

THE TRUE AXIOM

Writing Short Stories Inspired by Science



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TABLE OF CONTENTS

| | | |
|----------|---|-----------|
| 1 | Introduction | 2 |
| 2 | The Writing Process | 3 |
| 2.1 | Choice of Genre | 3 |
| 2.2 | Where to Start | 4 |
| 2.3 | Research | 5 |
| 2.4 | Creating a First Draft | 6 |
| 2.5 | Editing | 7 |
| 2.6 | Self-Publishing | 8 |
| 3 | Inspiration and Connection to the Sciences | 10 |
| 3.1 | Overarching Themes | 10 |
| 3.1.1 | The Futile Pursuit of Truth | 10 |
| 3.1.2 | Circularity and the Ouroboros | 13 |
| 3.1.3 | Consciousness in the Face of Reality | 16 |
| 3.2 | A Minute of Silence Before Midnight | 17 |
| 3.3 | Mirrors | 18 |
| 3.4 | Midday Moon | 19 |
| 3.5 | The Socialising Monkey Theorem | 20 |
| 3.6 | A Pair of Dice | 21 |
| 3.7 | Rubikon | 21 |
| 3.8 | Droplets in a Pond | 23 |
| 3.9 | A Letter to You | 25 |
| 4 | Conclusion | 27 |
| 5 | Acknowledgements | 29 |
| 6 | Bibliography | 30 |
| 6.1 | Images | 30 |
| 6.2 | Books and Magazines | 30 |
| 6.3 | Scientific Journals and Papers | 31 |
| 6.4 | Online Sources | 31 |
| 7 | Appendix | 33 |

1 INTRODUCTION

According to Stephen King, “If you want to be a writer, you must do two things above all others: read a lot and write a lot. There’s no way around these two things that I’m aware of, no shortcut.”¹ While I have always been an avid reader, most of my writing until now had been in the form of essays for school. Whenever the teachers allowed it however, I preferred to write stories instead of argumentative texts. As such, it was long overdue for me to finally take the creative craft into my own hands and use that freedom to produce an original work. After many long nights and re-written sentences, I brought my dream to fruition and published my first book: A collection of short stories called *A Quiet Night*.

I decided very early that I would like to write short stories, as it is the genre that I am most familiar with. Unlike other short story collections, this project was not simply going to be an anthology of literary pieces, but of texts with a common theme, so I could unite all stories into one product. Therefore, before I even began to write, I worked out the theme that I wished to make the subject of my work. As I am just as passionate about mathematics and physics as I am about writing, I decided that I would connect my writing to these other passions. The inspiration on how to do that came from an earlier work of mine.

In January of 2018, I produced an analytical paper treating the symbol of *Maxwell’s Demon* in Max Frisch’s “Homo Faber”.² Maxwell’s Demon is a thought experiment in thermodynamics first proposed by J.C. Maxwell in 1871.³ I was fascinated by how Frisch managed to encapsulate the most important aspects of “Homo Faber” within that symbol: The thought experiment dealt with the same ideas as the book, namely the irreversible passing of time, chaos versus determinism, and the impossible wish for an infinite life.⁴ What I found most interesting, however, was not how carefully chosen this thought experiment was by Frisch, but rather how one could interpret a merely scientific principle and apply it to human and societal ideas.

¹ King, Stephen. *On Writing: A Memoir of the Craft*, Scribner, 2000. p. 145.

² The paper can be found here: <https://www.scribd.com/document/437623391/Homo-Aeternus>.

³ Maxwell, James Clerk. *Theory of Heat*, Longmans, Green, and Co., 1902. p. 338.

⁴ Horn, Peter. *Der Maxwellsche Dämon und die Entropie zur Liebe*, 1994. pp. 2-4.

As such, I aimed to create a link similar to the one established by Frisch, but reversed, meaning that I started with inanimate scientific principles, and wrote stories to match them, just like “Homo Faber” matches Maxwell’s Demon. In other words, I tried to treat a concept from mathematics or physics as I would treat a good book: Striving to understand the hidden messages, or what it could tell me about life and the world. Obviously, in a book those messages are intentionally placed, while the natural sciences do not have a moral. That is irrelevant, however, as one can still be inspired by such concepts.

As I intended to write a *collection* of short stories, I decided that I would self-publish the stories in a book, which would be the creative product of my matura paper. The main goal was thus to write, design and self-publish a short story collection inspired by scientific ideas.

2 THE WRITING PROCESS

2.1 CHOICE OF GENRE

It was clear from the very start of this project that I would write short stories. The main reason was, of course, that it was the only genre in fiction where I had some experience. Whether it be an essay that must be finished in two lessons or a story written at home on the weekend, I never spent more than a few hours on a text. Therefore, most creative texts I have written are short stories.

But there is more to it than just practicality. I find that short stories are more natural than other genres, as they are the perfect format for spontaneous ideas. A novel takes a lot of time and planning to write, poetry often requires careful thought about metrics and rhyming, but short stories can be written in one short, inspired burst. This is because they usually focus on one mood. Edgar Allan Poe argues that “*A short story must have a single mood and every sentence must build towards it.*”⁵ Therefore, if one has a firm grasp of the mood that should be encapsulated, the rest often comes naturally. As F. Scott Fitzgerald

⁵ Poe, Edgar Allan. *Graham’s Magazine*, Volume 20, Number 5, (Review by Edgar Allan Poe of Nathaniel Hawthorne’s collection *Twice-Told Tales*, Volume 2.) 1842. pp. 298-299.

puts it, you have to “[f]ind the key emotion; this may be all you need [to] know to find your short story.”⁶

However, this does not mean that short stories can always be written quickly or without a second thought: Some of my stories also needed thorough planning. But I think that short stories are the genre we naturally gravitate towards when we want to put an interesting idea into words.

Additionally, this genre offers great artistic freedom because when writing a collection, one is not constrained to one specific format, theme or style. Personally, I am especially fond of visual endings, as can be seen in “Mirrors”, “Midday Moon”, “A Letter to You” or even “The Socialising Monkey Theorem”. These endings would hardly have been possible within a novel.

The short story therefore was a perfect fit for my project, as it allowed me to experiment while still not being overwhelmingly complex to create.

2.2 WHERE TO START

Even though my goal was to find inspiration in the sciences, it was not always necessary to start with the scientific concept. In “A Minute of Silence Before Midnight”, the initial inspiration was simply the image of a child sitting on a bell tower. The connection with mathematics was developed later. Sometimes a word or phrase was the first inspiration: I liked the word “Rubicon”, noticed that it sounded like “Rubik” and began working from there for “Rubikon”. Similarly, I remarked that the phrase “A Pair of Dice” could be mistaken for “A Paradise” when said quickly and decided to incorporate this into a story. For “Midday Moon”, I found anagrams of “entropy” and thought about how to integrate them into a narrative.

Other times, however, the scientific concept really was the first spark of a story. The meaning behind “A Letter to You”, which is also the overarching theme, was the result of pondering the nature of mathematics. “The Socialising Monkey Theorem” was also mainly inspired by the Typing Monkey Theorem.

⁶ Strowbridge, Clarence C. *American Short Story Masterpieces*. Dover, 2013. p. xii.

In general, I have found that inspiration can come from anywhere, and I formed the habit of writing down any idea that seemed interesting, no matter how small or irrelevant it seemed. But inspiration is not always a sudden flash of creativity; most often it is a long and strenuous process. For many of the stories, even if I had an initial spark, I would have to expand it into a complete and working idea. And when one is trying to find inspiration to invent a new story, I have found that the best friend of creativity is often boredom. I would sometimes spend hours in front of a white sheet or walking around, at times concentrating rigorously on the story, other times letting my thoughts wander, and usually, some new ideas always appeared.

The main concept of a story was always the hardest to find. Once I had that, I started to write down ideas for that concept and began to develop a plot. Only when I had a story roughly planned out, would I start writing.

2.3 RESEARCH

A common piece of advice for creative writing is to “write what you know.” On the other hand, British novelist Kazuo Ishiguro remarks that *“‘Write about what you know’ is the most stupid thing I’ve heard. It encourages people to write a dull autobiography. It’s the reverse of firing the imagination and potential of writers.”*⁷

I, too, wrote about things previously unknown to me. However, it is crucial to do enough research, both before starting on a new story and while writing or editing it, or else the story will not come across as genuine. I almost exclusively used the internet for research, as it is easy to find very specific information. I learned a lot about Irish tea culture while writing “Midday Moon”, and similarly I found several accounts of how it feels like growing up deaf for “A Minute of Silence Before Midnight.” I also used Google Maps quite often,

⁷ Admin. “Kazuo Ishiguro Talks Zuckerberg, Game of Thrones and His New Novel.” *Shortlist*, 11 Mar. 2015. Retrieved: 24 Nov. 2019, <https://www.shortlist.com/news/kazuo-ishiguro-talks-zuckerberg-game-of-thrones-and-his-new-novel>.

especially the street view feature; the setting of “A Pair of Dice” is even entirely inspired by a real place⁸ near Las Vegas.

Of course, the largest part of my research was dedicated to mathematics and physics, by sifting through fascinating Wikipedia pages or watching educational videos on YouTube, which offered excellent explanations of complex subjects.

2.4 CREATING A FIRST DRAFT

British author Terry Pratchett once said that “*The first draft is just you telling yourself the story.*”⁹ This is an incredibly helpful approach, as it encourages one to just write without thinking of outside perception. The first draft is about tying together all the ideas one has collected for a story, and about creating an atmosphere. While setting, plot or characters may change during editing, the atmosphere and initial inspiration should remain the same, so as not to lose the core concept of a story.

It is better to continue writing even when one is unsure of the quality, because “*You can always edit a bad page. You can’t edit a blank page*”¹⁰, as the American writer Jodi Picoult notes. There were moments when I felt stuck and it seemed impossible for the story to advance. Instead of trying to find the perfect next sentence, one should simply try to reach a conclusion. It is much easier to improve upon an existing mediocre story than to write it perfectly on the first try. However, there may be times when even writing poorly is a hassle and one struggles to find the right words, so much so that the writing is slowed down drastically. I have found that in those cases a good night’s sleep can bring a new perspective to a story.

⁸ “THE RESORT ON MOUNT CHARLESTON” *TripAdvisor*. Retrieved: 18 Nov. 2019, https://www.tripadvisor.com/Hotel_Review-g45978-d557993-Reviews-The_Resort_on_Mount_Charleston-Mount_Charleston_Nevada.html.

⁹ “A Quote by Terry Pratchett.” *Goodreads*. Retrieved: 24 Nov. 2019, <https://www.goodreads.com/quotes/644139-the-first-draft-is-just-you-telling-yourself-the-story>.

¹⁰ Charney, Noah. “Jodi Picoult on Writing, Publishing, and What She’s Reading.” *The Daily Beast*, 3 Apr. 2012. Retrieved: 24 Nov. 2019, <https://www.thedailybeast.com/jodi-picoult-on-writing-publishing-and-what-shes-reading>.

Other times, especially with my shorter stories such as “Mirrors”, “Rubikon” or “A Letter to You”, the first draft came effortlessly. This was largely due to the simple plot of the stories, which allowed me to write without having to plan ahead. Instead, I could focus on capturing the initial thought of the story. These types of stories produce the best results when written immediately after the initial inspiration, and when written in one day.

2.5 EDITING

King’s advice on editing is to *“write with the door closed, rewrite with the door open.”*¹¹ While the first draft should be as personal as possible, editing must be objective. It is not always easy to accept criticism, as a creative text can be very intimate. But when editing, one must learn to part from ideas, even if they might have seemed great in the beginning. I found that it is best to wait at least one day after writing a story before editing it. This allows one to distance oneself from the product and therefore be more unbiased while making revisions.

Personally, I always started the editing process by printing out the story and reading it aloud, marking parts that seemed awkward or that I did not like. Then, I would pass the story on to Ms Buergi, my primary advisor. She would mark any grammar or vocabulary issues and provide valuable feedback regarding the content. This proved to be incredibly helpful, as a second perspective can reveal issues that one would not have noticed otherwise. Sometimes I asked friends or family members, to chime in as well, to get even more diverse feedback.

However, it is essential not to accept criticism blindly: Some ideas might be worth keeping, and different people might expect different changes to be made to a text. In the end, a story must primarily please the author. A particular balance has to be found between removing personal bias while editing without taking away what makes a text unique.

¹¹ King, *A Memoir*, p. 57.

2.6 SELF-PUBLISHING

I wanted to have a physical book as a product, but traditional publishing was clearly not a realistic option, as this would have required me to hire a literary agent. Additionally, I would have had to compete against professional writers. Therefore, I decided that I would self-publish instead.

Self-publishing refers to any kind of publication which does not involve an established publisher. This means that the author oversees all the steps of the process, except printing and selling the book.¹²

I considered different self-publishing options and soon settled on *kindle direct publishing* or KDP, a service provided by amazon.com. KDP offered some important advantages: There were no upfront costs, because the books are printed on demand. I could decide the price, the only condition being that it had to cover the printing cost. Additionally, I would keep all rights to my stories. And because the book would be distributed over Amazon, this meant that it would be available on a widely known and trusted website.

After having sufficiently informed myself, I began to prepare my finished manuscript for print. First, I formatted the interior: I had to find the right page size and margins, as well as choose fonts and styles for the text. This step was done entirely with Microsoft Word. Next, I designed a book cover (see *Figure 1*) using GIMP, an image manipulation program. Then, I had to enter the metadata of my book, such as description, keywords, categories, title and author name. After having set the price, I was ready to publish.

¹² Morrissey, Siobhan. *Self-Publishing vs. Traditional Publishing: How to Choose?* Miami Herald, 16 Nov. 2014. Retrieved: 27 Nov. 2019, <https://www.miamiherald.com/news/business/biz-monday/article3950085.html>.

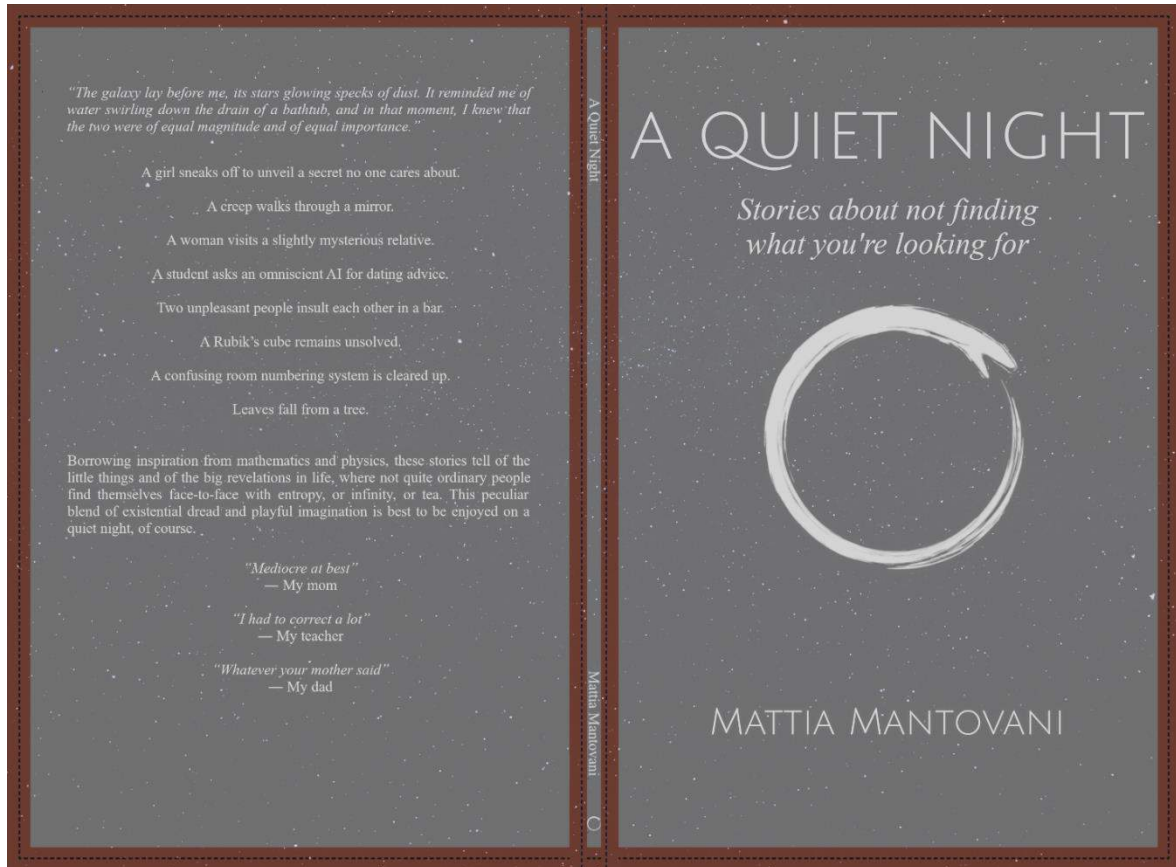


Figure 1: Final cover design with superimposed guidelines. The dotted black lines indicate the trim size, i.e. where the cover will be cut/folded. The red region indicates the margins. All relevant content should stay within the margins.

There are some disadvantages to self-publishing. First and foremost, it is much more time consuming than regular publishing, especially when done for the first time. This is mainly because the author has to prepare the book for print himself. Additionally, I found that with KDP, the guidelines are not always clear or intuitive. As a result, I had to re-do some steps multiple times, e.g. due to wrong measurements being given for the cover or margins. Another drawback is that a self-published book will not get reviewed by editors, so some mistakes might go unnoticed. And lastly, the book will not be marketed or promoted through self-publishing (unless the author does it), and it is very unlikely that it will be picked up by a bookstore.

Still, self-publishing is a great tool, especially for aspiring writers who might not yet be ready for the scrutiny of traditional publishers.

3 INSPIRATION AND CONNECTION TO THE SCIENCES

3.1 OVERARCHING THEMES

Before I started working on the collection, I spent a lot of time devising the main concepts of my book, so that all of the stories would be tied together. In order to find these main concepts, I wished to draw inspiration from the sciences. I therefore began with a thorough investigation of mathematics. This resulted in three main themes that would unite the stories.

3.1.1 THE FUTILE PURSUIT OF TRUTH

The first question I posed was whether mathematics has a clear, agreed upon definition, which I soon found out that it has not.¹³ For the purpose of my book, I decided to work with the formalist definition, as it was closest to my personal belief.

According to formalists, such as David Hilbert, mathematics is only a language and a game.¹⁴ So on one hand, mathematics is a language, where symbols such as operators and numbers have certain meanings. These symbols form the vocabulary of mathematics. Simple mathematics can therefore be easily translated into English: Two and two equals four. And on the other hand, mathematics is a game. But it is no arbitrary game with arbitrary rules: Hilbert argues that “[mathematics] is a conceptual system possessing internal necessity that can only be so and by no means otherwise.”¹⁵ In other words, it must be logical. $2+2$ must always equal 4, because there is no other possibility. There is no way to put two apples in an empty basket, then two more, and end up with something else than four.

Therefore, mathematics might be called the study of the patterns that arise when we use the mathematical vocabulary logically. So, ultimately, our mathematical system is defined

¹³ Tobies, Renate. *Iris Runge: A Life at the Crossroads of Mathematics, Science, and Industry*. Springer Basel, 2012. p. 9.

¹⁴ Detlefsen, Michael. “HILBERT’S FORMALISM.” *Revue Internationale De Philosophie*, vol. 47, no. 186 (4), 1993. pp. 285–304.

¹⁵ Hilbert, David, et al. *Natur Und Mathematisches Erkennen: Vorlesungen, Gehalten 1919-1920 in Göttingen*. Birkhäuser, 1992. p. 14.

by the rules of logic. But what are these rules? One might be inclined to say that $2+2=4$ is a rule, because the veracity of the statement seems to arise naturally, just by thinking about it. In fact, however, we draw this conclusion using much more basic logical rules. The most basic rules of mathematics can be formalized into what we call axioms.¹⁶ For example: For any value x and y , if $x=y$ is valid, then $y=x$ must also be valid. This is called the symmetric property of equality. As one can see, this axiom describes an extremely basic concept.

If one combines multiple axioms, one receives an axiomatic system. Similar to a rule book, an axiomatic system determines the very basics of what is allowed. All of mathematics is based on an axiomatic system, although which exact axiomatic system should be used is still being debated.¹⁷ Every proof in mathematics can, in theory, be derived from its set of axioms¹⁸, even though it might be an incredibly complex or time-consuming process. This means that mathematics is defined by the axioms.

This was the basis for my reflexions, and from this I wanted to derive a concept that I would use in my stories. My next question was therefore: What is the root of mathematics? This question belongs to the field of *philosophy of mathematics*. Because philosophical theories usually cannot be proven, it is a highly debated question and it does not of yet have a clear answer. The following arguments stem from my personal philosophy and do not reflect all of the different opinions in the field, as my goal was only to use them as inspiration for my book.

I will explain the philosophical model I personally used as a frame for my stories and ideas relating to them. I argued that to find the root of mathematics one must first ask how we choose the axioms that we use. There are two main criteria. First, we must choose them in such a way that no contradiction happens. Additionally, we want to make sure that the resulting system is intuitive and logical. It should reflect the way we think already and the way we would automatically work with mathematics. This means that the axioms are chosen based on human logic.

¹⁶ Wikipedia contributors. "Axiom." *Wikipedia, The Free Encyclopedia*, 19 Oct. 2019. Retrieved: 20 Oct. 2019, <https://en.wikipedia.org/wiki/Axiom>.

¹⁷ Begg, Andy. "Mathematics 101: Reconsidering the Axioms." *International Journal of Mathematical Education in Science and Technology*, vol. 42, no. 7, 2011. pp. 835–846.

¹⁸ Megill, Norman. "Proof Explorer - Home Page." *Metamath*, 14 Oct. 2019. Retrieved: 23 Oct. 2019, <http://us.metamath.org/mpegif/mmset.html>.

However, human logic is not an absolute truth: Logic is a tool that we humans developed through evolution, as it allowed us to understand and manipulate the world better.¹⁹ This brings us to the limitations of human logic: As it stems from evolutionary processes, it is adapted to daily life. In other words, logic is an incomplete instinctive extrapolation of the rules of the universe. Since mathematics is based on logic, it is the formalization of these instincts. This is exactly the problem: Our logic works very well for counting apples, but not so well for anything outside of our scale, such as quantum physics. And therefore, we are limiting the potential of mathematics, as our method for choosing axioms is primitive. We have built the greatest cognitive tool since the invention of language on the basis of apple-counting. It is like using Excalibur to cut a birthday cake.

This was the first and most important concept I developed for this project. The underlying idea was therefore that to truly unify all of physics, one would have to find the correct set of axioms, so that the rules of that axiomatic system not only coincide with the logic of human everyday life, but also with the internal logic of microscopic or relativistic processes. It would be an axiomatic system which perfectly coincides with the underlying rules of the universe. I called this idea the “True Axiom”. I imagined that finding it would mean to gain a completely new understanding of logic and of all processes in the universe. This, of course, is just a philosophical theory I devised for the purpose of the creative process only.

But there is a problem with the concept of a “True Axiom”: There are two theorems of mathematical logic, called *Gödel’s incompleteness theorems*, which mathematically prove that first of all, in any system of axioms there will be obvious truths we cannot prove, and that secondly, no axiomatic system can demonstrate its own consistency.²⁰ Applying these concepts to my idea of a “True Axiom”, it is clear that even if such an axiomatic system existed and one were to find it, it could not explain all processes in the universe, and there would be no way to know if it truly is the “True Axiom”. Therefore, according to this philosophical model it is impossible to bring physics to completion.

The concept of a “True Axiom” is closely related to the notion of absolute truth. If there is no way of completing physics, no way of having absolute understanding of the universe,

¹⁹ Smith, Jan M. “Evolution and Logic.” *Epistemology versus Ontology*, 2012, p. 135.

²⁰ Goldstein, Rebecca. *Kurt Gödel: Jahrhundertmathematiker Und Grosser Entdecker*. Piper, 2007. pp. 186-187.

then absolute truth cannot exist. Any statement can be true only within its context. For example, in the macroscopic world it is completely correct to say that an object cannot be in two places at the same time, but in quantum physics this is possible due to superposition.²¹ For any statement, there might be an unexplored situation where that statement is incorrect. Therefore, absolute truth does not exist, but rather only knowledge, which is relative truth: Statements that are correct within their context, even though they cannot be proven.

Consequently, applying this idea to my book, I decided that the stories should be about quests for truth, which eventually turn out to be futile, as we saw that absolute truth cannot exist within this philosophical model. The only thing that can be achieved is knowledge. But knowledge is useless without wisdom, and wisdom is a uniquely human trait, which in contrast to knowledge, does not necessarily stem from cold observation, logic or reason, but rather emotion, experience and understanding.

The underlying message of my texts is therefore that we, as humans, strive for truth, attain only knowledge and lack the wisdom to use it properly. It should thus not be our goal to increase our power over nature, but rather to first take a good, hard look at ourselves and think about who we want to be. For me, it is obvious: We should strive to be human. We should strive to cultivate the positive aspects of our human nature, such as compassion, creativity, bravery, and ingeniousness, so that we may learn to use the knowledge we gain to the true benefit of humankind.

3.1.2 CIRCULARITY AND THE OUROBOROS

A second idea arose while I was already in the middle of writing my third story. It was the idea of a circular book. I achieved this effect by making the first and the final sentence identical, and by implying that the book was actually written by a character in a story. Additionally, the idea of circularity is represented by the ouroboros (see *Figure 2*), the snake or dragon eating its own tail, which appears on the cover and at the very end of the

²¹ Leman, Jennifer. "The Biggest Quantum Breakthrough Yet-Literally." *Popular Mechanics*, 2 Oct. 2019. Retrieved: 25 Nov. 2019, <https://www.popularmechanics.com/science/math/a29339863/quantum-superposition-molecules/>.

book. The ouroboros originated in ancient Egyptian iconography but was later adopted by western culture. It was most notably used in alchemy as a symbol for eternity and the cycle of birth and death.²² I will go into further detail regarding the implementation of circularity in chapter 3.9: *A Letter to You*.



Figure 2: A depiction of the ouroboros from 1478, originally found in an alchemical text²³

Once again, this idea of circularity stemmed from a scientific concept, namely a theory in physics called the *Boltzmann universe scenario*. It is named after Ludwig Boltzmann, an Austrian physicist who first proposed the theory in 1896.²⁴ To understand it, we first have to understand one of the key features of the universe: Entropy.

Entropy is a measure of disorder.²⁵ The second law of thermodynamics states that in a closed system, entropy must always increase, which is to say that disorder must increase.²⁶ One example from everyday life would be the mixing of milk and tea: The molecules will mix evenly, and it is impossible to stir the tea in such a way that the milk molecules will

²² Editors of Encyclopaedia Britannica. "Ouroboros." *Encyclopædia Britannica*, 11 Dec. 2017. Retrieved: 23 Nov. 2019, <https://www.britannica.com/topic/Ouroboros>.

²³ Figure 2 retrieved: 30 Nov. 2019, <https://en.wikipedia.org/wiki/Ouroboros>.

²⁴ Wikipedia contributors. "Boltzmann brain." *Wikipedia, The Free Encyclopedia*, 29 Oct. 2019. Retrieved: 28 Nov. 2019, https://en.wikipedia.org/wiki/Boltzmann_brain.

²⁵ Daintith, John. *Oxford Dictionary of Chemistry*. 6th ed., Oxford University Press, 2008. p. 77.

²⁶ Forrest, Jeffrey Yi-Lin, et al. *Systems Science: Methodological Approaches*. CRC Press, 2017. p. 99.

separate from the tea again. This is because the molecules will automatically tend to arrange themselves in a state of disorder. It is crucial to note that the second law of thermodynamics, unlike other physical laws, is a statistical phenomenon²⁷; there is no physical force that compels the molecules to mix, but the mixing is rather a result of probability. An even distribution is simply the most probable outcome.

This tendency towards the most probable outcome can be applied to the universe as a whole, meaning that the universe tends towards the most disordered state.²⁸ Much like with the tea, where cold milk and hot tea form an even mix, the universe will inevitably approach an even mix. This means that all particles in the universe will make up a sort of “uniform soup”, without there being such a thing as planets or stars. As this “soup” will be all at the same temperature, this state of the universe is called *heat death*. It is also sometimes called *Big Chill* or *Big Freeze*, as it will in fact be quite cold.²⁹

This is the basis of one of the greatest unsolved problems in physics³⁰: If entropy always increases, then how come that we live in a universe with rather low entropy? Would it not make more sense for the universe to be in a constant state of maximal entropy, i.e. heat death? Boltzmann advanced two theories to resolve this problem. The first was that the universe started in a state of low entropy for unknown reasons. This is the most widely accepted theory nowadays. The second theory is less popular due to some valid criticism which will be explored in chapter 3.9: *A Letter to You*. However, it is still fascinating to think about. It is the theory of a Boltzmann universe.³¹

Boltzmann argued that since entropy is statistical by nature, there would be some fluctuations of order even in a state of heat death, with atoms arranging themselves into organised patterns simply by coincidence. It is therefore also possible (although immensely improbable), that some atoms could arrange themselves to form an entire galaxy, or even

²⁷ “7.3 A Statistical Definition of Entropy.” *Massachusetts Institute of Technology*. Retrieved: 24 Nov. 2019, <https://web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node56.html>.

²⁸ Forrest, *Systems Science*, p. 99.

²⁹ Wollack, Edward J. “WMAP- Fate of the Universe.” *NASA*, 29 June 2015. Retrieved: 25 Nov. 2019, https://map.gsfc.nasa.gov/universe/uni_fate.html.

³⁰ Wikipedia contributors. “List of unsolved problems in physics.” *Wikipedia, The Free Encyclopedia*, 24 Nov. 2019. Retrieved: 30 Nov. 2019, https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_physics

³¹ Wikipedia contributors. “Boltzmann brain.” *Wikipedia, The Free Encyclopedia*, 29 Oct. 2019. Retrieved: 28 Nov. 2019, https://en.wikipedia.org/wiki/Boltzmann_brain.

an entire supercluster of galaxies. This would be a Boltzmann universe. Note that a Boltzmann universe describes only a small region of a universe where entropy is not maximal. Intelligent life might also occur, again simply by atoms that randomly align themselves to form a functioning organism or even just a brain. This would be a Boltzmann brain.³² If one assumes time to be infinite, sooner or later these things *must* happen, simply by chance. Boltzmann claimed that it is possible that our observable universe is simply a random fluctuation in an otherwise uniform universe of heat death. He even went so far as to say that this is the most likely scenario.

These random fluctuations of order could produce anything, of course, from entire galaxies to toasters, since both are only very specific arrangements of atoms. When analysing this in connection to the stories, I asked myself: What if a Boltzmann brain arises, by chance of course, that is somehow intelligent enough to understand and reverse entropy? (Alternatively, it could also have that knowledge implanted already) In such a case, that Boltzmann brain could be able to reverse heat death and return the universe to a state of low entropy. This event could look like the Big Bang.

This would create a circular process, where every time that heat death occurs, sooner or later a Boltzmann brain arises that is capable of reversing entropy. The universe is therefore started anew, but not necessarily in the same way. The ouroboros symbolises this process of birth within death and its infinite nature. This is the second important theme of my book.

3.1.3 CONSCIOUSNESS IN THE FACE OF REALITY

Finally, there is a third theme: The subject of how the mind and the material world relate to each other. This theme was not inspired by science, but rather arose naturally while writing. The two most prominent questions are whether consciousness (in this case relating to humans) has a purpose and whether consciousness is a product of the material world or the other way around. This is most pronounced in four of the stories, namely “The Socialising Monkey Theorem”, “Rubikon”, “Droplets in a Pond” and “A Letter to You”. In these stories I explore different aspects to these two questions; the details of these aspects

³² O’Dowd, Matt. “Are You a Boltzmann Brain?” *Space Time*, 26 Apr. 2017. Retrieved: 25 Nov. 2019, https://www.youtube.com/watch?v=nhy4Z_32kQo.

will be treated later in the respective chapters. In “The Socialising Monkey Theorem”, the main character believes that the purpose of human life should be understanding the universe through pure rationality, and he eventually realises that this is a one-sided perspective. “Rubikon” is about the necessity of consciousness for the material world to exist, and the necessity of the material world for giving purpose to consciousness. Another aspect is the fractalized solipsism of “Droplets in a Pond”, in which consciousness is the only thing that exists and all else is just imagination. Finally, “A Letter to You” treats the idea of whether the mind can ever truly understand the material world.

3.2 A MINUTE OF SILENCE BEFORE MIDNIGHT

The theme of a futile pursuit of truth is obvious in this story: The girl sets out to reveal the secret of hearing, only to realise that she will never be able to hear. However, she understands that this does not matter, as she can use her creativity as a means of imagining sound.

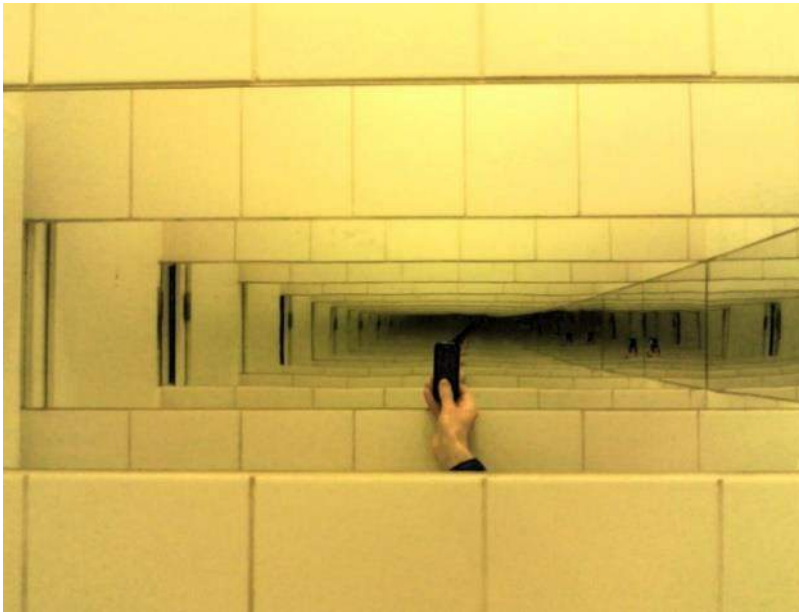
This story has its roots in the idea of describing the fourth spatial dimension. It is impossible for humans to imagine a four-dimensional object visually. However, we can describe it mathematically by simply adding an additional axis and transferring what we know about three dimensions to 4D.³³ This is also a way of imagining the fourth dimension, although not visually, but rather using mathematics as a tool.

Similarly, the girl is missing a sense which she cannot imagine in the usual way. However, instead of mathematics, she uses her creativity as a tool to imagine sound.

³³ Groleau, Rick. “NOVA | The Elegant Universe | Imagining Other Dimensions.” *PBS*, Public Broadcasting Service, July 2003. Retrieved: 20 Nov. 2019, <https://www.pbs.org/wgbh/nova/elegant/dimensions.html>.

3.3 MIRRORS

The configuration of two mirrors reflecting each other as in *Figure 3* is called an *infinity mirror*.³⁴ It is an example of the *Droste effect*, where an image appears within itself recursively.³⁵ This effect was named after “Droste’s Cacao”, a Dutch brand of cocoa in the early 20th century, as their tins (see *Figure 4*) featured this type of recursion.³⁶



*Figure 3: An infinity mirror as seen from an observer standing between the two mirrors*³⁷



*Figure 4: An example of the Droste effect. The image on the tin contains the tin itself.*³⁸

However, not only are the two mirrors recursive, but also the protagonist’s personality is: His daily routine is marked by repetition, and his stalking obsession bears self-similarity, as his observation of his favourite photograph becomes an observation of himself, a reflection. He believes that with every photograph he takes, he will get closer to his full potential, to complete knowledge of the woman he is stalking. Similarly, while he is walking, he thinks that he is getting closer and closer to her full potential or “purity”. However, what

³⁴ Gbur, Gregory. “Infinity Is Weird... Even in Infinity Mirrors!” *Skulls in the Stars*, 30 July 2011. Retrieved: 27 Nov. 2019, <https://skullsinthestars.com/2011/07/30/infinity-is-weird-even-in-infinity-mirrors/>.

³⁵ Wikipedia contributors. “Droste effect.” *Wikipedia, The Free Encyclopedia*, 8 Nov. 2019. Retrieved: 20 Nov. 2019, https://en.wikipedia.org/wiki/Droste_effect.

³⁶ Törnqvist Egil. *Ibsen: A Doll’s House*. Cambridge University Press, 2000. p. 105.

³⁷ *Figure 3*. Retrieved: 30 Nov. 2019, https://en.wikipedia.org/wiki/Infinity_mirror

³⁸ *Figure 4*. Retrieved: 30 Nov. 2019, https://en.wikipedia.org/wiki/Droste_effect

increase of information is believed to be due to quantum processes that occur entirely at random and can therefore not be predicted exactly.⁴²

What does this have to do with freedom of choice? If the universe were deterministic, that would mean that it would be possible to predict a human's entire life. Their destiny would be written in stone, and therefore they would have no real freedom of choice.

But since information is *not* constant, the future is unpredictable, and therefore humans are too. This means that there are different paths possible for any human, making them free.

There is a sort of duality to humanity's relationship with entropy: On one hand, entropy is the enemy of order, and humans and their bodies are highly ordered. On the other hand, entropy grants humans real freedom of choice. Patrick is the personification of this positive aspect of entropy.

3.5 THE SOCIALISING MONKEY THEOREM

The idea behind this story is quite obviously the *Typing Monkey Theorem*, a thought experiment that was first proposed in 1913 by Émile Borel, a French mathematician.⁴³ It is usually a purely mathematical thought experiment, but it can be applied to the universe because of the same mechanisms that produce a Boltzmann universe/brain. In fact, Boltzmann brains are simply a very specific result of the Typing Monkey Theorem.

Again, we can see the circular nature of the situation: Novak's life occurs infinite times, and so does the universe's life. But the central conflict of "The Socialising Monkey Theorem" is that of logic versus emotion. Novak believes that his purpose in life should be to find the truth through methods of reason. However, he himself is paradoxically still influenced by feelings. In the end, he realises that it is impossible for a human to be purely rational, and that there is no absolute answer or truth that can be found through reasoning.

⁴² Hawking, Stephen, and Leonard Mlodinow. *The Grand Design*. Transworld Digital, 2015. p. 72.

⁴³ Borel, Émile. "Mécanique Statistique Et Irréversibilité." *Journal De Physique*, vol. 3, 1913, pp. 189-196.

3.6 A PAIR OF DICE

In this story, the old man draws parallels between the *Game of Pig* and life. But what inspired me for this story was actually the application of game theory to the entire universe. As mentioned before, certain quantum processes occur at random. This can be seen as throwing the dice. These random occurrences either increase entropy or let it remain constant, but entropy can never decrease. Similarly, in the game one either wins points or retains the same point count, but one can never lose points. Here we have the negative aspect of entropy: It can be described as a *non-zero-sum game* where disorder always increases, bringing the universe closer and closer to heat death.

The aspect of *perfect* and *imperfect information* is connected to the aforementioned theory of a non-deterministic universe: Even with perfect information, it is impossible to predict the future. This time, however, the focus is on the negative side of this unpredictability of the universe, and consequently of life.

On the less scientific side, this story treats the topic of vastly differing opinions and perspectives, and the importance of having an open mind. While I do not agree with either of the two main characters or their beliefs, I believe the increasing polarisation due to information bubbles on the internet is extremely problematic. Therefore, I wrote a story where two opposite worldviews collide and somehow have an impact (however small) on the other's outlook on life.

3.7 RUBIKON

The idea behind "Rubikon" is related to the *Hilbert cube*, which is a cube of countably infinite spatial dimensions.⁴⁴ I asked myself what it would look like to turn such a Hilbert cube into a Rubik's cube. For inspiration regarding the description of the cube, I turned to videos of (projections of) 4D cubes rotating (See *Figure 5-8*), then 5D and then 6D, trying to imagine how that would look like in countably infinite dimensions. The description is therefore not mathematically accurate.

⁴⁴ Wikipedia contributors. "Hilbert cube." *Wikipedia, The Free Encyclopedia*. 26 Dec. 2018. Retrieved: 22 Nov. 2019, https://en.wikipedia.org/wiki/Hilbert_cube.

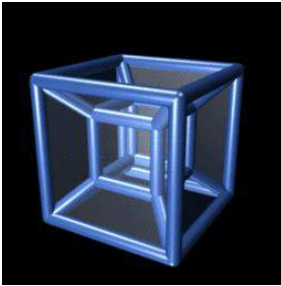


Figure 5: Depiction of a tesseract. The tesseract is the 4D analogue to the cube. The depiction shows a 3D model of a tesseract; it only shows a projection. As it is only a picture, it is in fact a 2D projection of a tesseract.⁴⁵

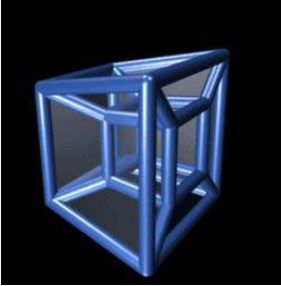


Figure 6: The same tesseract rotated by 90° in the fourth dimension

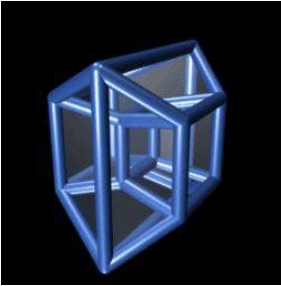


Figure 7: The same tesseract rotated by 180° in the fourth dimension

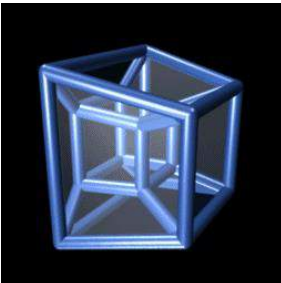


Figure 8: The same tesseract rotated by 270° in the fourth dimension

The meaning behind this story relates once more to an aspect of the relationship between consciousness and the material world. This time, I began my argumentation with the idea of a magical asteroid. Its magical power is that it does not attract other objects, i.e. it has no gravity. Additionally, this asteroid is so far away from every star that no light reaches it. It is therefore impossible to detect and has no influence over any other body. It is as if it did not exist, and it would be unreasonable to assume it *does* exist. This makes it effectively non-existent. As such, something only exists if it is observable.

⁴⁵ Figure 5-8. Retrieved: 30 Nov. 2019, https://en.wikipedia.org/wiki/Four-dimensional_space

However, the only entity that can truly observe is an aware organism. This leads to my personal notion of the defining property of consciousness: Consciousness provides existence through observation.

In this way of thinking, there is an interesting relationship at play between consciousness and the material world. Without consciousness, the material world would not exist. But consciousness cannot exist in isolation, because it is tied to self-awareness, and there has to be something to observe so that self-observation and consequently self-awareness can occur. Thus, the material world provides consciousness with a purpose – to observe.

A similar relationship exists between a normal Rubik's cube and its owner. The owner scrambles the cube, therefore creating the puzzle, and in turn, the cube provides the owner with a purpose, which is to solve the puzzle. And just as it is consciousness that ensures the existence of the material world and therefore something to observe, it is the owner who ensures that there is a puzzle, by scrambling the cube.

In my story, however, the cube cannot be solved. This is again a parallel to the idea of the "True Axiom" which is impossible to achieve. The true solution to the infinity cube is realising that it is useless to try and solve. Still, trying to solve it is not negative or foolish just because it is impossible. There is a lot to learn from the process alone. This is also applicable to the search for absolute truth: Just because it is a futile search does not mean that it has no value.

3.8 DROPLETS IN A POND

Fractals play an important role in this story, as fractalization is the core of the professor's theory. Within the philosophical model of the story, I thought about the size of these "droplets of consciousness". I considered consciousness as not being quantifiable, but I still made a distinction between the God-like beginning or "pond", and the subsequent "droplets". For me, the "droplets" are centralised entities of awareness: They are beings, such as humans, who have an identity, a sense of the self; they are shaped by personal experience. These "droplets" are therefore unique and separated from each other. The "pond", on the other hand, I deemed to be of a different nature. I thought of it not as an individual with feelings or memories, but as a more general concept of distilled awareness,

not tied to a body or a place or a time. It is a concept that exists entirely detached from the universe, and in the story, the universe stems from this “pond” of first consciousness.

In the story, it is described how this initial awareness divides itself into the conscious beings in the universe. But how would such a process be possible, when consciousness cannot be quantified? How does one get from this idea of a spread-out, pure awareness to individuals with an identity? I assumed that it would be like dividing a plane into the single points that make it up, which would only be possible by dividing it infinite times.

I developed the idea of a “fractal tree of life”: I imagined this process of infinite division by using a fractal tree (see *Figure 9*). The tree trunk would be the “pond”, and the individuals would be the very tips of the branches. Between the trunk and the tip of a branch, an infinite amount of divisions takes place. This is how I envisioned the fractalization of this original consciousness.

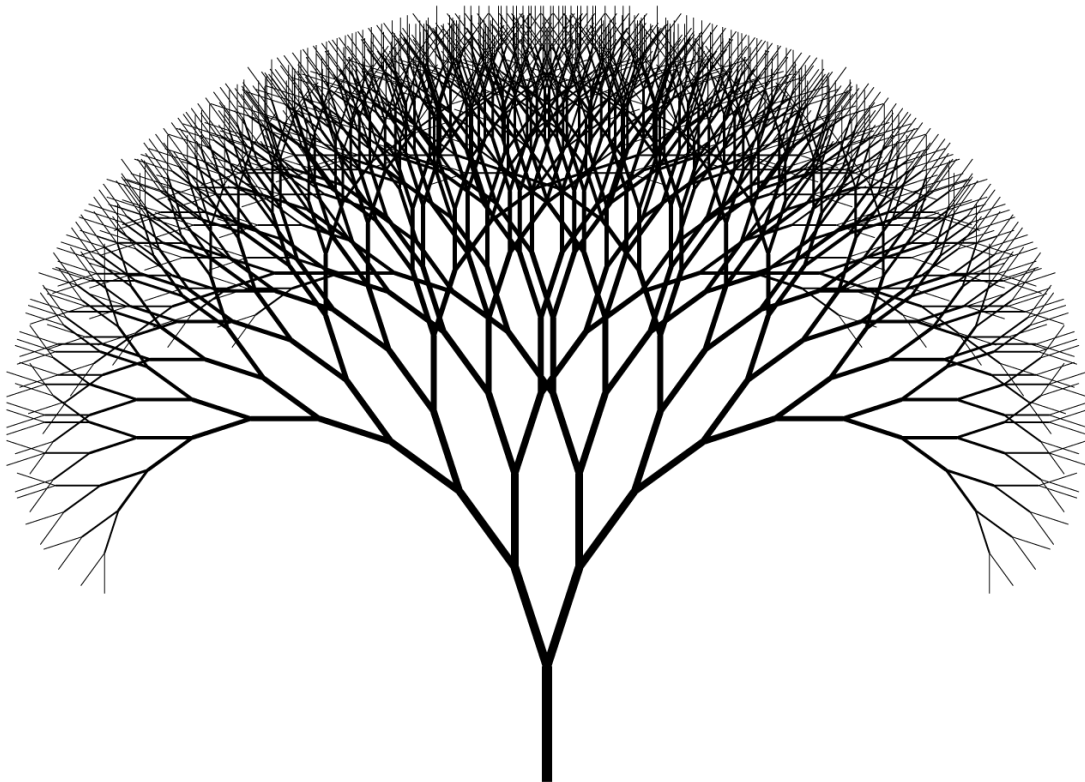


Figure 9: A depiction of a simple fractal tree. In theory, each branch divides into two branches, therefore there should be an infinite amount of bifurcations. This would of course be impossible to depict. ⁴⁶

⁴⁶ *Figure 9*. Retrieved: 30 Nov. 2019, <https://www.cleanpng.com/png-fractal-art-fractal-tree-index-mathematics-olive-t-1131435/>

The professor's theory is a variation of solipsism. However, instead of assuming that one can only be sure of the existence of the self, he assumes that one can only be sure of the existence of consciousness in general. Like in previous stories, the professor understands that the search for a universal truth is futile. This is ironically the answer to the puzzle that consciousness posed itself in the story, which causes him to "re-join the pond". In this case, the realisation of the futility of the quest is actually the destination of the quest.

3.9 A LETTER TO YOU

The last story is also the most cryptic, but it takes up all the important themes again. Firstly, it describes the very end of the search for a "True Axiom", and the protagonist believes that he has found it, understood the universe and is therefore meeting God. This turns out to be incorrect, as the narrator reveals that he is in fact the author of the book. This disproves the idea of a "True Axiom" and of absolute truth once again, because it implies that the universe could always be part of something larger, just as the book is part of our universe. For example, even if one understands our entire universe, it could still simply be a simulation, making all truth in that simulation relative.

This ties into the idea of the Boltzmann brain once again, which brings us to the main counterargument to the Boltzmann universe scenario. It is a *reductio ad absurdum* (which means to disprove a statement by leading it to absurdity through logical conclusions) of Boltzmann's original theory, and it goes as follows: If any low-entropy system only exists due to fluctuations of a heat-dead universe, then smaller fluctuations must be more probable, e.g. it is more probable that atoms randomly arrange themselves to create a marble rather than an entire planet.⁴⁷ Therefore, the most common type of consciousness would not be one that exists within an entire Boltzmann universe, but rather a single brain that emerges by chance, because a brain is a much smaller and less complex structure than an entire galaxy.⁴⁸ Following that logic, the most probable explanation for one's own

⁴⁷ Carroll, Sean M. "Richard Feynman on Boltzmann Brains." *Preposterous Universe*, 27 Apr. 2015. Retrieved: 30 Nov. 2019, <http://www.preposterousuniverse.com/blog/2008/12/29/richard-feynman-on-boltzmann-brains/>.

⁴⁸ Carroll, Sean M. "Why Boltzmann Brains Are Bad." Walter Burke Institute for Theoretical Physics, *California Institute of Technology*, 6 Feb. 2017.

consciousness would *not* be that it arose within a Boltzmann universe. Instead, it is most probable that one's consciousness is, in fact, a singular Boltzmann brain which deludes itself into thinking that an entire universe exists. Such a brain would therefore by chance be wired in such a way that it has all of one's memories and perceptions. However, it would probably only exist for a few seconds at most, as it is only a small fluctuation.⁴⁹ The counterargument to the Boltzmann universe scenario is therefore that if Boltzmann's theory were true, the most probable explanation of one's own existence is that one only became sentient a few seconds ago and will disappear in a few seconds, all the time believing its own fabricated memories and sensations. This is indeed quite absurd.

Obviously, this is a rather far-fetched idea. Nevertheless, this thought experiment is not meant to provide a meaningful theory, but rather to challenge the current frame of thought by pushing it to its boundaries. And it is not impossible for this theory to be true; but it is impossible to prove.

In my opinion, this *reductio ad absurdum* perfectly displays the limits of truth: One cannot know whether one's entire life is simply a second-long fabrication of a random fluctuation in an otherwise dead universe. Similarly, the protagonist could never find out on his own that he only exists for the duration of a story.

Therefore, the protagonist has not found the "True Axiom". Instead, he is handed a pen and encouraged to write on, which he does. He writes the first sentence of the collection, therefore closing the loop. This is symbolised by the ouroboros that appears at the end of the story, indicating that the book is circular and infinite, as it contains itself.

In this story, there is also a direct addressing of the reader, in which he or she is encouraged to "create" too. On one hand, this is an invitation for the reader to try their hand at a creative craft themselves. But on the other hand, this relates back to the idea that we, as humans, should not exclusively strive for truth, knowledge and power, but rather cultivate our humanity. There is a certain hope in this story: Humanity is becoming more and more powerful. I truly hope that we will use this power to create, not to destroy.

⁴⁹ O'Dowd, Matt. "Are You a Boltzmann Brain?" *Space Time*, 26 Apr. 2017. Retrieved: 25 Nov. 2019, https://www.youtube.com/watch?v=nhy4Z_32kQo.

4 CONCLUSION

My main goal for this project was to write, design and publish a collection of short stories inspired by mathematics and physics. And while the roads of this undertaking were not always smooth, I have finally arrived at my destination: *A Quiet Night* is available for purchase on Amazon (Figure 10) and as I held the very first copy in my hands (which can be seen in Figures 12, 13 in the appendix), I knew that all the hard work was worth it. The book turned out even better than I could have hoped for, and while the stories are of course not perfect, they are certainly the best stories I have ever written.

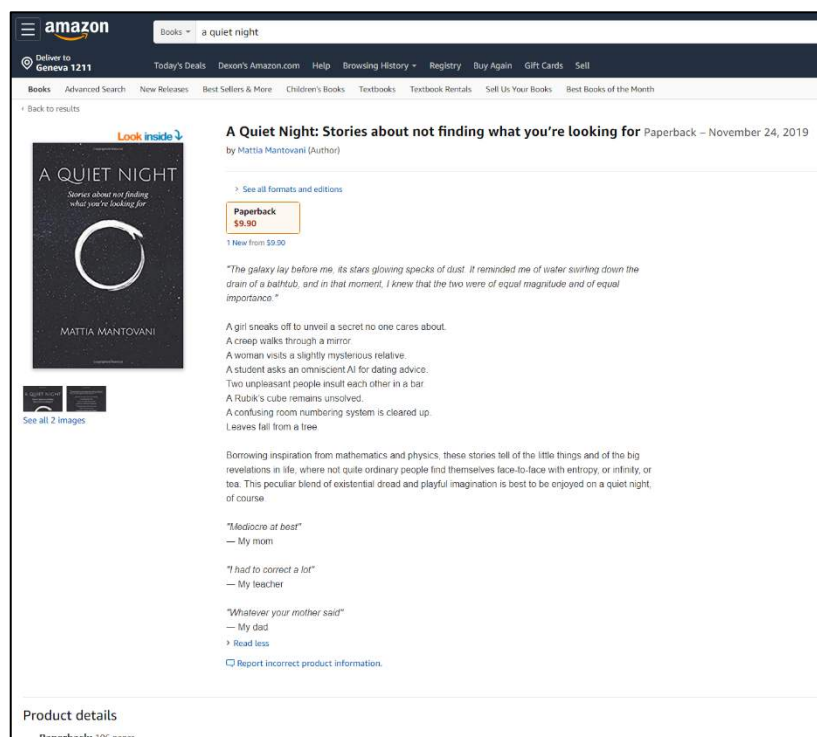


Figure 10: *A Quiet Night* on Amazon, available worldwide

Naturally, there are things that I could have done better. I underestimated how long the writing process would take, as I was used to writing stories in a few days and hardly editing them. If I had had more time, there are some aspects that I would have liked to explore more. Firstly, I had the idea to integrate the video format into my work as well, perhaps to explain the scientific background of my stories. And secondly, it would have been interesting to see how the book would perform commercially and what kind of feedback it would get from readers. This, however, would have required me to publicise and promote my book. Both of these ideas would have taken more time to realise. Nonetheless, I feel like I fully exploited the timeframe that was given.

I realised fairly quickly that I would have to work consistently. This was not easy, as I had to make time to write without neglecting scholarly duties. I wrote the entire collection in the span of three months, starting mid-August and being ready for print around mid-November. I recorded the time spent working each day (including short breaks). Excluding the days when I was not at home, on average, I spent 2h03min each day working on the stories.

In total, I spent around 160 hours on the book; the distribution of which can be seen in *Figure 11*. The category “Research” also contains developing initial ideas, as the two often went hand in hand. It might seem surprising that preparation for print should take that much time (around 33 hours), but that is largely due to the fact that this includes cover design, and that I had to repeat the formatting process a few times because of unforeseen problems.

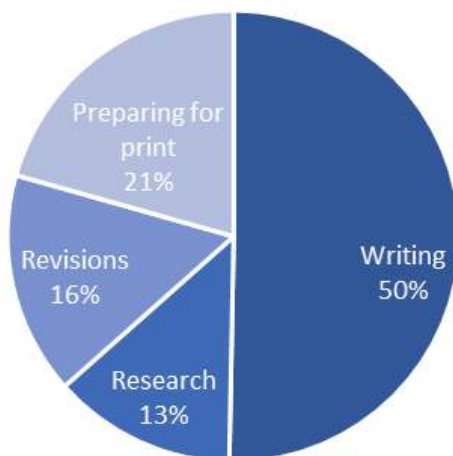


Figure 11: Distribution of work time in percent. Most time was spent on writing, which took around 81 hours

The book itself meets all the goals I had set for myself. Each story is inspired by the sciences and I believe that I have succeeded in connecting the stories with their respective scientific concepts. This peculiar way of inventing a story fits in well with modern times and shows that writing is not only about language, but rather an interdisciplinary process.

The overarching themes are present in each story, so that the stories complement each other nicely in the collection; it feels like a single work. I am also very satisfied with the design, especially the cover. For me, this project was therefore a great success, which shows that it is possible to write and self-publish a book independently, without neglecting other responsibilities and without spending any money. It was a formative experience from which I have learnt a lot, and not only about writing.

5 ACKNOWLEDGEMENTS

First and foremost, I would like to thank my primary advisor, Heidi Buergi, for all the helpful feedback, for recognising when a story did not quite work out and for then telling me how to *make* it work. I would also like to thank Michael Graf for being my secondary advisor and for introducing me to the fascinating field of philosophy of mathematics. Of course, I could not have completed this project without the help of my friends and family, who kept me sane and in a good mood. I especially owe thanks to Alexandra Horvath for her great ideas and her sincere support of my work, and to Carla Herren for being a fan from the very start.

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7 APPENDIX

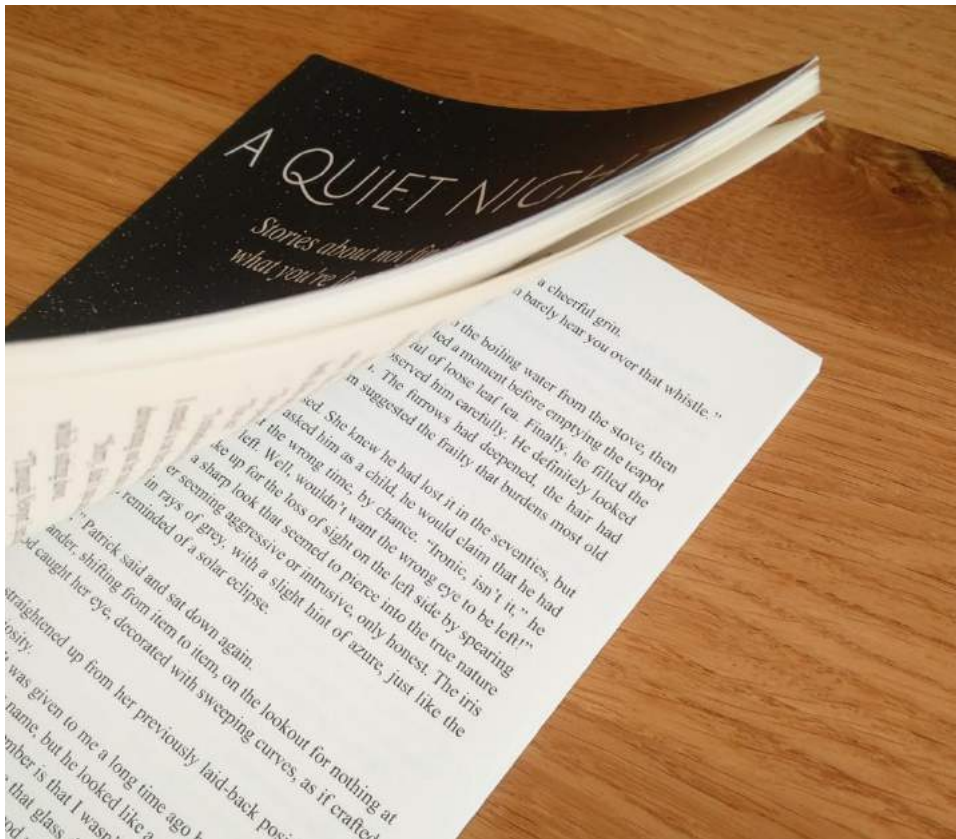


Figure 12: The interior of the book, typeset in Times New Roman

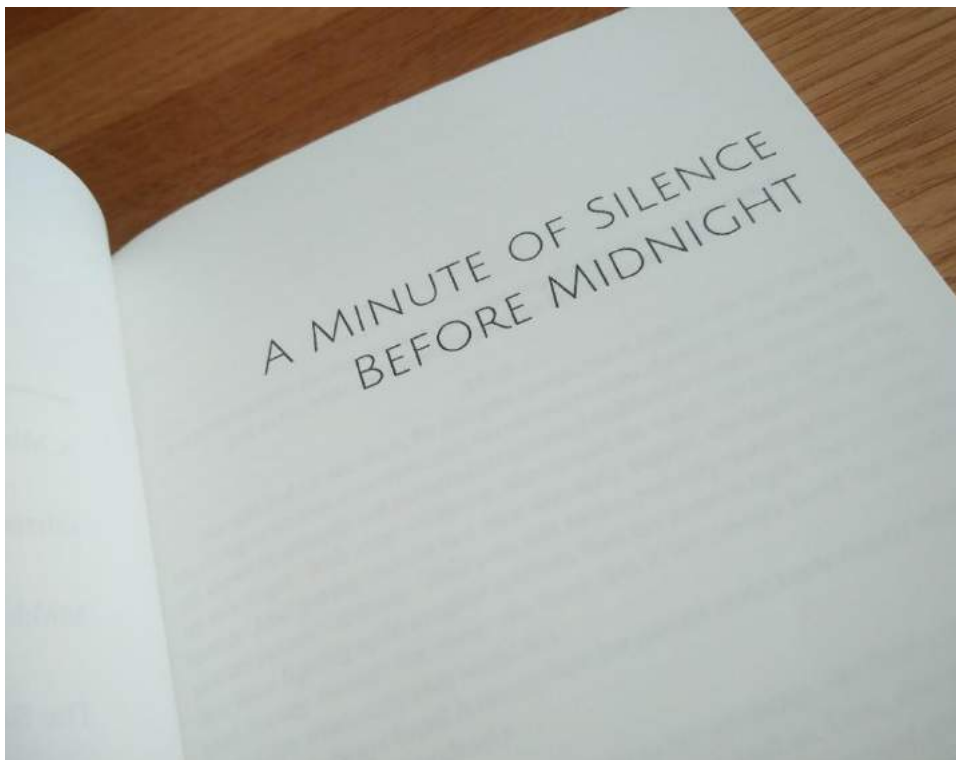


Figure 13: The title of a short story, typeset in Julius Sans One