A STUDY OF TWO SCULPTURES AND HOW THEY MIGHT INTERACT WITH HUMANS

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ABSTRACT

We describe two sculptures from the exhibition *Catenations*, made by *Nisse Bergman* the 14th of November 2019 at *Konstfack University of Arts, Crafts and Design*. We show that it is possible to place the production of the sculptures in a scientific as well as an artistic context and that the human brain plastically change through external stimulus. We create a mental web containing kinetic sculptures, abstract art, the etymology of words like "blue" and "fetish", the biological workings of eyes and synapses as well as artificial neural networks and artificial intelligence and place the sculptures on that scene.

1 Introduction

In this paper we will attempt to situate Nisse Bergmans practice in a broader art context. We will discuss Nisse Bergmans practice in general and in particular two sculptures displayed at the exhibition, *Catenations*, the 14th of November 2019 at *Konstfack University of Arts, Crafts and Design*. We will touch upon subjects from multiple research fields to situate the sculptures in both an art and a scientific context. The different subjects are weaved together into a larger theme throughout the text. In the *Background* chapter we will briefly explore kinetic and technology art. We will talk about how technology influences the way we talk and think about the human body and how that has changed over time. We will also explore neural networks, artificial intelligence, and the incomplete definitions of intelligence and how that undefined intelligence may run amok if uncontrolled. The *Methodology* chapter will cover the methods of research and how this article was constructed. In the *Construction* chapter we will thoroughly go through the particulars and details of the production of the sculptures including materials and techniques as well as the mathematics of cable packing. We will also talk about *W.I.E.R.D* and the replication crisis of psychology research. We will touch upon the etymology of the word *fetish* and the linguistics, biology and history of the color *blue*. We will also go though the optics and functionality of the mammalian eye.

2 Methodology

This research has been conducted by collecting a number of interesting subjects that have been found in the corpus of the authors everyday reading. The subjects was then categorized and sorted in a relational graph. The research is made "from the outside in" meaning that we started with a detail, a word, an idea or a material, and see where it leads to. This paper is written using this very technique, starting with the footnotes and references and trying to connect them

at a later stage. The subjects contains information from a number of different scientific fields such as art, linguistics, biology, mathematics, physics, computer science, philosophy, engineering, psychology and history.

After the collection phase a section was written on each subject. In some occasions the similarity of theme made it possible to fit multiple subjects in one section. The subjects was researched primarily by finding internet articles about the subject in question and then researching that articles sources. The initial articles gave us a good introduction while the research into the sources gave a better and deeper understanding of the subjects. Collecting these seemingly unrelated subjects, researched separately, and then gluing them together gave a broad set of angles to approach the work. The intention was to create a hermeneutic cycle where the different parts refer to each other, neither the whole text nor any individual part can be understood without reference to one another [70].

In some cases we have used the sources we have found directly but in other cases we have used the sources source. This is partly due to the fact that internet references does not look as good in a paper but also since we enjoy reading the true source. This might lead to some misquotes since we sometimes quote transitively but it is an artistic freedom we have decided to take. We have also tried to imitate the somewhat over complicated language and over specific interests of the technical paper for the same reason. The main text is both supposed to be readable in itself but also intended to be a vessel for the footnotes to be attached to.

From software development we have taken a format where reading a body of text (the program code) does not flow linearly from top to bottom but instead back and forth like a directed graph. We're interested in experimenting with that form in this paper by relatively extensively using footnotes to let the reader depart from the main text and temporarily branch into sidetracks. We have done this to not only in this paper show in text that this is the way Bergman works in practise by structuring this paper in a similar way.

We have been inspired by the aesthetics of the contemporary scientific paper, specifically from the fields of physics, math and computer science. For that reason we have tried to mimic the look and layout of this paper using the arXiv[1] standard template written in LaTeX[2] markup. The use of the first person plural "we" instead of the singular "I" is used to refer to the writer as is tradition in scientific papers. Being true to the style of natural sciences papers, which this paper is trying to emulate, we have used the reference and citation style of *Institute of Electrical and Electronics Engineers* (IEEE) [44].

3 Background

In the early 20th century[3] a movement of artists using technology emerged within a field called *kinetic art* [11], [25], [42], [59], [72], [81]. This is a movement that still exists today in contemporary art [18], [27], [35], [46], [65], [85]. Kinetic art uses technology as a material and part of the art is the very fascination with the contraption. This fascination of technology has produced an exuberant plethora of contraptions created to draw pictures [16], [17], [26], [28], [34], [48], [54], [58], [80], [84] and workings of the machine. Other contemporary art refers to technology without, de facto, using a technical apparatus [8], [13], [51], [52], [56], [63], [67] while some avoid using physical objects completely instead only using advanced technology to produce for example videos [4], [69], [78].

The most recent technology of a specific time or era influences the way that humans think about how their minds work and have produced analogies between technology and said mind [47]. In the classical antiquity where chemistry was the most advanced technology there was an idea that the bodies health dependents on an equilibrium of "the four humors", or vital fluids: blood, phlegm, yellow bile (choler), and black bile [40]. Excess or lack of these fluids would result in different temperament and moods. In the late 1800s the the steam engine was invented. Freud argued that repressing desires builds up a pressure until it finds other outlets. He thought it to be able to lead to sublimation, reaction formation, or the construction of symptoms [24]. When the telephone network expanded throughout the western world in the 1920's people began to use the expression "how are you wired?" referring to the mental constitution of someone. In the current age we have started to think of minds as computers. That it is possible to "reprogram" someone. The most

[1] arXiv is a free distribution service and an open-access archive for scholarly articles in the fields of physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics. It is commonly used for pre-prints for peer review

[2] LaTeX, written by Leslie Lamport [53] and released in 1984, is a typesetting software widely used in academia for the communication and publication of scientific documents in many fields, including mathematics, statistics, computer science, engineering, chemistry, physics, economics, linguistics, quantitative psychology, philosophy, and political science. It also has a prominent role in the preparation and publication of books and articles that contain complex multilingual materials, such as Sanskrit and Greek. LaTeXuses the TeXtypesetting program for formatting its output released by Donald Knuth [50] in 1972

[3] Kinetic sculptures did exist before the 20th century e.g. the automaton puppets of the renaissance

advanced computer systems right now have taken inspiration from the human brain by modeling them like a synaptic[4] network.

Stacking together differentiable functions, and optimizing their parameters to perform various tasks has in recent years flourished under various names, such as (Deep) Neural Networks[5], Deep Learning or Differentiable Programming [29].

Using these techniques has shown great progress in recent years. While it seems as if we are on the brink of creating a truly artificial intelligence it is probalby not true. The new artificial neural networks are intrinsically conservative and therefore not intelligent[6,7,8,9] nor creative.

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[4]Synapses connect the electrically excitable neuron cells. Sensory neurons respond to stimuli such as touch, sound or light and transmit that information via the spinal cord to the brain [22]. If the voltage to a neuron changes by a large enough amount over a short interval that neuron generates an all-or-nothing electrochemical pulse via the synapses to other neurons. The synaptic signals may be excitatory or inhibitory, increasing or reducing the net voltage. These signals further propagate through the nervous system. It is believed that an increase in synaptic efficacy arises from a presynaptic cell's repeated and persistent stimulation of a postsynaptic cell [37]. This is an attempt to explain synaptic plasticity, the adaptation of brain neurons during the learning process. Neurons that fire together wire together [37].

[5]Artificial neural networks, or deep neural networks as they are also called, are generally constructed as a large directed graph ordered in layers where the nodes and edges are the artificial neurons and synapses. An artificial neural network takes data like sound, text or images as an input and outputs a prediction and an estimation of how confident the network is at that prediction. The task objective is controlled by a fitness function that rates the result. For example, in the case of speech recognition input is sound waves and the output is written text. For tasks as text synthesis the input might be the first couple of sentences of a text and the output may be a lengthy synthesized continuation. For sentiment analysis the network may get an online review as input and outputs a prediction about how likely the review was positive.
Networks are trained by being fed a large amount of examples and the network adjusts the weights and biases in their nodes and edges to adapt to the data. Different network architectures use different methods to rate the quality of the result and gauge the learning process (the fitness function). One technique called *Convolutional Neural networks* uses convolutions to find higher-order features in data. It is usually supervised in the sense that it is provided labeled examples hand crafted to include both the question and the answer. The predicted and correct results are then back propagated through the network and the weights and biases are adjusted to minimize the mean error. This technique is particularly good at classification tasks like identifying faces or street signs and other aspects of visual data.
Another technique called *generative adversarial networks* is an unsupervised learning method used for tasks where the objective is to synthesize novel results like speech synthesis, text generation or image style transfer. It works by constructing two networks where the first network generates a result and the second is a discriminator that tries to find flaws in that result. Both networks feed their errors back into the other, and they train in tandem and do not have to be supervised. After repeating this process several million times with different examples fed into the system the neurons are carefully dialled in to fire only when they should. In a way, an artificial neural network constructed with its distributed processing and communication nodes, could be seen to be not only analogous with the human brain but also with human society at large. A single individual is just as much a node in the graph of society as a neuron of a brain.

[6]In the mid 1960s scientists began constructing artificial neural networks inspired by information processing and distributed communication nodes of biological systems such as the human brain. In recent years with vastly more powerful computer processors than were available in the mid 60s, research has made significant breakthroughs in several areas. The pace of progress in recent years has been truly remarkable and some neural network architectures have now even reached super human levels of performance. In parallel with these improvements, technology research has also been made into the definition of intelligence. This research has made arguably less progress in the last two centuries since the first mechanical computer was constructed.

[7]In 1931 Kurt Gödel proved with an incompleteness theorem [30] that it is possible to construct a statement that a given consistent formal system of logic could not prove. Despite being a true statement, it is unprovable in the given system. Gödel conjectured that the human mind can correctly eventually determine the truth or falsity of any well-grounded mathematical statement (including any possible Gödel statement), and that therefore the human mind's [31]. This has been taken as a proof of that the human mind is essentially different from a computer since a computer is a formal system and a human can prove something unprovable. Hence, a human is not a computer.

[8]Alan Turing tried, in his 1950 paper *Computing machinery and intelligence* [82], to reduce the problem of defining intelligence to a simple question about conversation. Turing notes that no one (except philosophers) asks the question "can people think?" and suggests that if a machine can answer any question put to it, using the same words that an ordinary person would, then we may call that machine intelligent. Turing proposes a test where a human evaluator would judge a natural language conversation between a human and a machine. If the evaluator cannot reliably tell the machine from the human, the machine is said to have passed the test and is, according to Turings definition, intelligent.
One criticism of the Turing test is that it is explicitly anthropomorphic using humans as the baseline of intelligence [60], [76], [83].

[9]It has been speculated that whenever artificial intelligence is able to improve on itself it will lead to a runaway reaction [6] of self-improvement cycles, with each new and more intelligent generation appearing more and more rapidly, causing an intelligence explosion and resulting in a powerful superintelligence that would, qualitatively, far surpass all human intelligence. The consequences have been compared to the changes that human intelligence brought: humans changed the world thousands of times more rapidly than

They are only perpetuating statistically reoccurring ideas biased towards the input data. If the artificial neural network is trained on conversations from Reddit it will be heavily biased towards the tone of speaking and thinking found in that training data. Ironically insufficiently diverse data has also been a major issue for psychological research[10].

The origin and inspiration for the two sculptures that we are describing in this paper comes from photographs taken in data centres. Workers in these data centres arrange the cables in very intricate ways. It appears to serve little practical advantage being so notoriously meticulous. It can be concluded that the reasoning to spend the additional time and effort must have other causes such as creating fetishes[11]. The sculptures are an attempt to replicate this kind of fetishes. This is done not only by very carefully arranging the cables and polishing the surfaces but also making sure that the surrounding space is neat and clean. Although, being quite rare, the photographs of cable arrangements are sometimes spread through internet forums. The spreading of the photographs is not intended for an external audience, but they are made for the same group of people making them. There is no intention to explain or to proselytize.

4 Construction

While creating the sculptures for the *Catenation* exhibition it was of paramount importance to avoid the apparent reference to science fiction and instead steer the spectator to think more about pure science. Science is in this case defined as including formal, natural and social sciences although an additional stress has been put upon the formal and natural sciences for greater effect.

The two sculptures are clad on the front with 39 stainless steel plates measuring 500 by 500 mm. Stainless steel, also known as *inox*, is a steel alloy consisting of a minimum of 11% chromium and a maximum of 1.2% carbon by mass [45]. The addition of chromium makes the steel corrosion resistant, or stainless, so no oil lubrication or other rust retardant such as paint is required. It is hard enough to be polished to a high reflectance surface finish. Although the plates have been lightly polished, some of the scratches and markings from the nibbler are still present, resulting in 90 and 45 degree lines on the surface.

The steel plates are made in four variants. The first one consists of central matrix of 28 by 28 holes with every other row offset half the horizontal hole distance making a total of 784 holes (fig. 2a). The second consists of eight 7 by 7 matrices making it a total of 392 holes which is exactly half the number of holes than in the first one (fig. 2c). The third plate type has 252 slots punched out also with every other row offset by half the horizontal hole distance (fig. 2b). The fourth type does not have any holes or slots. (fig. 2d).

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evolution had done, and in totally different ways [64]. Similarly, the evolution of life had been a massive departure and acceleration from the previous geological rates of change, and improved intelligence could cause change to be as different again. Some have argued that having no definition of intelligence is therefore irrelevant since the outcome is the same [36]. Artificial neural networks have various differences from biological brains. Specifically, neural networks tend to be static and symbolic, while the biological brain of most living organisms is dynamic (plastic) and analogue [9]. Currently, artificial neural networks are orders of magnitudes smaller than the biological counterparts but function similarly to the way biological neurons work in the sense that they either increase or reduce the amplitude of output signal depending on the input signal.

[10]In 2008 researchers pointed out that most articles in American Psychological Association journals were about US populations when U.S. citizens are only 5% of the world's population [3]. Psychologists had no basis for assuming psychological processes to be universal and generalizing research findings to the rest of the global population [1], [61]. More researchers found a systemic bias in conducting psychology studies with participants from "W.E.I.R.D" (western, educated, industrialized, rich and democratic) societies. They claimed that although only 1/8 of people worldwide live in regions that fall under the W.I.E.R.D classification, 60–90% of psychology studies are performed on participants from these areas and gave examples of results that differ significantly between people from WEIRD and tribal cultures, [15], [39]. A decade later 80% of the samples used in studies published in the journal, Psychological Science, were still from the W.E.I.R.D population [68]. Psycology research has in the last decade been struggling with a replication crisis [75]. It has been found that many scientific studies are difficult or impossible to replicate or reproduce. In 2015 *Open Science Collaboration* found that less than half of 100 articles from high ranking psycology journals was not possible to reproduce [62]. A study published in 2018 tried to replicate 21 social and behavioural science papers from *Nature* and *Science*, finding that only 13 could be successfully replicated [12]. Similarly, a team of 186 researchers from 60 different laboratories conducted replications of 28 classic and contemporary findings on psychology. 14 of the 28 findings failed to replicate despite massive sample sizes [49].

[11]A Fetish is an "expressive and irrational devotion or commitment to a particular thing". The word comes from the French *fétiche* via the Portuguese *feitiço* 'charm, sorcery' (originally an adjective meaning 'made by art') that in turn comes from the Latin *facticius* in the general sense meaning 'made by human skill or effort'. The word initially meant "cleverly made, neat, elegant" but in the Middle Ages the Romantic derivatives of the word took on magical senses. The related Spanish word *hechizo* can mean "artificial, imitated" but also "bewitchment, fascination". The specific Portuguese use of the word that was brought to English probably began among Portuguese sailors who used the word as a name for charms and talismans worshipped by the inhabitants of the Guinea coast of West Africa.

The holes in the stainless steel plates are made using a machine called a *nibbler*. A nibbler is a computer controlled machine that punches holes by pushing a hardened steel die with high pressure through the plate. The machine has high positional accuracy and repeatability resulting in uniform holes. Stainless steel is considerably harder to drill than mild steel and it wears a lot more on tools hence drilling was not a viable option. Two options other than nibbling were considered: laser cutting or water jet cutting. However, both those techniques are suboptimal for small holes and would have been slightly more expensive.

Although the holes were made for an interference fit [55] for the cables, the machine couldn't hold such a tight tolerance, resulting in some holes being slip fit and others being an overly tight interference fit. The cables also had an outer diameter tolerance of plus minus a few ten microns. As little as 50 microns is the difference between a too tight and too loose fit. The variance was largest between different cable packages that may be the result of the batches being produced on machines with slightly different wear.

The blue[12,13] cables attached to the steel plates are *category 5e UTP* cables [2] used for transmitting data in networks. It is by far the most common domestic network cable. The conducting material in the wire is typically made out of solid copper or copper clad aluminium that is insulated with a layer of polyethylene and an outer jacket of polyvinyl chloride (PVC). The outer jacket can be made in any colour but the inner insulation material have colours specified in the Category 5 standard. UTP stands for *Unshielded Twisted Pairs* referring to the eight 24 gauge wires twisted in pairs to mitigate crosstalk [77] i.e. unwanted signal leakage between the wires. In total around 10 kilometres of cables are used in the sculptures.

The screws holding the stainless steel plates are STHB FZB self drilling and self-tapping screws, also made out of stainless steel (fig. 4).

The larger sculpture is 3500 mm wide, 2500 mm tall and 1000 mm deep including the wooden wall it is mounted on. The wall is painted black to disappear into the surrounding room. The smaller sculpture is 1500 mm wide and tall and 90 mm deep. It is mounted on steel legs and has a steel cladding on its sides and back.

The cables emit from the centre of the sculptures in larger packs and then branch out into consecutively smaller groups terminating in final groups of seven. Seven circles has a proven optimal packing[14], no rattlers and six-fold rotational symmetry (D_6) so it was chosen as a starting point (fig. 6a). Therefore the number of holes on the stainless steel plates

[12]Linguistically the word *blue* is of particular interest. In many languages from completely different language families and geographies *blue* and *green* are colexified i.e. expressed as a single cover term. Basic colour terms are words that are monolexemic, highly frequent and agreed upon by the speakers of that language as a colour that cannot be described using any other words. According to these rules *light blue* is not a basic colour term since it is a subset of *blue* and also a compound word (not monolexemic). English contains eleven basic colour terms: *black*, *white*, *red*, *green*, *yellow*, *blue*, *brown*, *orange*, *pink*, *purple*, and *grey* but other languages have a different set of colours referring to different parts of the spectrum. In *Pashto*, commonly spoken in Afghanistan and Pakistan, uses the word *shīn* to denote blue as well as green. Latin had a word for green, *viridis*, which all romantic languages derive their word for green from. Latin did not have a word that covered all shades of blue so most contemporary romantic languages get their word for blue from a German root instead (Proto-Germanic *blēwaz*). In the Celtic languages the word *glas* is usually translated as "blue"; however, it can also refer, variously, to the color of the sea, of grass, or of silver. Furthermore, the ancient Egyptian word *wadjet* covers the range of blue, blue-green, and green. Wadjet is both the name of the goddess represented by a cobra, "the green one", and the eye of Horus. But it is also the name of Egyptian blue in faience ceramics. Some languages on the other hand have more than one name for blue. Russian makes a strict distinction between light blue (голубой, goluboy) and plain or dark blue (синий, siniy) similar to that an English speaker would consider red and pink to be separate colours [41]. The Múra-Pirahã language spoken along the Maici River in Brazil lack any unique colour terminology, being one of the few cultures that only have specific words for light and dark. Researchers have suggested that being able to distinctly name a colour makes it easier to distinguish it. There has been several studies of the OvaHimba people living in northern Namibia that speaks a variety of Herero called OtjiHimba [73]. In OtjiHimba there are four colour terms *zuzu* (dark shades of blue, red, green and purple), *vapa* (white and some shades of yellow), *buru* (some shades of green and blue) and *dambu* (some other shades of green, red and brown) [71]. It has been found that it takes longer for a OvaHimba person to distinguish between two colours that fall under the same colour category, compared to people whose language separates the colours into two different colour categories [71]. Similarly, it has been shown that it is harder for an English speaker to distinguish two shades of green than one shade of blue and one shade of green with the same colour distance. This suggests that the language we use affects our perception and how we process and remember phenomena.

[13]Virtually all animals and plants that appear blue are not blue by pigmentation [79]. Plants are tweaking their red pigments and mixing it with other molecules or using pH shifts to make them appear blue. Birds and most butterflies use iridescence which is an optical phenomenon of certain surfaces to appear to change colour as the angle of observation or illumination changes [29]. It is caused by multiple reflections from two or more semi-transparent surfaces in which phase shift and interference of the reflections modulates the incidental light by amplifying or attenuating some frequencies more than others or by diffraction grating in which a periodic structure splits and diffracts light into several beams travelling in different directions. Conversely it is impossible to extract the blue colour since that would cause the micro structures to fracture. The only known living being that is able to produce blue pigment is the Nassaea genus of nymphalid butterflies found natively throughout South America [79]. This rarity in nature is also the reason blue was a very expensive pigment until it was chemically synthesised in the early eighteen hundreds.

are made in multiples of seven. Dressing larger collections of cables are harder. The literature contains only a few known packings of multiple of seven that has no rattlers and rotational symmetry. Fortunately the largest known number is 91 and that happens to be a multiple of 7 (fig. 6c). When gathering the cables it is important that they arrange as tightly and neatly as possible to avoid bulges and gaps between the cables.

If one thinks of the cross section of the cables and the cable ties as perfectly geometric circles the problem of packing them with high density can be described as packing *n* congruent circles into a circle of unit size. This has been extensively studied [19]–[21], [32], [33], [57], [66] and there is a whole branch of mathematics concerned with the geometry and combinatorics of packing circles. Unfortunately, packing circles is in a complexity class called "non-deterministic polynomial time" meaning that there exist no known fast general algorithm to compute the optimal packings for all *n*. This remains an open and active field of research. Packings of $n \leq 1 \geq 7$ circles have known optimal arrangements that are trivial to prove. Where $8 \geq n \leq 13$ and $n = 19$ circles have packings mathematically proved to be optimal. The remaining packings with $n \leq 20$ have conjectured optimal solutions but with no definitive proof (see table 1). When the number of circles to pack increases the problem gets considerable harder to solve. There are currently only reasonable to good known packings but none proven to be optimal for packings with more than 20 circles.

Apart from finding the densest packing it is also important for visual appearance that the packing is symmetric, and that the packed circles do not have any degrees of freedom for movement, so called ”rattlers“. One example of that is the best known packing of 29 circles (fig. 6b). Having all these properties makes a packed group of cables look very tight and ordered.

Handling 91 long cables can be a bit cumbersome and the cables have a tendency to tangle. This is due to the factory winding the cables onto a drum giving the cables a permanent shape memory consisting of a slight curve.

To avoid tangling a “comb” was produced out of *Perspex* (Polymethyl methacrylate) with holes in the pattern of the best known packing for 91 circles. With the comb it is easier to hold the cables in place whilst securing them.

The cables are held together with about 7,000 cable ties (fig. 5). Using cable ties is a technique that was borrowed from professional cable dressers although sometimes Velcro tapes is used. Traditionally, especially in the case of telecommunication cables, waxed linen twine was used to bind together groups of cables with a series of lock-stitches [10]. It’s important not to tighten the cable ties too hard since it over stresses the PVC jacket material which deforms it plastically and makes it turn milky white [5]. Tightening too loose makes the cables rattle and move away from its optimal packing resulting in a sloppy appearance. Repeated dressing of cables in groups of seven gives the skill to count cables just by holding them in the hand and by tightening the cable ties to the perfect tension by listening to the clicks they give off.

Nearest the stainless steel plates over straining was disregarded, and the cable ties were tightened as hard as possible since that makes the cables protrude slightly out of perpendicularity to the steel surface resulting in more friction and less risk of them falling out of the holes. This technique in combination with the relative tight fit of the cables makes it possible to avoid using glue or other adhesive.
When entering the holes, the cable in the centre of a group goes into the middle hole and the two cables to the side into hole one and seven. The two cables facing upwards go into hole three and five and the two remaining cables go into hole two and six. This way the group is flattened with the least amount of bending, further avoiding cable discolouration. The remaining unused part of the cable ties are trimmed and the locking mechanism are turned away from the viewer to reduce visual[14] clutter.

[14]All mammalian eyes have a lens that focuses light onto the retina. The retina consists of neuroepithelial photoreceptor cells arranged in an approximately hexagonal grid that are capable of visual phototransduction. The photoreceptor cells absorb photons (electromagnetic radiation in the visible spectrum), triggering a change in the cell’s membrane potential leading to its electrical polarization. This polarization ultimately leads to either the transmittance or inhibition of a neural signal that will be fed to the brain via the optic nerve. There are currently three known types of photoreceptor cells: rods, cones and photosensitive retinal ganglion cells [23]. The rods are extremely sensitive and can be triggered by a single photon [7], [38] while cones require significantly brighter lights to produce a signal. In the human eye there are three different types of cones distinguished by their response to light of different wavelengths.

The three types of cone cells respond roughly to light of short, medium and long wavelengths. Although the cells actually responds to blue, green-yellow and yellow respectively called blue, green and red cone cells (fig. 8). Colour experience is calculated from the relation between these three distinct signals but the precise process is not well understood [43]. The calculation is also temporal so an exposure of one colour over a longer period of time will saturate the cells and make the brain adjust to normalize the signal. For a human to perceive violet, a colour that has a very short wavelength, the brain compares the high signal from the blue cone cells with the very low or completely missing signal from the green and red cone cells. The human retina contains about 20 times more rod cells than cone cells [74] but the number and ratio of rods to cones varies among species, dependent on whether an animal is primarily diurnal or nocturnal.

5 Conclusion

We described two of Nisse Bergmans sculptures in a scientific style. The *Construction* section is written to be overwhelmingly dry and dense of information similar to what can be seen in scientific articles published in e.g. *Science* and *Nature*. The main text refers to unusually long footnotes that expand on different pieces of information. This type of long footnotes are not commonly seen in scientific articles but, as this is not a scientific article, but an artistic essay, we deemed it was defendable. The footnotes touch upon the fact that humans tend to change psychologically as an effect to external stimulus and how computers do the same. An argument to whether computers are able to be intelligent ends without a definitive answer but raises the question of what intelligence really is, and if even humans are intelligent. Different subjects are woven into the main text, sometimes by footnotes. While it is sometimes clear how the written subjects relate to the sculptures it is sometimes harder to see the relation.

While the cones and rods contribute information used by the visual system to form a representation of the visual world, conscious sight, the third type of photoreceptor cell, the photosensitive retinal ganglion cells, does not appear to do so. It is thought to affect non-image-forming functions like circadian rhythms, behaviour and pupillary reactions. Most work suggests that the peak spectral sensitivity of the receptor is between 460 and 484 nm [86] (somewhere between violet and blue). Blue light dilates your pupils and restricts the secreting of the hormone melatonin into the body preventing sleep.

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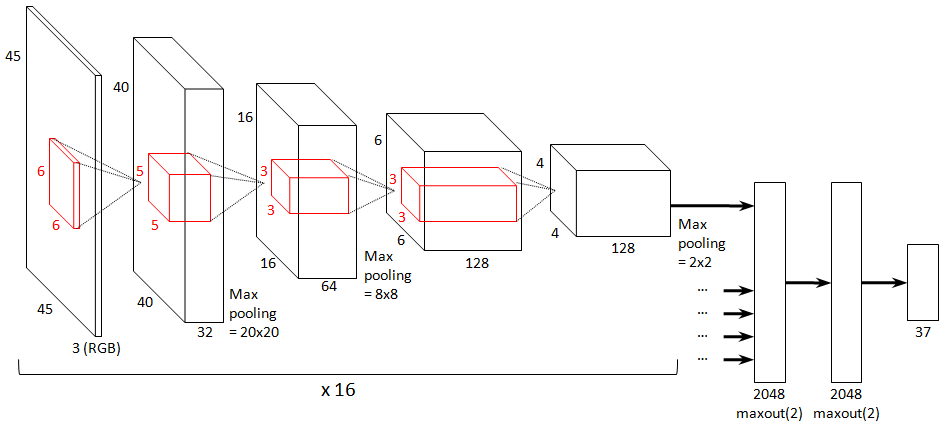
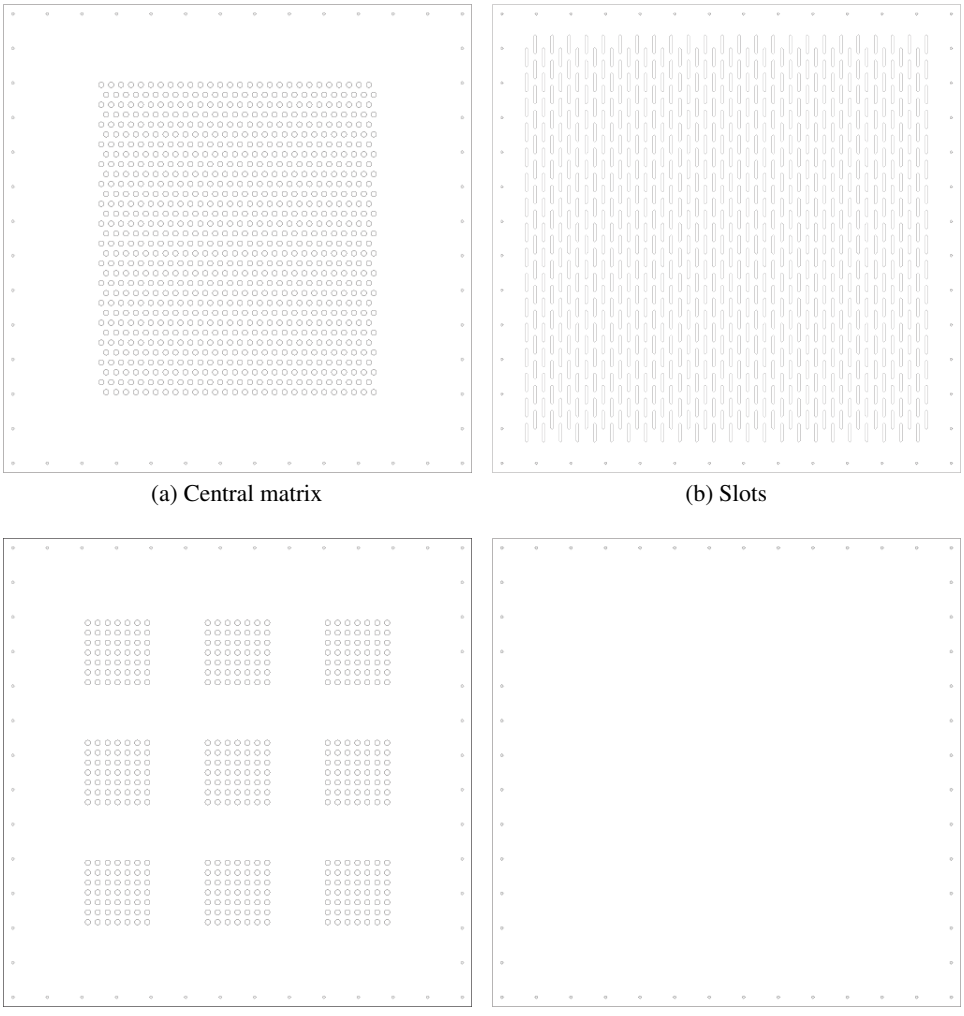


Figure 1: Khrizhevskys diagram of a convolutional neural network architecture for classifying an image



(a) Central matrix

(b) Slots

(c) Seven by seven arrangement

(d) Plain

Figure 2: Different type of stainless steel plates

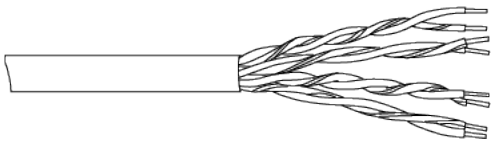


Figure 3: Cat 5 wiring. Pair 1: Blue, blue/white. Pair 2: Orange, orange/white. Pair 3: Green, green/white. Pair 4: Brown, brown/white.

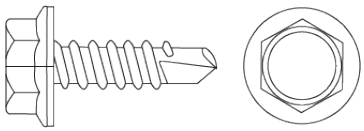
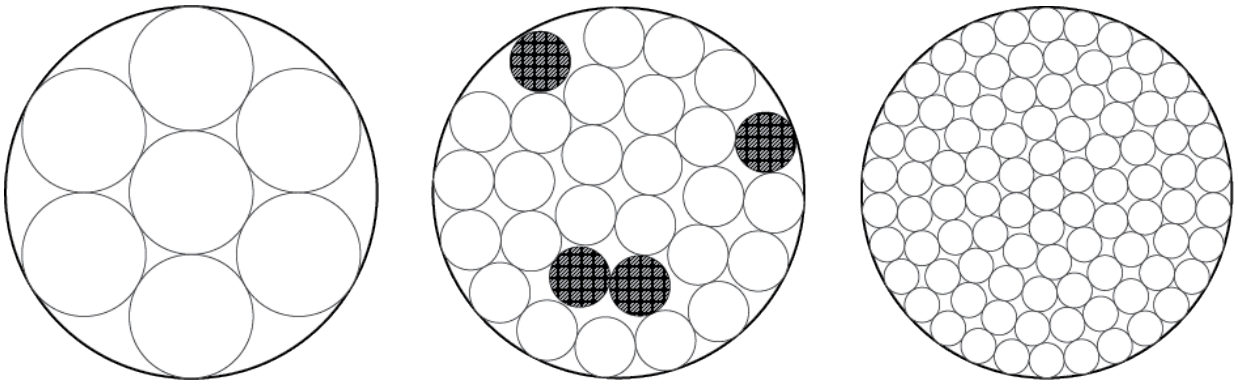


Figure 4: STHB FZB screw

Figure 5: cable-tie



(a) Proven optimal packing of seven circles.

(b) Best known packing of 29 circles has four rattlers (dashed) and does not have a well packed outer layer resulting in gaps.

(c) Conjectured optimal packing of 91 circles.

Figure 6: Examples of circle packings

Figure 7: Male Nessaea obrinus

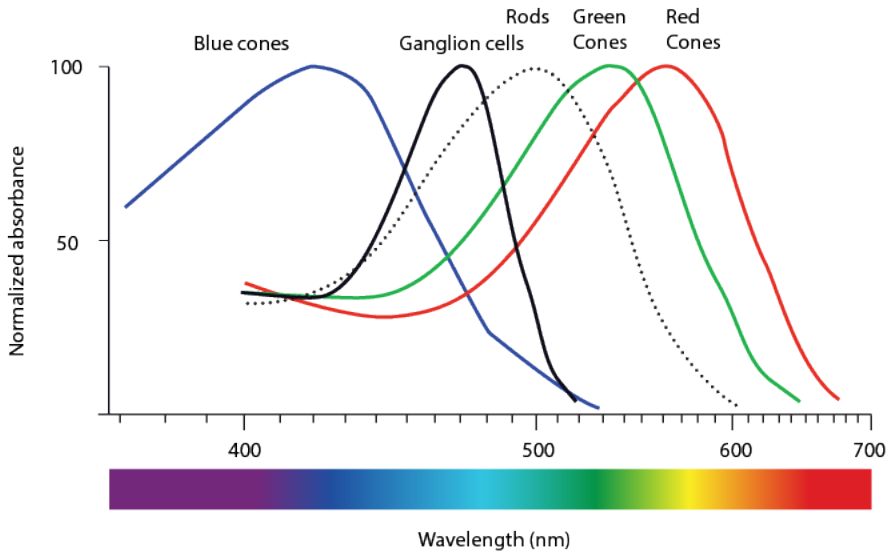


Figure 8: Normalized human photoreceptor absorbances for different wavelengths of light

N	radius	distance	ratio	density	contacts	rattlers	boundary	symmetry group	optimal
1	1.000	1.000	1.000	1.000	-	1	-	-	proven
2	0.500	2.000	2.000	0.500	3	-	2	D_2	proven
3	0.464	1.732	2.154	0.646	6	-	3	D_3	proven
4	0.414	1.414	2.414	0.686	8	-	4	D_4	proven
5	0.370	1.175	2.701	0.685	10	-	5	D_5	proven
6	0.333	1.000	3.000	0.666	12	-	6	D_6	proven
7	0.333	1.000	3.000	0.777	18	-	6	D_6	proven
8	0.302	0.867	3.304	0.732	14	1	8	D_7	proven
9	0.276	0.765	3.613	0.689	16	1	9	D_8	proven
10	0.262	0.710	3.813	0.687	20	-	8	D_1	proven
11	0.254	0.684	3.923	0.714	24	-	8	D_1	proven
12	0.248	0.660	4.029	0.739	24	-	9	D_3	proven
13	0.236	0.618	4.236	0.724	26	-	9	D_1	proven
14	0.231	0.600	4.328	0.747	29	-	10	D_1	conjectured
15	0.221	0.567	4.521	0.733	30	-	10	D_5	conjectured
16	0.216	0.553	4.615	0.751	32	-	11	D_1	conjectured
17	0.208	0.527	4.792	0.740	35	-	10	D_1	conjectured
18	0.205	0.517	4.863	0.760	42	-	12	D_6	conjectured
19	0.205	0.517	4.863	0.803	48	-	12	D_6	proven
20	0.195	0.485	5.122	0.762	38	1	13	D_1	conjectured
21	0.190	0.470	5.252	0.761	38	2	14	D_1	no
22	0.183	0.450	5.439	0.743	44	-	13	-	no
23	0.180	0.440	5.545	0.747	46	-	13	-	no
24	0.176	0.429	5.651	0.751	44	2	16	-	no
25	0.173	0.420	5.752	0.755	48	1	13	-	no
26	0.171	0.414	5.828	0.765	48	2	15	-	no
27	0.169	0.407	5.906	0.773	54	-	15	C_3	no
28	0.166	0.398	6.014	0.773	52	2	14	C_2	no
29	0.162	0.389	6.138	0.769	50	4	17	-	no
30	0.161	0.384	6.197	0.781	60	-	16	D_2	no
31	0.158	0.377	6.291	0.783	84	-	12	D_6	no
...									
91	0.094	0.209	10.56	0.814	210	-	30	C_6	no

Table 1: Best known packings of circles into a circle