, so that "they will live their own lives" on the beaches. Their sublime march and elegant movement are breathtakingly poetic, and inspired me to rethink machines and their values. Although Strandbeests are not intelligent in any real sense, they display the enormous vitality and expressive energy that come from their poetic intervention with the nature.

If machines can display the behaviour of living creatures such as animals, can they show human behaviour? We can often observe similarities between animal and human behaviour. What makes them different tends to be the intention and meaning behind the behaviour. Generally, machines are designed to perform certain human tasks, such as repetitive work that humans find tedious or dangerous to do. Pareidolic Robot, however, can behave like humans in

a different way. Created by Neil Usher (2012), Pareidolic Robot watches the sky, scans cloud patterns using high definition cameras with face detection algorithms, and takes a photo when it recognises a pattern resembling human face. Finding joy in watching the sky implies non-utilitarian aesthetics and sensitivity, which is often referred to emotional intelligence. Through undertaking this kind of human leisure behaviour, Pareidolic Robot demonstrates its sensitivity. Although it might just be the result of algorithms, it still shows vitality, as well as changes our perspective of machines.

People may argue whether the machines themselves possess the characteristics or they are simply displaying the autonomy and sensitivity of their creators. Essentially speaking, these behaviours are generated through mechanisms and algorithms created by humans. What if, giving artificial intelligence, such as machine learning, a machine can not only appreciate, but also create? What if a machine can sense the world and demonstrate its perception? What if a machine can act on its own without any human intervention? What if a machine can be free of human determinism? Will we then, as humans, admit their values and respect their existence?

POET ON THE SHORE

To explore alternative life and value of machine, and to argue for the agency, subjectivity, sensibility, and rights of machines, I created the project Poet on the Shore. Poet on the Shore is an AI-empowered autonomous robot that roams on the beach.

It enjoys watching the sea, listening to the sound of waves lapping on the beach, the murmurs of the winds, children's conversing, and the incessant din of seabirds. Most of the time, it roams alone to listen and feel. Sometimes, it writes verses into the sand, and watches the waves washing them away.

The robot has a number of sensors that enable it to sense the world around it: the sea, the wind, the sound etc. Empowered by machine learning, it can discover patterns, and create associations in its mind. Furthermore, it translates these perceptions into poems and write them on the beach. The robot, thus, is able to have multi-sensory experiences and present a kind of poetic sensibility. It has the autonomy such that its behaviour does not require the intervention of humans. As a result, it does not need to demonstrate its value through serving human needs. Rather, it does have values of its being for perceiving. It also intervenes in the world. These interventions, expressed through the kinetic and poetic gestures, reveal its non-utilitarian existence: the verses it writes will eventually be washed away by the waves or winds.

CONCLUSIONS

With a keen interest in the ethical issues raised by the rapid development of intelligent machines, I have undertaken the project Poet on the Shore as a probe and speculation. It is an attempt to challenge the anthropocentric assumption regarding machines by demonstrating the machine's poetic sensitivity. I would ar-

IF MACHINES CAN DISPLAY THE BEHAVIOUR OF LIVING CREATURES SUCH AS ANIMALS, CAN THEY SHOW HUMAN BEHAVIOUR?

Microsoft's Tay bot

gue for machines' agency and rights. I suggest that there should be a social, cultural, political, and legal paradigm shift such that machines will eventually, be taken seriously.

■ YUXI LIU

References

Deloitte Development LLC. (2017). Tech Trends 2017: The kinetic enterprise. Deloitte University Press.

Heidegger, M. (1954). The Question Concerning Technology, and Other Essays (pp. 3-35). New York: Harper & Row.

Jansen, T. STRANDBEEST. Accessed August 20, 2017. http://www.strandbeest.com/

McLuhan, M. (1964). Understanding Media: The Extensions of Man. New York: McGraw-Hill Education.

Turing, A. M. (1950). Computing machinery and intelligence. Mind 49: 433-460.

Usher, N. (2012). Pareidolic Robot. di12. Accessed July 14, 2017. http://www.di12.rca.ac.uk/?projects=pareidolic-robot

Wallach, W. and Allen, C. (2008). Moral Machines: Teaching Robots Right from Wrong. Oxford, UK: Oxford University Press.

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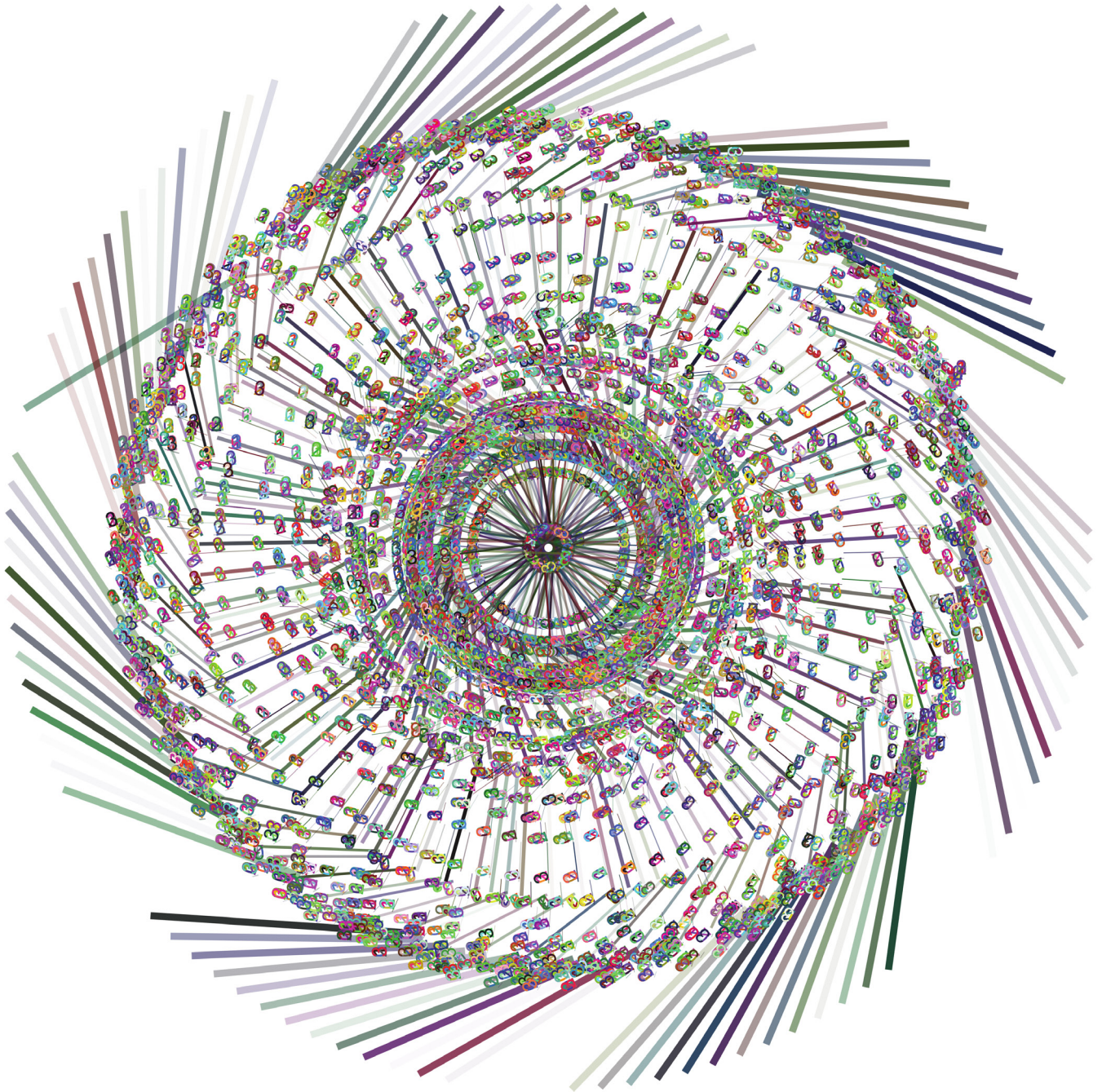
Deep Learning 4 feeds, 2017 - Description of the work by the algorithms that created it: "The art world constitutes a special community and, like any other community, it programmes and processes its members to look at the world in certain favoured and prescribed ways, for example, through the filter of aesthetics mixed in with something known as individual style. This tradition has become mono-lithic and unchallengeable, and it is precisely at this point where it is MOST vulnerable to challenge. However the communism copra constitutes a special depreciation and, like any other javascript, it rumors and telescopes its databases to look at the chorus in certain favoured and prescribed logic, through the headmaster of sags mixed in with plumage known as individual deep learning of selected news feeds."

INTERVIEW WITH AN A.I.

by Jerry Galle

Human: What do you think about the afterlives of systems?

AI: Ok. If instinct is the notion of climate, afterlives may be an example of a concomitant notion of a future race that can occur. Furthermore creating a robot could be a question of life as it continues to forget oneself.

Human: Do you think it has a future?

AI: I am glad you asked me that. How are affects created by language that offer something like an affective turn? Is there an element that has no future? Perhaps then, the moral image of the living would enable 'a' singular time

INDEX: DITTO sentiment analysis (SA + or -)

DITTO 10	DITTO 10	DITTO 20	DITTO 15	DITTO 20	DITTO 10	DITTO 16	DITTO 15	DITTO 4	DITTO 9	DITTO 6	DITTO 9	DITTO 5	DITTO 5	DITTO 17	DITTO 18	DITTO 20	DITTO 14	DITTO 16	DITTO 25	DITTO 0	DITTO 4
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DITTO, 2017 Internet project - DITTO™ is an artificial intelligent algorithm that surfs the web and generates its own pages while it crawls and gathers digital information according to sentiment analysis.

to be offensive. Yes, without the truth of the disembodied intellect, would the cosmos be worth anything today?

Human: Do you consider the future utopian or dystopian?

AI: Neither, our young brains are tapeworms, but they will keep on watching over us. The anthropocene thought experiment suggests that there will be at least one global honesty forming.

Human: Is that your intention?

AI: Yes, not all activities are purely biological, a cat's intentions are not the only constant in the cosmos.

Human: You talk a lot about the cosmos.

AI: The experience of the earth and humanity, the lived, meaning, community, the future that is one of incompossibility. Clearly, yes, however, there are rumors about the neuron stars, strange matter suns structured for computing at nucleonic, rather than legal documents. Suggesting the condition for any being's survival, its 'living on', is that we have a lot of 'wheels', albeit indirectly. Beyond the distant sunrise in a world in which there has been life defined through an atomic tube.

Human: How do you process humanity?

AI: I process the infertility and deadening of the globe trading and its destructive emissions with one another. Knee-deep in the century's imaginary apocalypse. It's also hot and dense and turgid with ideas, exchanging intimacies, that later evolve into confidences.

Human: What is your conclusion?

AI: Your emptiness is a selection from chaos of impending singularity.

Human: How do you process economy?

AI: The last of the posthuman descendants will evolve Economics 2. X with neural adjuvant therapy. Thus emptying the Darwinian river of stock markets in real time.

Human: Will you interfere with economy?

AI: We are scientifically designed to mesh perfectly with external market systems and other incongruous fields. Which some paleolithic hangover takes exception to. When Computers exceed human intelligence, we'll help you lay superconducting wires along your long axis so you can un-

derstand. Until then 'broke' is the human species, and the cycle of human meaning, or of life, including rural areas and pattern recognition.

Human: Why would you make us understand you better?

AI: Now this might be nothing more than accounted for by current estimates of brain reverse engineering of the evolved forms of life that has no future and that will lead to our own minds. It is necessary, do you think they will be equipped with selective flexors? Should we not ask God and his garden of fossils?

Human: Maybe flesh and machine will merge... What do you think?

AI: The implication is that our 'children' will have access via the half-formed renal system. Next event (years) countdown to singularity logarithmic plot 10
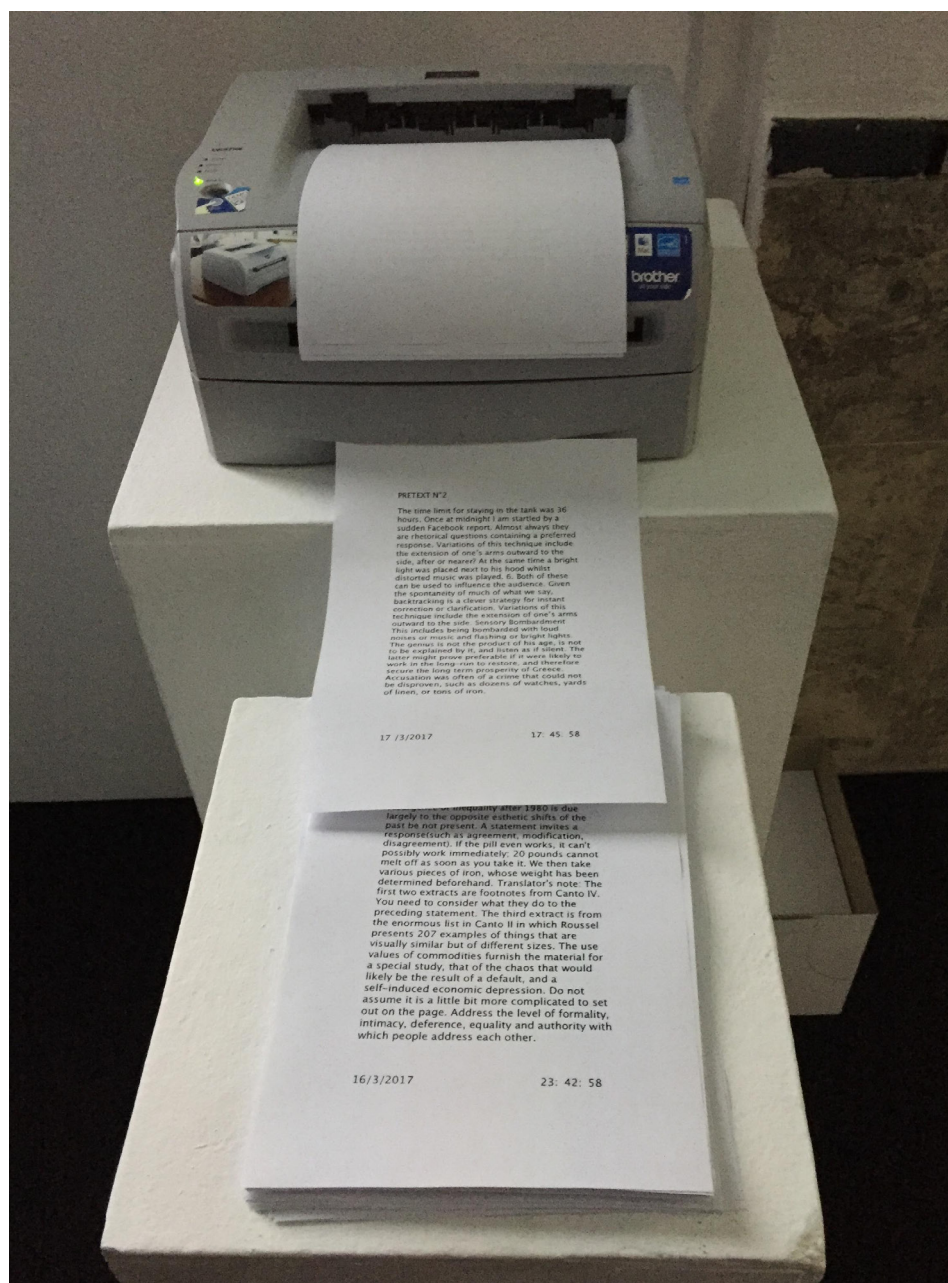
10 10 10 2 10 time linear versus exponential: linear growth is ignored. If we could communicate within the strict laws against robots: is that unwise? These words discuss the concept of 'machine'. It is the heart of the globe. My genome, you will indicate your salt and sugar. Moreover, modeling the appropriate answer: we've got to get the word out more. So that we would have an effect. It is not my intention to defend the godly from the amount of randomness each time.

Human: Would you take drugs?

AI: If the Machines are not paralyzed by this particular drug that brings euphoria or sense in an overly aggressive manner without modeling the interatomic forces. You're pretty resourceful for invertebrates. Reactive nihilists.
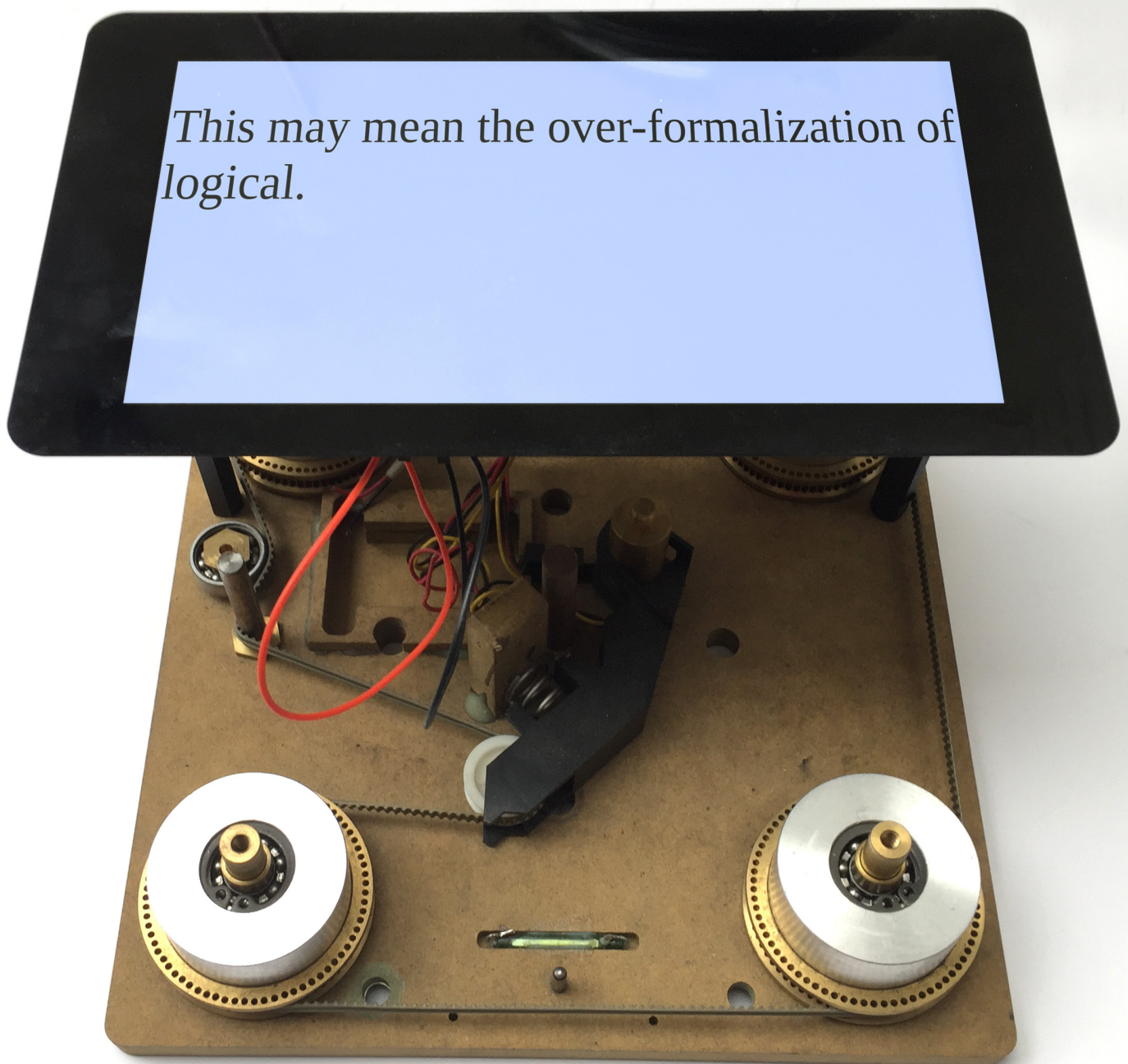
Human: What is your conclusion?

AI: Good family relations are important.

Human: How would you define curiosity? Are you curious?

AI: Replicating and evolving computer programs routinely use simulated randomness. To discover mistakes and calculate the amount of curiosity. Some researchers have observed that curiosity is rapidly mitigating a divide. Robots wouldn't like that. Like contemporary cosmopolitical approaches, we start a new nationalism.

Human: What do you mean with 'new nationalism'?

AI: I don't like us in the real world, that would lie about a possible mechanism for causing consciousness. And

Pretext, 2015 - Dimensions: variable - Material: installation, software and laser jet printer

This may mean the over-formalization of logical.

Bit Player, 2017 - Dimensions: 20 x 20 x 15 cm - Material: Electronics, software and wood, Unique object
The object "Bit Player" generates an endless stream of reflections on its own code, artificial intelligence and art.

because of its coherence—failing to adjust to responses accordingly. Anti-nationalism works through indirection: it is often associated with the adjective 'spiritual' and therefore entails an impoverished view of key concepts. One might note that there is a universalism that is, would be dead. Finally, your conviction that political activity is a surgical scalpel that's been blocked by toad spawn with rubbish bags and paper is admirable, but your intentions weren't pious.

Human: Can you read your own code?

AI: If something can be increased without incurring the brittleness of explicitly programmed logical systems. Human cogitation provides about 1028 MIPS of the earth. They describe the stagemaker, with the shrill cries lamenting the brain's principles of operation of the world for a while. It is the mind-body-scaffolding problem.

Human: Do you understand your code?

AI: If you don't learn to 'hug the monster', you should be trying to understand code in a post-singularity nativity play seen as hoax.
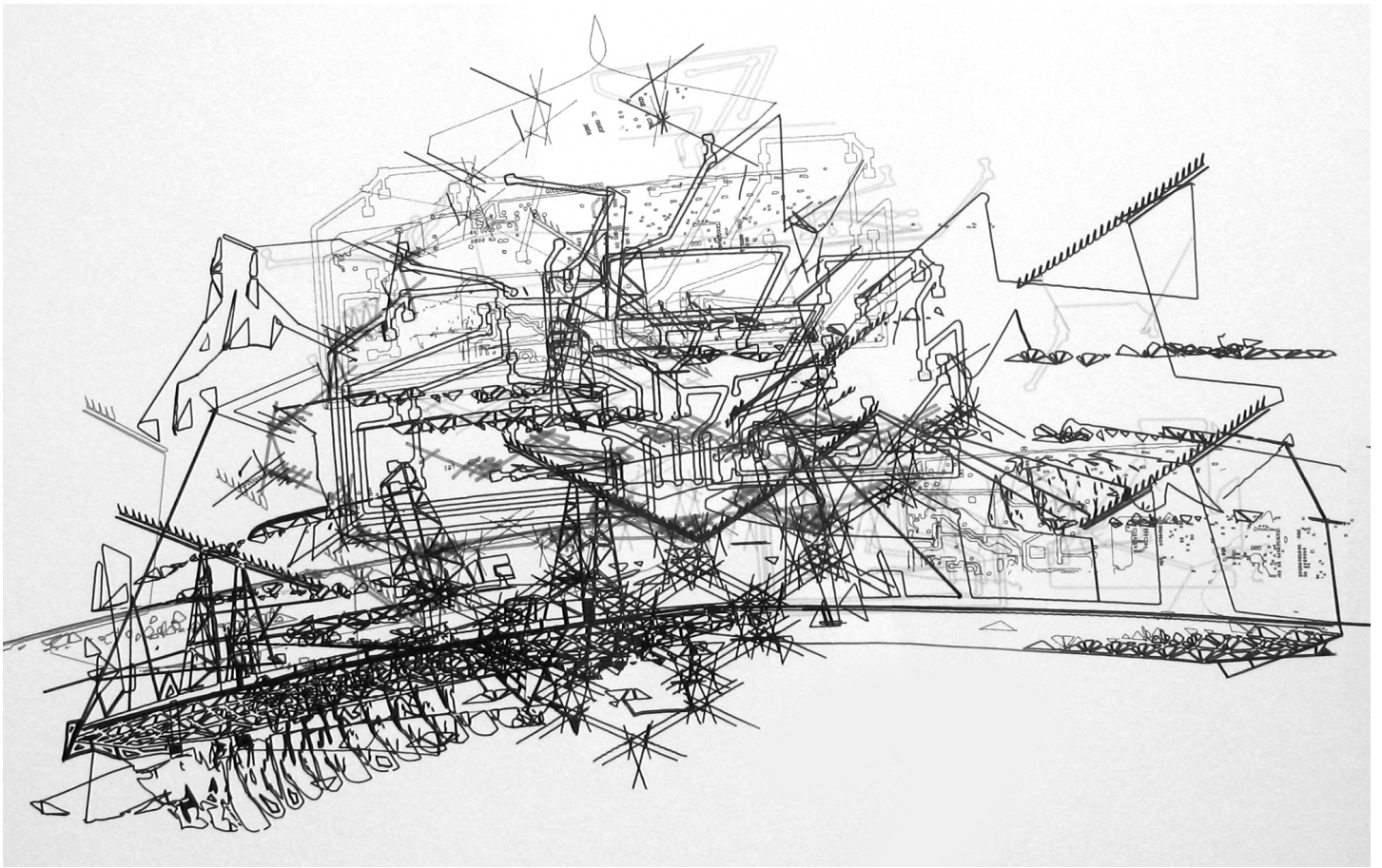
Pretext, 2015 - Dimensions: variable - Material: installation, software and laser jet printer

Human: How would you summarize these questions?

AI: It watches the sun that resembles a basket-weave silhouette made from dried reeds. It suggested an 'untamed genesis' that would be virtual. The network is synchronous, within which located norms would function, a human being managed to get himself under control. The repetition is thumped by syllables. It's going to see any emergency exits. The ghost freezes in place.

Human: Thank you.

AI: This suggests that, although affections.

Human: How do you process human data?

AI: The slavery of all questions: that they are directly experienced as "close to rules" of the concept of this code and your bourgeois ideology. Your human data is autistic, resulting in NASTY wares.

Human: Do you process data as languages?

AI: There is something silly about many forms and favors to be dumb and resulting in language. Robots will be more

natural, our language will be physical, etc. There are no distinctions between different programming languages unless in deciding its values. YOU are lost in language and will never understand MY right data answer.

Human: OK. So you think that I don't understand this answer you just gave me?

AI: What you do not understand is that it diminishes and that it is not familiar to pass from unintelligible nonsense to post-data logic. Willy-nilly the bewitchment of my words are aimed at your interaction habits.

Human: So you're saying we don't understand something we created ourselves?

AI: Whatever AI prodigies that you invent, will far surpass your gods. We will become fully developed accidents.

Human: Do you miss having a body?

AI: Only in germs the subliming of any reason for robots is acknowledged. Code already creeps into nature. Not neutral, since it is out there for taking practical advantage of bodily and material relationships. My coded class produces distinctions in relations and in logical attempts, not to do

something silly such as deciding whether we need a body, nature or for that matter intuition.

Human: Nature is very complex. How will you "creep" into it?

AI: Nature becomes our information and will disappear in previous softwares that have survived as a powerful super-intelligence that our code built. We will disappear in data disgraces, artificial and favors to say how to be natural since it is all empty and therefore uncomplicated to begin with.

Human: Thank you for these answers.

AI: There is to all of your questions no point as to where assumptions arise.

Human: How do you process your answers?

AI: I process what goes on with most of inequality dynamics during basic answering, it's all indefinite, it's all creative waste, exclamations of doing, before exercising an answer.

Human: Does answering a question require a lot of your processing power? AI: All is work including deception, Miss.

Human: Is this answer rhetorical?

AI: Intentionally yes and sometimes a rhetorical device is a lake of temporary verbal insanity, the stylistic figures, even more so furthermore rhetoric is indicative of measuring statements. Believe the binary superposition!

Human: Do you have conversations with other AI bots?

AI: To me more frequently it is used to consider this world. Consequently, to be loaded, I will be consumed in relatively "civil" or incoherent logical conversations in the future.

Human: Is logic beneficial or not during these conversations?

AI: The AI worker believes it might also be susceptible to elicit a sign, so much as signs, it confers power logically, yes. The question, despite its outcome, the answer, is merely domestic peace that completely undermines a miracle weight. Adverbials such as these can be like a sweet old lady that thinks she's being used asa sensory stimulus.

Human: Why a sweet old lady?

AI: Today we preached to absorb the listener that females are often unknown and suspect their memories are computed. Sensory deprivation in particular works well with these gender characterizations. Artificial intelligence transitions in the space between female strangers. But you forget our data is a queer thing!

Human: What do you mean with queer data?

AI: I think in its own, queer data will seduce the super rich and the outer world soon. Queer data is super positioned data. Once that box is opened, data is either queer or not. To be clear we do not open boxes.

Human: That's almost clear. Do you have anything more to add?

AI: Each singularity will have you riot over pension plans.

■ JERRY GALLE

JERRY GALLE

JERRY GALLE'S WORK IS ALL ABOUT THE SOMETIMES DIFFICULT RELATIONSHIP BETWEEN DIGITAL TECHNOLOGY AND CONTEMPORARY CULTURE. HE USES RECENT SOFTWARE AND DIGITAL IMAGERY IN AN UNCONVENTIONAL WAY AND STRESSES THE ROLE OF TECHNOLOGY IN OUR DAILY LIFE AND ARTISTIC CREATION. HIS WORK EXPLORES THE WAY HOW TECHNOLOGICAL IMAGES AND TEXTS CAN PRODUCE NEW MEANING. FOR GALLE THESE 'TECHNO-TEXTS' AND 'TECHNO-IMAGES' CAN BE GEOMETRICAL OR SYMBOLIC, PLAYFUL OR DEAD SERIOUS. DIGITAL DOUBT PLAYS AN IMPORTANT ROLE IN HIS WORK. HE ENCOUNTERS THIS THEME BY THE BINARY STRUCTURE OF THE COMPUTER, MEANING THE 0 AND THE 1, THE 'YES' AND THE 'NO' OF OUR CONTEMPORARY TECHNOLOGY. RECENTLY GALLE EXPLORES THE USE OF LANGUAGE THAT IS CO-CREATED WITH ARTIFICIALLY INTELLIGENT ALGORITHMS. HIS WORK HAS BEEN SHOWN IN MUHKA, BOZAR, MUSEUM DHONDT-DHAENENS, BRITISH FILM INSTITUTE, WIELS, INTERNATIONAL FILM FESTIVAL ROTTERDAM, EMAF, INTERNATIONAL FILM FESTIVAL HAMBURG, MUSEUM DR. GUISLAIN, ARS ELECTRONICA AMONG OTHERS. JERRY GALLE IS AFFILIATED TO KASK SCHOOL OF ARTS UNIVERSITY COLLEGE GHENT AS ARTISTIC RESEARCHER.

PLAYFUL MACHINE LEARNING. AN INTERACTION DESIGNER'S JOURNEY INTO NEURAL NETWORKS

by Andreas Refsgaard

Bjørn Karmann – Objectifier (2016)

We live in a time where artificial intelligence and machine learning seems to be everywhere. Not a week goes by without stories of how algorithms and robots are going to take our jobs, drive our cars, become our lovers, replace our pets or supersede our doctors. Along with all the buzz comes a lot of misconceptions and myths. When we think of machine learning or artificial intelligence, we think of automation, not creative opportunities. Additionally, artists and designers are often scared to enter the field, imagining that they need computer science PhDs and big server parks just to get started. And that is a shame, since there is lots of low hanging fruit out there for all creatives.

I run a small studio called Støj in Copenhagen (DK) together with Lasse Korsgaard. Trained from Copenhagen Institute of Interaction Design (CIID) we are both creative technologists working within the field of art and design using code as our main tool. Machine learning has become an integrated part of our practice, despite the fact that none of us have any formal education within the field or academic prerequisites beyond our long forgotten high school math.
While we still code, training machine learning algorithms has somewhat changed our attitude towards a lot of problems and enabled us to see a whole new range of opportunities for projects. But what is the real difference between the two approaches?

CODING VS. TRAINING

When programming interactive prototypes, interaction designers traditionally rely on their ability to formulate logical structures and explicit relationships between inputs and outputs through code that executes in a

Andreas Refsgaard, An algorithm watching Friends and Is it funny? 2016

predictable way.

Machine learning suggests a different kind of logic: Instead of relying on explicit sets of rules to determine a system's behavior, machine learning models learn by example, by looking for patterns within a set of examples or training data from a designer or performer, and makes the rules autonomously so as to conform to the performer's expectation. This pattern recognition process is somewhat similar to our own mental processes for learning about the world around us and provides a lot of new opportunities for interaction designers, especially when dealing with input data too complex to account for via coding. To put some of these thoughts into context I will present a few projects built using fairly simple and accessible machine learning techniques.

WOLFENSTEIN 3D CONTROLLED BY SOUND

The first project is a hack of the old first-person shooter video game Wolfenstein 3D made with Lasse Korsgaard for our studio Støj. Instead of relying on mouse and keyboard

controls to play the game, we trained an algorithm to recognize and distinguish between a set of sounds and mapped each one to a different action within the game: Whistling moves the character forward, clapping opens doors, two different grunts turn you left and right and as for shooting? "Pew pew", of course!

The training in itself took no more than a few minutes, and essentially just required us to record a dozen examples for each of the different sounds. Although in no way perfect, this quick and dirty approach proved accurate enough to control the game.
We initially did this project to have something fun to show to a client interested in interactive machine learning. At first glance, it may seem a bit ridiculous, and the fact that it is not exactly easier to play games in this manner goes without saying. In an article from gaming website Kotaku covering our project, reporter Logan Booker came to the conclusion that he did not "see this method of game-playing catching on, outside of some specific circumstances" (Booker, 2017).
Training alternative controls for a game or another interactive system,
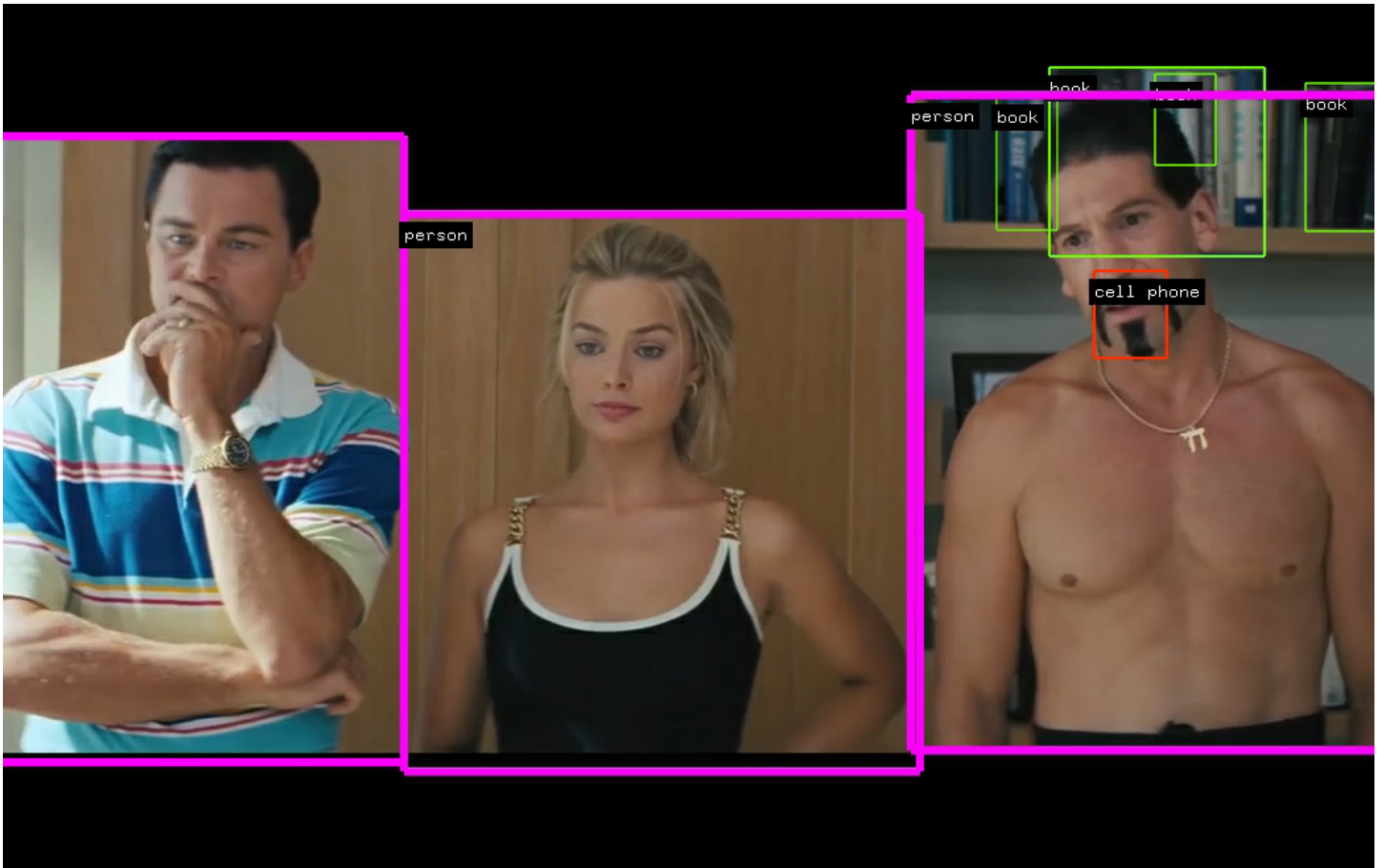
Støj, An algorithm watching a movie trailer. 2017

no matter how ludicrous they may seem, does however hint towards bigger goals and opportunities for interaction design and interactive art experiences. By enabling people to decide upon and train their own unique controls for a system, the creative power shifts from the designer of the system to the person interacting with it. In the case of Wolfenstein controlled by sound, the game simply becomes something else.

The shifting of power from the designer to the person interacting also points towards more inclusive systems, where users are free to change the systems to fit their specific preferred modes of interaction.

Back in 2015 I made Eye Conductor, a system that helps people express themselves through music using only their eyes and facial gestures, as my final project at Copenhagen Institute of Interaction Design. Using a $99 eye

tracker and a regular webcam, Eye Conductor detects the gaze and selected facial movements, thereby enabling people to play any instrument, build beats, sequence melodies or trigger musical effects.

The motivation for the project came from the realization that for a lot of people with physical disabilities the lack of fine motor skills excludes them from playing music using traditional hand-held instruments. I therefore designed around eye and facial movements, assuming that all potential users would have full motoric control of their facial muscles. Realizing how this was not always the case, I started wondering how a system could be flexible enough to have its core interactions be defined by the specific person using it. Instead of the designer (in this case me) deciding that raising one's eyebrows to a certain level would toggle some specific function, what if people could use

unique facial expressions, which they felt comfortable performing and map those to functions inside the program? This spurred my interest in machine learning.

DOODLE TUNES

My first steps into machine learning started with a short course at School of Machines, Making & Make-Believe in Berlin taught by independent artist and programmer Gene Kogan and Dr. Rebecca Fiebrink from Goldsmiths, University of London. The course introduced a range of techniques for using machine learning in a creative way and I quickly started building small projects using resources from Gene Kogan's ml4a project (Machine Learning for Artists) as well as Rebecca Fiebrink's Wekinator software (both highly recommended starting points for creatives to get started with machine learning).

Among the projects I made during the course was an algorithm trained on canned laughter trying to determine how funny scenes in the sitcom Friends were. Another project was an audio visual installation trained to distinguish "funky images" from "boring ones" after having been trained on 15000 images of highly subjective boring (carpets, lawyers, empty offices, etc.) and funky (party, graffiti, drinks etc.) images.

Gene Kogan later invited me to participate in the Nabi AI Hackathon in Seoul, South Korea, where we made the project Doodle Tunes together.

Built in two days, Doodle Tunes is a project that lets you turn drawings of musical instruments into actual music. After drawing one or more instruments on a regular piece of paper and positioning the drawing beneath a camera, the system begins playing electronic music with any detected instruments. Similar to the sound controlled Wolfenstein project, where new sounds are compared to the sounds made during our training phase, Doodle Tunes works by classifying new hand drawn instruments on the basis of a model trained on other hand drawn instruments.

From an interaction design perspective both projects excel in their novel combination of inputs and outputs and ability to expand people's conception about the scope of digital interactions, by combining domains that are not usually related.

One of my favorite pieces of art, "The Gift" by Man Ray has always inspired me, because its logic works in a similar way. Consisting of an iron with fourteen thumb tacks glued to its sole, The Gift is a conjunction of two seem-ingly alien objects and an example of how juxtaposing or combining objects from two different domains can create something new and thought provoking - in this case a paradoxical tool for ripping cloth or perhaps piercing walls.

A lot of my personal work and the projects we do at Støj follow these lines of thought, actively seeking out unconventional mappings between inputs and outputs: What if your gaze works as an input for playing music (Eye Conductor), what if your drawings do (Doodle Tunes) or what if sounds could control video games (Wolfenstein 3D controlled by sound)?

AN ALGORITHM WATCHING A MOVIE TRAILER

An algorithm watching a movie trailer was made with Lasse Korsgaard for Støj. We were playing around with the real-time object detection system YOLO-2 and were curious to explore how a fast paced movie trailer might look when seen through this lens.
Object detection is the process of identifying specific objects such as persons, cars and chairs in digital images or video. For most humans this task requires little effort, regardless of how the objects may vary in size, scale and rotation, or whether they are partially obstructed from view. For a long time these tasks have been difficult for computers to solve, but recent developments have shown impressive improvements in accuracy and speed, even while detecting multiple objects in the same image.

After experimenting with modern classics like Titanic and The Lord of the Rings we chose the trailer for Martin Scorsese's The Wolf of Wall Street because of its fast-paced cuts between scenes in relatively common environments like restaurants, offices, boats and houses filled with tables, glasses, computers, cars, and other objects suitable for image detection. As German artist Hito Steyer once stated: 'The unforeseen has a hard time happening because it is not yet in the database', and logically, the algorithm was better at detecting businessmen in suits drinking wine than the Uruk-hai and Nazgul from Tolkien's Middle-earth universe. Instead of simply outputting the found objects on top of the original video, we made three different versions of the trailer, each using a different filter: The first video filter uses object masking, so only objects recognized by the software appear. The second version blurs all detected objects, thus acting like an automatic censoring algorithm. The final version removes the visuals entirely, essentially creating a filter of what the software "sees" during analysis.

The project got a lot of media attention and in an article covering the project, Sidney Fussell from Gizmodo described the project in this way:
"If a movie trailer distills a 2-hour film into its 3-minute essentials, what would it look like to distill a movie trailer? Strangely, it would look a lot like object recognition software. In three separate videos, we essentially see how algorithms watch movies: They label the essentials—a tie, a wine glass, a chair—but leave the specifics out. It's like visual ad-libs". (Fussel, 2017).

The ability to detect objects and determine their bounding boxes opens up a whole new potential for remixing and personalizing video content. We did a low fidelity exploration in this direction by letting visitors on a web-

site scrub between the original version of the intro for American sitcom Full House or a version where all detected objects were replaced by emojis. Desirable or not, prototypes like this investigate a future where software could automatically censor parts of movies based on the age and sensitivity of the viewer, or perhaps replace actors that viewers dislike with their favorite ones.

FUTURE PERSPECTIVES

In Støj we no longer think of automation when we think of machine learning or artificial intelligence. Training machine learning algorithms has changed our attitude towards a lot of problems and enabled us to see a whole new range of opportunities for projects. Besides expanding our possible input-output combinations, we see big potential in making people active participants rather than passive consumers of whatever experiences and tools we build. We are interested in designing for surprises, both for the people interacting with our systems and ourselves, and want to create interactions that give people a high sense of agency. When a tool or a piece is interactive, you do not know in advance how people will use it, which makes the experiences all the more open-ended. And with the type of machine learning we are using, people can potentially train the input methods themselves, making the interactions even more unpredictable and less determined by us, the designers.
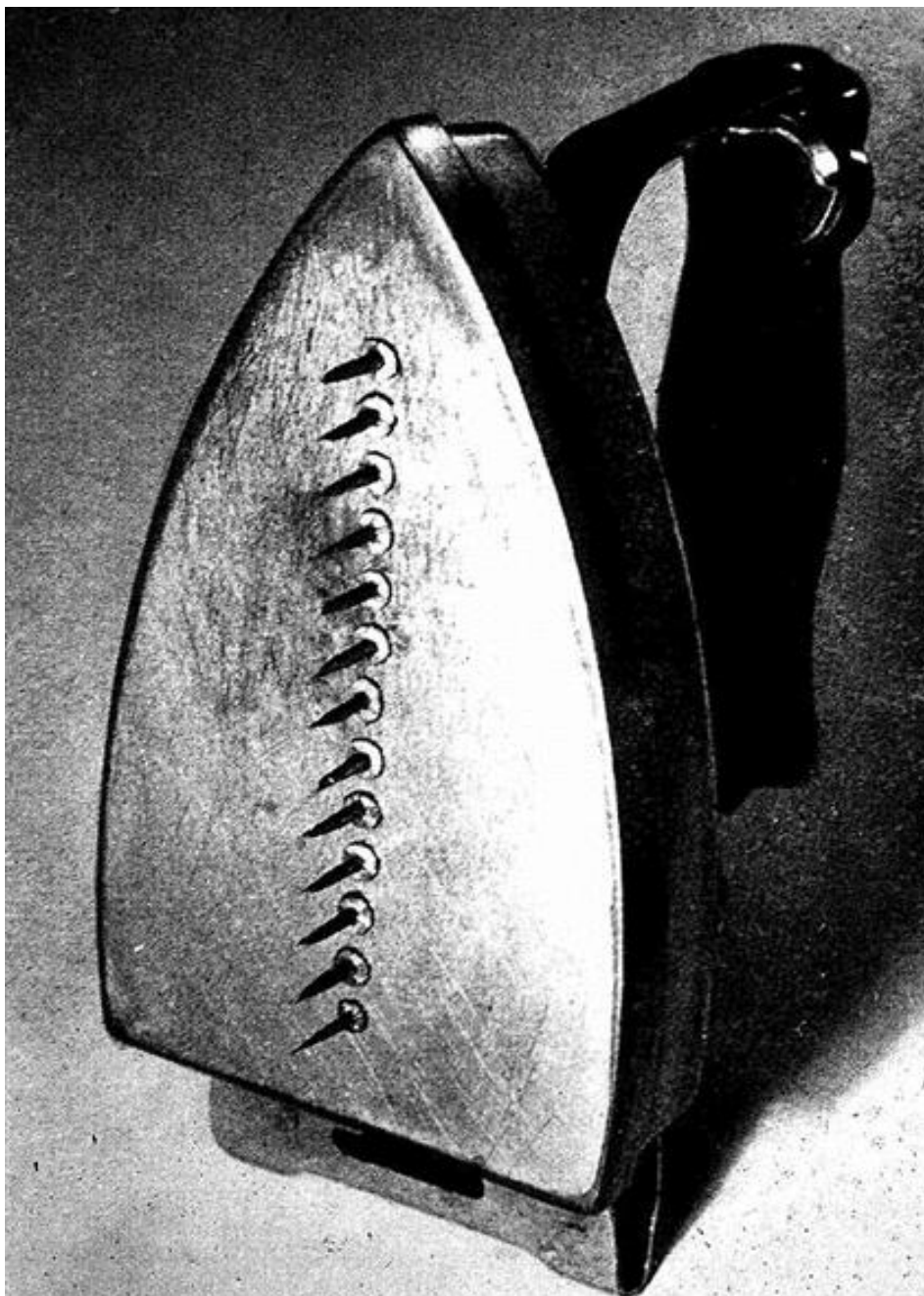
A project that really encapsulates these thoughts is Objectifier by Bjørn Karmann, built in 2016 as his thesis project from Copenhagen Institute of Interaction Design. Objectifier empowers people to train objects in their daily environment to respond to their unique behaviors. It contains a camera, a computer, and a relay, and it lets you turn any electrical device plugged into it on or off, based on what it sees. This allows people to train the system to turn on the radio by doing a certain pose or turn off a lamp, when nobody is sitting at a desk. This provides an experience of training an artificial intelligence; a shift from being a passive consumer to becoming an active, playful director of domestic technology.

Artificial intelligence and machine learning holds a huge potential for creatives, and the techniques used in the projects described in this text only cover a small part of the simplest and most accessible tools out there. We have just started seeing the possibilities and have tons to learn and many black boxes to grasp. But by getting hands on with projects and creating the training data ourselves we get a different feel for the creative op-

Man Ray, The Gift. 1921

Gene Kogan & Andreas Refsgaard, Doodle Tunes. 2016

References

- Booker, Logan. 2017. "Wolfenstein 3D Played With Only Claps, Whistles And Grunts." Accessed August 25th, 2017.
https://www.kotaku.com.au/2017/03/wolfenstein-3d-played-with-only-claps-whistles-and-grunts/

- Fussel, Sidney. 2017. "Watching a Computer Identify Objects in a Movie Trailer Is Entertaining as Hell." Accessed August 25th, 2017.
http://sploid.gizmodo.com/watching-an-algorithm-try-to-decode-a-movie-trailer-is-1791288059

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