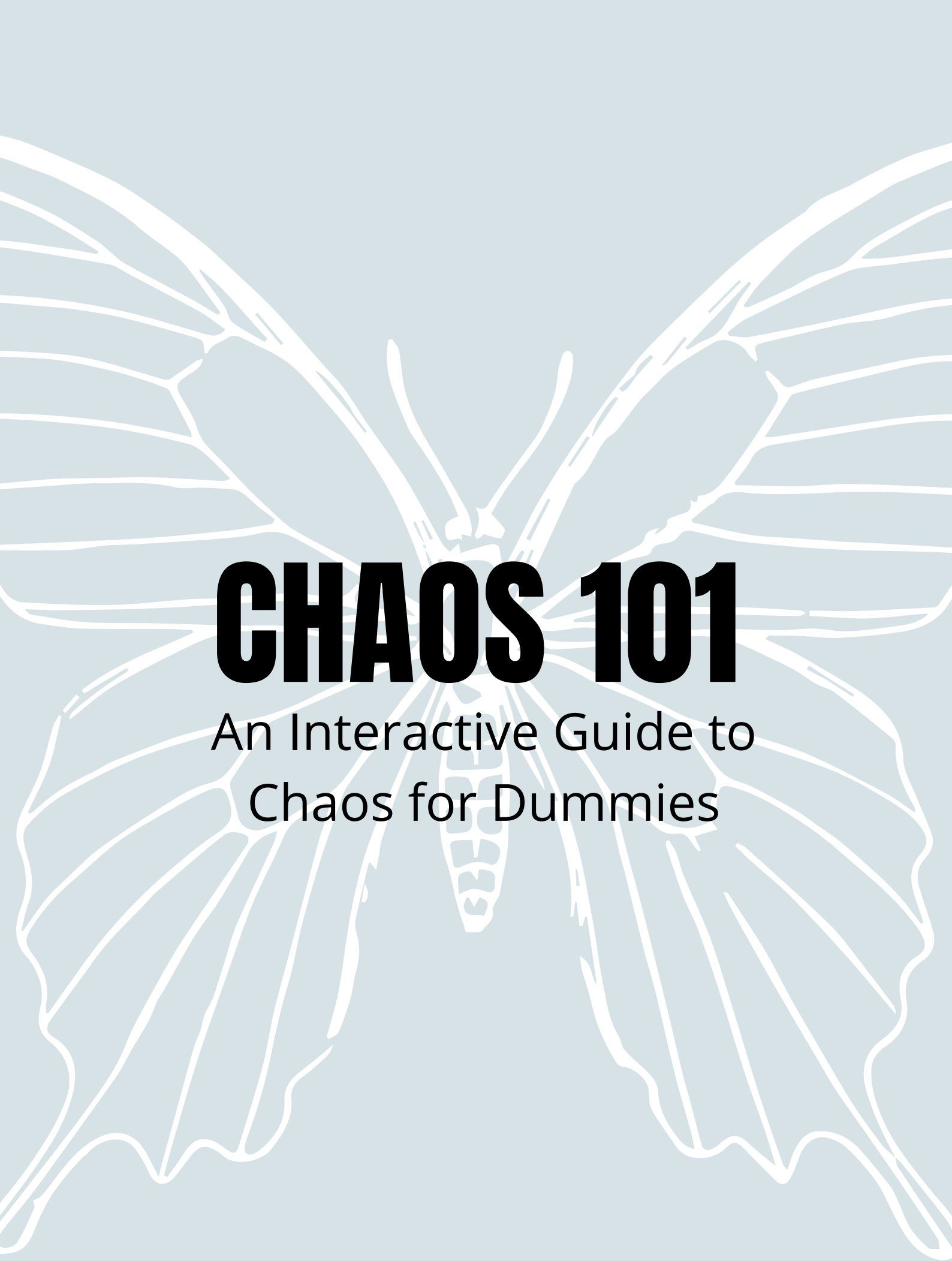

CHAOS 101

An Interactive Guide to
Chaos for Dummies

Utrecht University

This interactive journaling experience is brought to you by our research group for the *Humanities Honours Research Seminar* at Utrecht University, consisting of:

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Also with thanks to: Talitha Mayisha, Victor Rottier, Gerard de Jong, Luuk Leijtens, and Timo Lourens.

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Before we start....

WHAT DOES CHAOS MEAN TO YOU? USE THE WHOLE PAGE!

Introduction

Hello readers!

In this section, we would like to introduce ourselves to you. We are the creators of this interactive journaling experience, and we will be telling you about our disciplines and specialisations. We all had very different perspectives on chaos going into this project, so we hope reading about all our different types of input will be inspiring to you!

ESMEE - Hiya! As a student of English Language and Culture, with a specialisation in sociolinguistics, I love the opportunities that the Humanities Honours Programme gives us to think outside the box. I was able to combine my specialisation with the concept of chaos through this project, as well as my interest in podcast-editing, which is something I'd never have thought of otherwise!

HELEEN - Hi guys! As a Communication & Information Sciences student, this project was very fun and especially 'different' to do. Although it was kind of a (chaotic) rollercoaster sometimes & my understanding of chaos theory is still at a basic level (I'm not really a mathematician), I still learned a lot and really enjoyed working on this. I hope you enjoy reading this and listening to the podcast!

KIM - Hey there! I am in my second year of language and cultural studies with a specialisation in communication, interaction, emotion and cognition. My motivation for participating in this project was to figure out how chaos influenced my life, since it has a very prominent part in my life. I loved the interdisciplinary idea of the project and am very excited for you to read this!

LINDA - Hi! As a Artificial Intelligence student my studies are usually very beta oriented, so I appreciate the opportunity the Humanities Honours Programme has given me to explore other scientific tracks. Although it may have been a struggle at times, I am proud of the way we have been able to combine different views on chaos.

MARIT - Hey you! Another Communication & Information Sciences student here! I loved doing this project because I got to get out of the standard university curriculum and do something different for once. I especially enjoyed the creative part and the multidisciplinary aspect. Hopefully you will enjoy reading, listening, and learning about chaos!

MONICE - Hellooo! I'm a Liberal Arts and Sciences student with a major in Psychology and a deep love for classical mythology. This project allowed me to explore and expand both of my interests, and come across information on Chaos that I'd never explored before.

PIETER - Hi all! I am a general Artificial Intelligence student, and chaos has intrigued me ever since I read about chaos theory. The cool thing about this project is that we were able to take a subject that is really prominent in many different areas, and try to approach it from all of those perspectives. I am really glad with the result that lies before you and I hope that you will enjoy it, too!

3

RULE

USE THE APPOINTED PODCAST EPISODES WHILE ANSWERING THE PROMPTS

2

RULE

ANSWER THE QUESTIONS WITH AN OPEN MIND

6

RULE

TRY TO SEE A CONNECTION BETWEEN YOUR OWN DISCIPLINE AND THE THINGS WE TALK ABOUT HERE

4

RULE

DON'T RUSH IT! GIVE YOURSELF THE TIME TO GO THROUGH EVERYTHING AT YOUR OWN PACE

5

RULE

ALLOW YOURSELF TO BE CREATIVE AND THINK (CHAOTICALLY) OUTSIDE THE BOX!

1

RULE

DON'T LIMIT YOURSELF

1. Χαος in mythology

To know what chaos is, is to know where the word comes from. When there was nothing else in the world, there was Chaos. Chaos is a primordial god, a force that lacks structure and order; a messy state of being from which the world emerged.

Scan the QR-code on the right to find our podcast episode on the origin of chaos. In the rest of this chapter you can learn more about the classical authors who have written about chaos.

Quotes

"In the beginning there was only Chaos,
the Abyss (...) From the Abyss were born Erebos and dark Night."

- Hesiod, Theogony

"You, dumb shadows, and Chaos, Phlegethon, wide silent places of the night"

- Virgil, Aineid

"What we call chaos: a raw confused mass, nothing but inert matter,
Badly combined discordant atoms of things confused in one place"

- Ovid, Metamorphoses

Roll call: Meet the authors

Hesiod here, pleasure to meet you. As I was born around 700 BC, I'm one of the earliest Greek poets known to man. My life is somewhat of a mystery (or chaos, if you will). I lived in Askra, near the mythical mountain Helicon. I worked on the land with my father and my brother Perses. Winters were cold, summers were unbearably hot. In the midst of it all, the Helikon called to me. I listened, and became a poet of the muses.

Hello! My name is Publius Vergilius Maro, Virgil for short. I'm a part of the older generation of Roman poets, as I was born in 70 BC near Mantua. I went to school in Milan and moved to Rome to practice rhetorics, but... that didn't last very long. It turned out I was way too shy for public speaking, and I did it once, never again. I'm a huge introvert, earning me the nickname of Parthenias (Virgin). Thanks, guys.

Hi, my name is Publius Ovidius Naso, or Ovid. I was born in 43 BC, in Sulmo, Italy. My dad always wanted me to pursue a political career, but poetry was always in my heart. That, and the fact that I sucked at politics. I was banished at some point in my life, or was I...? It's a mystery, truthfully. Some say I was banished by emperor Augustine for my work, others say I made up the whole thing because I'm just *that* dramatic. Who knows...?

Prompt 1.1

Which author's view do you identify with the most, and why?

Prompt 1.2

Which author challenges your view the most? What can you learn from them?

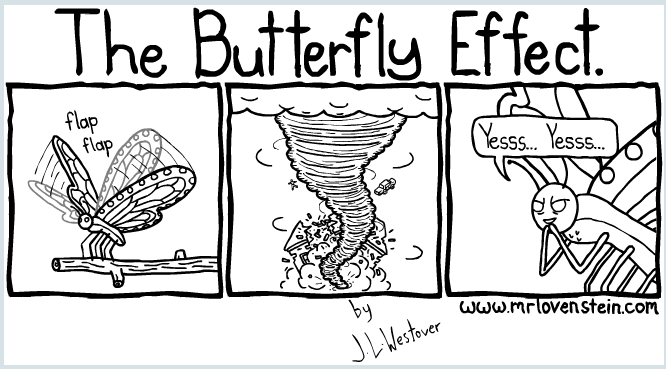
Prompt 1.3

If you were to personify Chaos, what kind of appearance would he, she or they have? Create your own chaotic character!

2. Chaos Theory

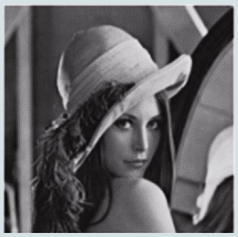
In this chapter we will explore the mathematical side of chaos, often referred to as chaos theory. Chaos theory is the study of seemingly random, or chaotic, patterns that arise from fully deterministic rules. These patterns have been detected in the weather, biological systems, the economy and many other fields! By exploiting our knowledge of these chaotic systems, we can create more accurate models that will improve scientific research.

Podcast

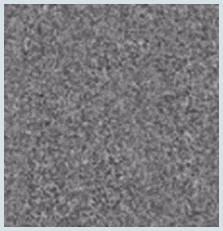


Simulations

Because chaos theory can get very mathematically complicated, we have created an all-round experience that makes chaos theory accessible to all readers. To get familiar with the fundamentals of chaos theory, scan the uppermost QR-code on this page to listen to the introductory podcast, where we discuss the basic characteristics as well as a few interesting applications. Furthermore, QR-codes to some interactive programmes have been added throughout this chapter, that let you explore the bounds of chaos theory. For those readers that are interested in the mathematics underlying chaos theory, scan the lower QR-code to find out more about attractors, the Lyapunov exponent, fractals and chaos control, along with a portal to all of the interactive programmes used throughout this chapter.



Chaos theory can be used for image encryption. By exploiting the apparent randomness of chaos, we can recolour pixels in a way that is indistinguishable from random.



Determinism

One of the most important characteristics of chaos according to chaos theory is determinism. This means that the rules that govern (chaotic) movements work in such a way that they, given a specific state of a system at a specific time, determine all future states of the system. As discussed in the podcast, a distinction can be made between global and local determinism. Assume for a moment that global determinism is a fact. Since you are a biological part of the world, your existence is determined. Your decisions are determined and you have no influence in what actions you take. This brings us to the controversial question:

'Is there room for free will in a globally deterministic world?'

There is, but things get tricky very quickly. One way to believe in both global determinism and free will, is to support the philosophical account of compatibilism. A classical compatibilist believes that you have free will, as long as you actively choose to do what is already determined. This is sometimes referred to as self-determinism. So, even though the event that has happened, would have always happened, because you actively chose to do so, this was in fact an act of free will.

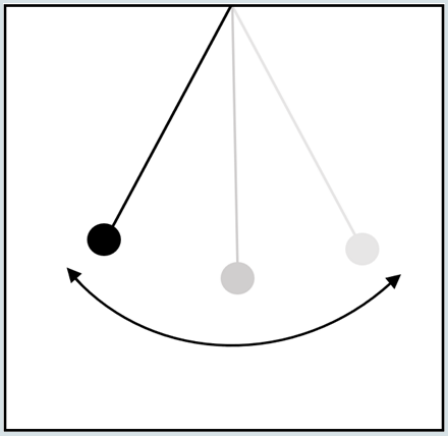
Another way to be able to believe in free will in a deterministic world, is to be a libertarian. Libertarians focus on causal relations between events and distinguish event and agent causation. Event causation does behave deterministically, like the path of a kicked football. Agent causation, however, is propelled by a mind and can start a whole new deterministic chain of causality. Where do those new chains come from, though? If they themselves have physical causes, like certain patterns of brain activity, then there can be no free will.

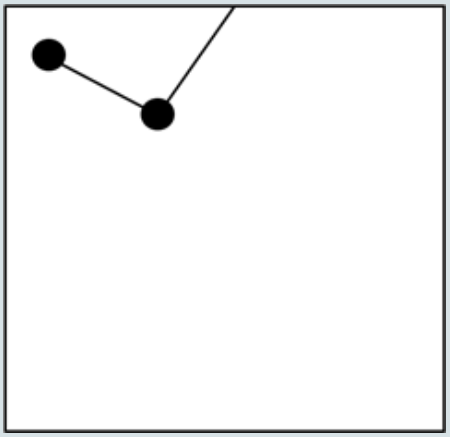
Prompt 2.1

Read the discussion about determinism and free will. Do you think there are other ways of looking at this problem? And do you think chaos theory poses a problem for global determinism?

Sensitivity

In the left picture below, you can see the dynamical evolution of a normal pendulum. It swings from left to right iteratively, coming to a halt eventually. The right image shows a schematic drawing of a double pendulum. The upper circle represents a hinge, by means of which the lower rod can move freely from left to right individually.





Prompt 2.2

Try to draw the dynamical evolution of a double pendulum in the image on the previous page. You can do this by drawing several future states, as in the single pendulum example, or by drawing a line starting from the lower circle, representing the movement path. Don't be afraid to draw outside the lines. Now scan the QR-code. Select 'setup' and then 'go' to check whether you guessed the trajectory correctly. Also have a look at the 'Model Info' to learn more about the code and the double pendulum.

Attractors

Prompt 2.3

To get an intuitive feeling for attractors, first explore a fixed point attractor. Scan the QR-code to open the programme. Try a few configurations of the x and y values. What do you observe?

"Chaos: When the present determines the future, but the approximate present does not approximately determine the future."

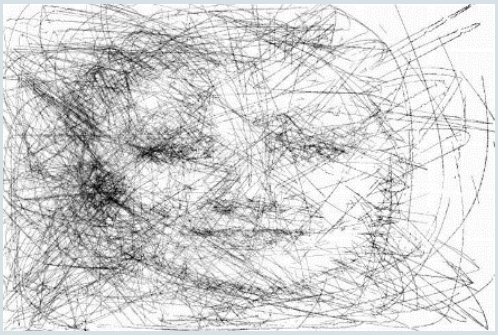
- EDWARD LORENZ

The two previous models, the pendulum and the fixed point attractor, are examples of dynamical systems. You can look at a dynamical system as an object that moves, or a system that has different states over time. As you saw in prompt 2.3, a dynamical system can converge to a point or a periodic motion. This is an example of an attractor: the behaviour of a dynamical system, to which it eventually “decays”. Beside fixed points and periodic motions, there are more kinds of attractors. In chaos theory, attractors can also be the ultimate complicated behaviour of a dynamical system.

Prompt 2.4

Scan the QR-code to get a further understanding of chaotic attractors. You can play around with the sliders yourself or follow these guidelines. Also have a look at the 'Model Info' to learn more about the code and the Lorenz attractor.

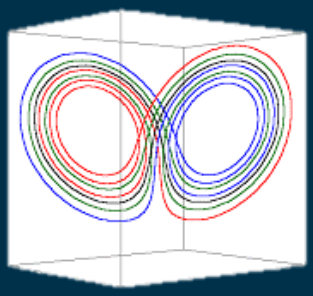
- Run the programme with the Classic parameter setting. You will see the famous Lorenz attractor.
- Now turn on 'compare-trajectories'. What do you observe?
- Try different values of coordinates by using the 'click' button and clicking on the canvas. Does the shape of the attractor change?
- Try out the other parameter settings. How does the attractor change?



Sketch of a face made by repeatedly drawing parts of a chaotic attractor. Images of 25 faces were used to get a mapping of facial features. A series of path start points on the trajectory of the attractor was selected and the attractor was drawn for some amount of time, depending on the facial feature information. You can read more about chaos is art in chapter 3.

Controlling chaos

The most common method for controlling chaos is the OGY method, named after the people who first introduced it: Ott, Grebogi and Yorke. It can also be quite intuitively understood without advanced mathematics. The basic idea of controlling chaos with OGY is to force the chaotic system into something that behaves orderly and predictably. Thus, we would like to convert the system into a fixed-point or a periodic cycle. Luckily, chaotic attractors are made up of infinitely many periodic orbits, as illustrated for the Lorenz attractor in the figure to the right. Unfortunately, periodic orbits in a chaotic system are unstable, which means that the system will diverge away form that orbit. So, the idea is to try to keep the system near one of these orbits, by 'tweaking' it, which means carrying out frequent corrections of deviations from the Unstable Periodic Orbit. When the system is closely following a UPO, it will behave periodically and will therefore be more predictable.



Prompt 2.5

This way of finding the hidden structure in chaos can be helpful outside of mathematics. Think about a time when your life was chaotic. Did you try to find some kind of ordering at that time? Find more tips and tricks for dealing with and embracing chaos in chapter 5.

3. ART

Art and chaos are very much intertwined. Scan the QR-code in the top left corner to find our podcast episode, and hear different artists talk about what chaos means to them in relation to their art work. In the next pages we will introduce the artists that you will hear from (in order of appearance in the podcast) and after listening, you can reflect on everything you've heard with the journal prompts.

Our first artist is Talitha Mayisha. Talitha is 31 years old and they are a spoken word artist. Talitha had their first open mic 3 years ago and they have been active as an artist ever since.

This is Victor Rottier, who is 33 years old. He works as a rehearsal director for Johannes Wieland. On top of that, he is a freelance choreographer. Victor has been dancing professionally since he was 15 years old.

Meet Gerard de Jong. Gerard is 69 years and he is a music teacher. Besides that, he plays guitar in his own band. He has been playing the guitar for as long as he can remember.

The next artist we would like to introduce you to is Luuk Leijtens. Luuk is 28 years old and he is a graduate student from ArtEZ, institute of arts. He has been working professionally as a visual artist for 4 years.

Our last (but definitely not least) artist is Timo Lourens, who is 22 years old. He has been in music theater since he was 6 years old. Now, Timo is a theater student with a focus on theater making.

Prompt 3.1

Now that you've heard the opinions of different artists about chaos, which one do you identify with the most? And what can you learn from the other ideas?

Prompt 3.2

Make your own art. Draw, write, paint... Do anything to create chaos, and don't be scared to go out of the frame!

4. Politics

To learn more about chaos in politics, scan the QR-code at the top of this page to go to our podcast episode, where we discuss what constant exposure to chaos does with people, and how that affects our political climate. Then, look at the definitions of "cultural hegemony" and "grand narrative" below, and reflect on the journaling prompts on the next pages.

Cultural Hegemony

"Cultural dominance or ascendancy; the predominance of a particular set of cultural norms" (OED)

Grand Narrative

"Ideas, concepts, notions, or beliefs which can function to legitimate certain social actions and practices" (Buchanan, 2018)

Prompt 4.1

Can you think of ways in which your mental organisation of our chaotic world is affected by your culture? Having now heard about "cultural hegemony" and "grand narrative", reflect on the extent to which you think your worldview is affected by these concepts. You can use the whole page to write down your thoughts about this.

Prompt 4.2 Can you think of a time in your life when there was too much chaos to make sense of a situation? When that happened, what did you do to make sense of the situation, or to provide yourself clarity?

Prompt 4.3 In the podcast, we discussed the effects of chaos on different movements, from human rights action to conspiracy theorist groups. Do you think there may be parallels between your way of dealing with chaos and the ways in which these different political movements make sense of the chaotic world?

Prompt 4.4

What is your opinion about the importance of cultural hegemony and grand narrative? Do you think it's possible to strike a balance between its flexibility and its rigidity, like we discussed in the podcast? If so, where do you think that balance lies? And if not, what other ways can you think of to mediate our chaotic world without a political breakdown? Use this page to reflect on this!

5.Psychology

How people deal with chaos

If you have made it this far through the journal, you are probably aware of what chaos actually is. You might still have your own vision and beliefs on chaos, and you might continue to interpret it in ways you have been doing your whole life. This is completely fine! We have created this journal with the intention to not only inform you on chaos, but also to help you manage the chaos in your life and find structure.

With that being said, one must not consider chaos **only** as evil. At certain times, we should try to see the beauty of it, and embrace the chaos in our lives. Consider what life would be like without chaos. You might think of it as tranquility at first, but think of how boring that would be after a few days. As the famous philosopher Friedrich Nietzsche once said:

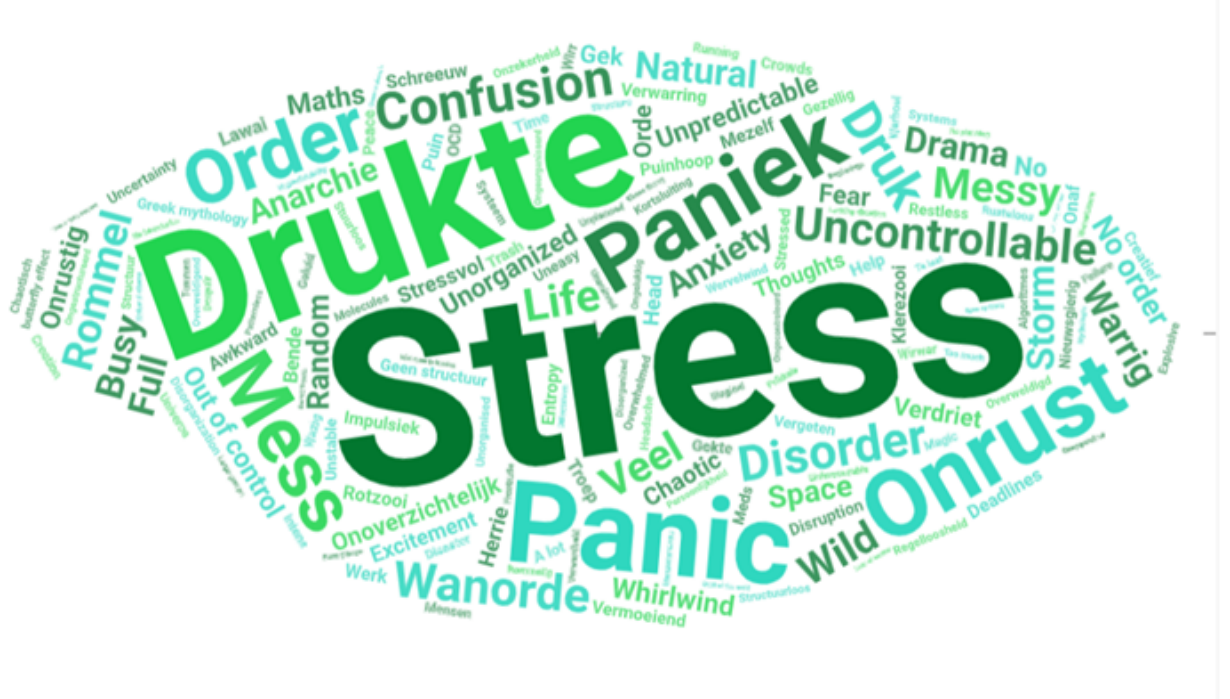
> "You must have chaos within you to give birth to a dancing star."
>
> FRIEDRICH NIETZSCHE

However, it is understandable that we like to structure our lives every once in a while. To make sure that you know that you're not alone in this, we've asked people about their opinions on chaos and how they deal with it. If you feel like bringing the calm back into your life, make sure to continue reading.

To figure out what people thought and knew about chaos, we have made a survey and have sent it to people we knew. We have received 86 responses to our survey, about 70% was female, a bit more than 25% (26,7%) was male and the rest identified as non-binary or preferred not to say. The biggest represented age group was that of age 16-20 (48.7%), the second biggest group was that of age 21-25 (44.2%) and about 5% was older than 30. We only had 2 people answer our survey who were non-Dutch (unfortunately), so our purpose of generating a multilingual wordcloud was toned down a bit . One person was from the USA, the other international was from Germany. The first thing that we noticed when reading through all of the answers was that a lot of the answers were quite similar, but they also had some individual differences

Via this QR you will be taken to our website, where you can see the questions we have asked people. You are free to fill them in for yourself. However, some questions have already been asked in the journal.

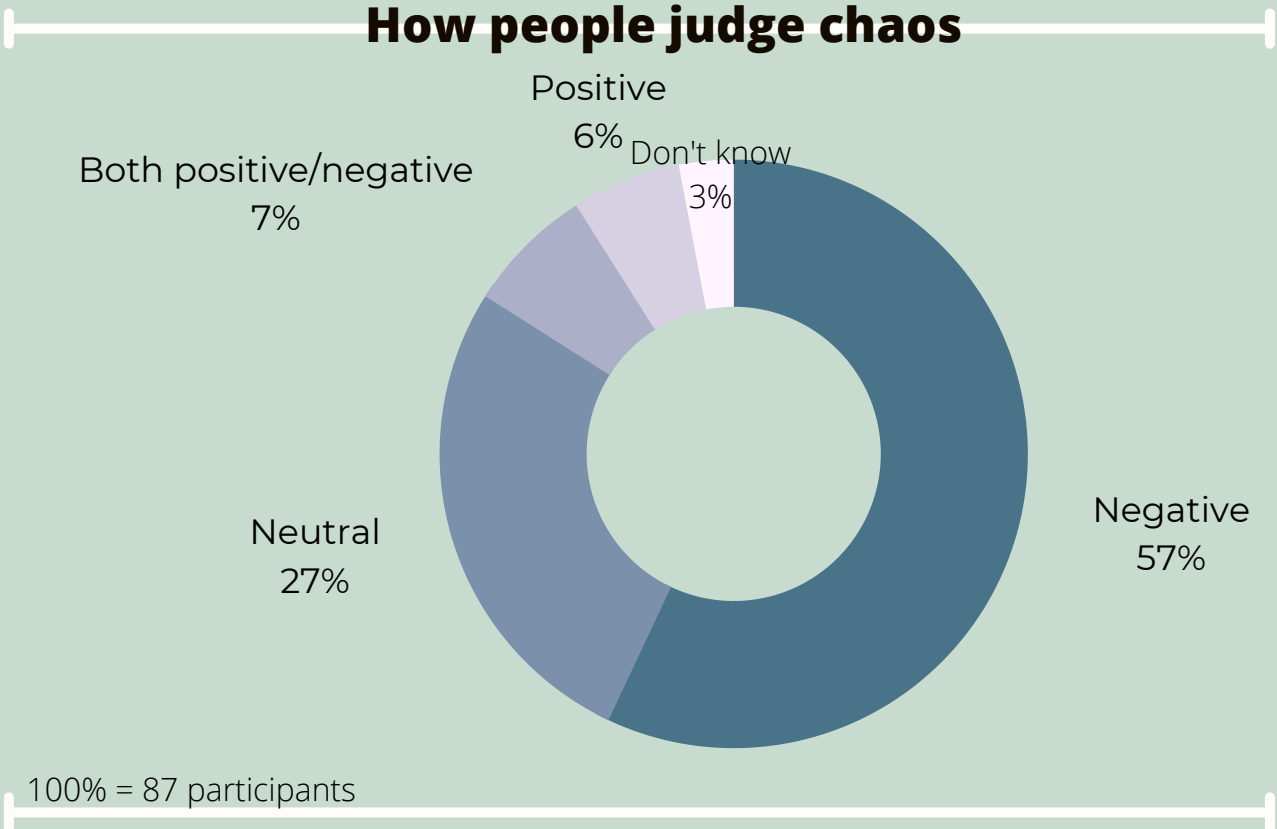
We asked the people who have filled in our survey to write down the first words that came to mind when thinking about chaos. They were allowed to answer this question in their native tongue, but most of them did it in English or Dutch. We have made a word cloud with all of the mentioned words that our participants associate with chaos, in whatever language they preferred. The result is on the next page.



As you can see, most people associate chaos with negative words like stress and panic. Remarkable is that most of the answers carry a negative association with them. Interestingly, when we asked the participants what kind of valence they would give chaos, about 43% of our participants told us they do not necessarily or always see chaos as a negative thing. In the pie chart on this page you can see the answers given by participants. This is a bit contradictory, but also shows us that even the answers are sometimes chaotic. Some people think chaos is dependent on the situation and not a negative thing by definition, but also not neutral. One participant said the following: “I think chaos is hectic and negative in its most standard form. However, I think chaos could be beautiful as well, as is visible in some musical pieces or artworks. Chaos could also relax one's mind sometimes, when the chaos outside of a person is suddenly less chaotic due to the environment. “ Another said this: “It honestly depends on the context. In case of mythology it's often neutral, and for me personally chaos can be both positive and negative depending on what I need to get done. If I'm working on something, I tend to create chaos, which isn't necessarily negative, it's just part of the process. However, if I leave that mess until later it might hinder other things and cause stress. So I guess the 'value' of chaos depends on its end.” Both of these answers show the versatility of chaos and that chaos does not mean one thing for everybody.

Banishing or embracing chaos?

When asking people if they thought their life was chaotic, the answers were very different as well. They ranged from yes, partly, no, to sometimes and a bit. The people who thought their life is not very chaotic, tend to be great planners. People who think their life is chaotic, tend to think their life has no structure. Some people think unpredictability and chaos are just part of life or they feel like there is no control. Here it seems that a solution to not being chaotic is planning and avoidance. However, we would advise you not to banish the chaos in your life completely. There are a lot of ways to get used to the natural flow of chaos and there are ways to tolerate it. Of course, chaos is not only rainbows and flowers and there are cloudy days, but in the next part we would like to give you some tips and tricks on how to deal with chaos and structure your life more.



How other people deal with chaos

In our survey, 86 participants told us how they deal with chaos in their lives. A lot of their answers overlapped, saying that they try to bring structure back into their lives by making to-do lists or a planning. Many participants mentioned that they also try to remain calm by either taking some rest or have some me-time. However, a few participants told us that they do not know how to deal with chaos. They panic, have mental breakdowns, feel stressed and freak out every once in a while. Although we do not recommend this as a way of coping with chaos, we understand that this can happen (we're all human, right?).

Survey findings:

how people deal with chaos

01 Plan, organize, make lists: add structure

02 Stay calm: take some rest

03 Embrace the chaos, meditate, go for a walk.

04 Panic, have a mental breakdown.

05 They simply don't.

Tips on how to deal with chaos

Now that you know how others deal with chaos, try to figure out what your response to chaos is. Maybe you're already on the right track, or maybe you realize that you need to do something about your mental breakdowns. To get you started, here are a few tips on how to deal with chaos.

#1 Take one thing at a time.

Try to create an overview for yourself on what you have to do. Prioritize your tasks and make sure to be realistic & not too hard on yourself.

#2 Take breaks.

Although you may feel like you don't have the time for a break, you should really rest every once in a while. Plan your breaks in to your schedule so you know when it's time to rest.

#3 Ask for help!

Don't be afraid to ask your family or friends for help when you need it. Talk about the chaos or feeling stressed. They might be able to help you, or at least talking about it may make you feel better.

#4 Everything is temporary

Remind yourself that the stress that you're feeling won't be here forever. Everything in life is temporary, so also the chaos that you're experiencing. It will get better!

Daily planner

Add structure to your day by making a to do list. Make sure to put realistic goals and prioritize them!

TO-DO LIST

PRIORITY GOALS

NOTES & REMINDERS

6. Chaos in you

PROMPT 6.1

Make a list of things that make you nervous. Does this match the time in your life when chaos took over?

PROMPT 6.2

What do I want? What stops me from achieving it? Is it related to chaos?

PROMPT 6.3

List your favourite things in the world, however small they are. Then look back at the page on the things that make you nervous. Aren't both lists equally chaotic? There's no order, no rules, everything randomly comes together in one list

Looking back...

REFLECT ON HOW YOUR ORIGINAL IDEAS OF CHAOS HAVE CHANGED AFTER GOING THROUGH THIS JOURNALING EXPERIENCE.