



# I/O VIVAT

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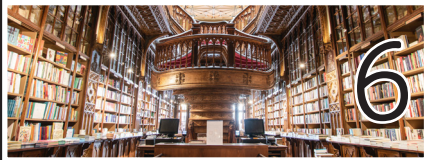
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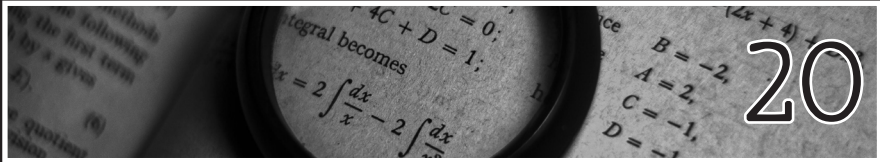
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I/O VIVAT

//Editorial

Dear reader,

Just before the holidays start, a new edition of the I/O Vivat falls on your digital doormat. Due to budgetary constraints, mostly the ever-increasing prices of PostNL, we have had to change the I/O Vivat to a digital-first publication. The Vivat will be published 3/4 times a year in its digital form: both as a .pdf sent to your e-mail box, and as blogposts on our digital platform <https://ioviv.at>). Do not hesitate to scan the following QR code to sign up for our website, so that you will not miss articles in the future!



In addition to our digital publications, the I/O Vivat will be published in its familiar physical version at least once a year.

This publication contains articles about the cryptography behind cryptocurrency, how AI can help you in becoming a better Pokémon trainer and in generating art and an explanation about the Pareto principle to make you a better investor. Furthermore, we have columns from our Programme Director, the ENIAC board, and the candidate board of Inter-Actief. Look backs on popular activities that were organized by Inter-Actief, such as Pandora and Hephaestus symposium. We once again give our previous chief editor a podium, allowing him to explain his work on making the web more accessible to everyone for the municipality. Last but not least, we visit Ecare, a company that specializes in software development for which develops software for use in hospitals. Happy reading :).

We thank you for reading the I/O Vivat!

Jelle Maas  
Ruben Groot Roessink  
Chief Editors I/O Vivat



# Pensions, Portfolios, and Pareto



By: Ewout van der Wal  
Editor I/O Vivat

**They wield vast sums of money that can change the economic climate of a small country in one fell swoop, take your money each month while you do not even complain, and you have probably never given them a second thought. No, this article is not about the lizard people, it is about pension funds!**

In the massive oceans of 21st-century finance, pension funds are the blue whales. Like their plankton-feeding counterparts, these gentle giants swim around our financial oceans, collecting tiny amounts of money from everyone with a job. Their goal is simple: the money you give them while you work is held for safekeeping and will be used to pay your pension when you retire. While this may seem simple on the surface, we have to wonder how these funds stay afloat in a cut-throat industry with its fair share of prolific failures. This begs the question: how do pension funds manage your money?

Put on your wetsuit, strap on your oxygen tank, and prepare to dive into the wonderful world of pensions, portfolios, and Pareto.

### Historical financial markets

The Dutch love to boast that Amsterdam is the birthplace of financial markets as we know them today. Often, this story is immediately followed by the far less known story about how tulip bulbs

also caused the first financial crash. However, the modern trillion-dollar financial industry likely traces its roots back further than this Dutch claim, all the way to 1300s Venice [1]. In this bustling heart of commerce on the Mediterranean coast, early brokers bought and sold debts, the predecessors of our modern-day bonds.

300 years later, the exploitation of the countries in what was then known as East India kickstarted the creation of the first stock market. In The Netherlands, England, and France, wealthy investors financed voyages to the East for a share in the profits of any ship that returned successfully. This spawned decentralized stock markets in port cities. The investor's shares in the voyage were printed on paper and formed the first stock-based investment portfolios.

By investing in several voyages at the same time, the investors could limit their exposure to the risk that a voyage would not make it back home because the average return on their investment was likely high enough to cover the cost. The 1602 charter for the Dutch East India Company (VOC) birthed the oldest centralised stock exchange: the Amsterdam Stock Exchange [2].

Nowadays, anybody can buy stocks (sometimes still called "shares") for a whole range of companies. Although 400 years have passed since the first stock market was founded, the fundamental idea is still the same. A stock gives the holder a claim to a portion of the profits of an enterprise and the right to cast their vote during shareholder meetings. Investors, both private and institutional, invest in collections of stocks, bonds, and other



financial instruments in the hopes of generating a profit. These collections of collections are known as portfolios.

### Modern portfolio theory

The method used to decide which financial instruments to include in a portfolio is known as Portfolio Theory. At the core of every investment decision is the trade-off between the potential returns of an investment and the risk of the investment losing value over time. In 1952, Harry Markowitz founded the Modern Portfolio Theory (MPT) by defining investment decisions as the trade-off between the expected return ( $\mu$ ) and the expected standard deviation of returns ( $\sigma$ ) for a given portfolio. Over 70 years later, the Markowitz model is still the foundation for how we think about the financial market.

Suppose we have the example portfolios as shown in Table 1 (for this explanation, we don't worry about how we find these candidates):

Assuming that these are the only possible portfolios, we now want to choose the portfolio that best fits our risk tolerance and also ensures that we are getting the best possible return. This makes some of the options in the table better than others. For example, portfolios B and E have a lower expected return and equal or higher expected risk compared to portfolio C. Therefore, a rational investor would never choose to invest in these portfolios unless they had some extra information not shown in the table.

Deciding between portfolios A, C, and D is not as simple. Each portfolio is better than the others in one of the performance metrics, but worse in the other. Portfolio D exposes an investor to the lowest expected risk and also generates the lowest expected return. An investor

is given a trade-off decision: do I take more risk to have a chance at a higher return? This trade-off is the basis of the Pareto-dominance principle.

The Pareto principle states that given two options that are evaluated on multiple performance metrics (the expected return and expected risk in the case of our portfolios) two things may happen: one of the options is Pareto-dominant or the options are Pareto-indifferent. A dominant option is better in one or more metrics and at least equally as good in all other metrics. In our example, portfolio C is dominant compared to portfolios B and E. When the options are indifferent, neither option dominates. In our example, the portfolios A, B, and D are indifferent. Which of the indifferent portfolios is the most optimal depends on the risks that an investor is willing to take.

In a real-world scenario, investors can create a near-endless number of portfolios. Performing the work of finding all potential portfolios, comparing them against each other, and choosing one portfolio to invest in is impossible to do by hand. Therefore, modern investment firms use sophisticated algorithms to search for, evaluate, and choose the best portfolio for their risk profile. To protect their competitive advantage, these algorithms are not publicly available.

Luckily, access to the internet enables anyone to apply the Modern Portfolio Theory to their investment decisions. The principles, algorithms, and market information can be accessed with a laptop, access to the internet, and the right keywords. To get you started, these are some resources you could use as a starting point for your very own deep dive into the wonderful, wild world of investments: a history of multi-criteria decision-making [3], one method to find or create portfolios [4], navigating

Portfolio	Expected return ( $\mu$ , higher is better)	Expected risk ( $\sigma$ , lower is better)
A	0.8%	6.3%
B	7.5%	8.1%
C	8.4%	8.1%
D	0.5%	5.9%
E	3.8%	8.9%

Table 1: Example portfolios.

search spaces effectively [5], and an example approach to portfolio optimization [6].

With this article, you are one step closer to understanding the wondrous mathematics that governs the choices made by pension funds the world over. So far, we have only scratched the surface of what is possible in the financial markets. To discover the rest is up to you. Happy investing!

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# How we support your studies

By: Rick de Vries en Daniël Jonker  
Educational Committee



//Column

//Column

**W**elcome to the new academic year! You came here to study, but we all have had experiences where it doesn't go so smoothly; from faulty exams, having trouble with exercises, a broken coffee machine and everything in between, Inter-Actief is here to help you. As a study association we have a variety of aid during your study progress;

- An exam database, where you can find old exams of every subject
- Free coffee at our association room
- A network of tutors (and yes, you can also apply to be one!)
- Discount on books
- Study evenings with TA's
- Complaint system on the website

Not only do we have these resources, but there is a board member just for you! Our *officer of educational affairs* is the person to talk about anything and everything study-related. He will make sure that Inter-Actief is in close contact with faculty members. An officer of educational affairs is constantly busy with meetings, discussing with the university what is important for students, and discussing many policies and quality of education. Not only is attending meetings something that is valuable, it is also important to keep in close contact with the faculty personnel and teachers. To do that, Inter-Actief focuses on organising activities together with teachers, such that you can get to know them in a different setting.

The EC organises several educational and fun activities throughout the year. Imagine enjoying a delightful meal while chatting with your professors at the Teacher Dinner. It's the perfect opportunity to connect with professors in a different setting than the regular lecture hall. Feeling frustrated due to difficult courses? Join our Kickboxing Workshop led by one of the teachers, and experience a unique way to engage with teachers and fellow students while breaking a sweat!

Don't miss our signature Week of Education, packed with a variety of activities designed to inspire and educate. From a hands-on Pizza Workshop to a casual drink with teachers, this week offers something for everyone. Additionally, we host a professional LinkedIn Workshop to help you polish your profile and stand out in the job market.

When an exam is coming up, our Study Evenings are a lifesaver. Enjoy free snacks and drinks while getting your questions answered by knowledgeable teaching assistants. These evenings provide a supportive environment to boost your studies and gain that evening motivation that you may lack at home.

As the new academic year begins, know that we're here to support you every step of the way. Whether you're here to have fun and engage with teachers, or to study and want help or useful resources, the Education Committee is here for you!

So, as the new academic year kicks off, remember, we're here to support you every step of the way. Whether you're facing challenges or aiming for greatness, together, we'll make it an unforgettable and rewarding ride.

table and rewarding ride.

Get ready to seize the opportunities ahead, to learn, to grow, and to make lasting memories. We're excited to meet all of you. Here's to an incredible academic year!

## Education Committee

The Education Committee is a committee consisting of nine members that help the Officer of Educational Affairs in forming a bridge between members of Inter-Actief and the studies Technical Computer Science and Business Information Technology.

The Education Committee is involved in handling education-related complaints, manages Inter-Actief's Wiki with previous (test) exams and summaries and organizes several education-related activities.

# From the Candidate Chairman

By: Thijs Krosman  
Candidate Chairman 46th Board of Inter-Actief



**T**he moment it all starts, you send a mail to the current board that you're interested in becoming a board member for the next academic year. When I started studying at the University of Twente I would have never thought I would be in this position at all. And yet here I am, writing this article, because I became the 46th candidate chairman and officer of internal affairs of Inter-Actief.

Now the time is flying by way too fast. At the moment of writing, I have been a candidate board member for more than 2 months already, and the end of the year is already getting close. I have already had the time to get to know Inter-Actief way better and even more important to get to know the rest of my candidate much better. I have already been introduced to what it means to be part of the Inter-Actief board and what responsibilities I will have next year. Not only have I been moving from meeting to meeting during the week, but I also got to know the other candidate boards and how to do my task as chairman and officer of internal affairs next year.

Even though we, as a candidate board, have learned as much as possible, we still have a big task ahead of us next year since we will be with only 4 board members. The last time Inter-Actief had a board with so few members was 12 years ago, when the association was way smaller than it is now. But even with all of this, we are still looking forward to taking up the challenge of running an association and trying to be the best for Inter-Actief.

Now that the summer holidays are almost here, it is also time to prepare for

the change GMM, but first there is the Kick-In. Now we have to give a good impression of Inter-Actief to the new students and try to convince them that it is worth it to become part of Inter-Actief.

After all of that, it is time for the change GMM. Here, we will reveal our plans for the upcoming year. The moment you start working on these plans, you get to find out what you want to achieve with each other. This was the first time for me that I had had to fully do my task as candidate chairman, and I think this went pretty well. This was my first confirmation that I made the right choice by signing up for the candidate board, and that I already have learned a lot in the last few months.

And then, after we are hopefully accepted by the GMM, our board year starts. We will have to do regular room duties, and all the responsibilities will be on our shoulders. We will be trying to help as many students as possible and get the first years involved in the association as well. Furthermore, we will continue stimulating hosting activities and try to be there for the members. We will be hosting study evenings, LAN parties, sporting activities and of course, our Tuesday afternoon drinks.

And of course, Inter-Actief wouldn't be anywhere without her members. And the best way to ensure that Inter-Actief can be there for her members is by listening to them. So if you want to know more about the association or us, you can always drop by the association room to spend some quality time with fellow students, ask questions about the study, or maybe leave some good ideas. This last point can also be done by sending an email to [goodidea@inter-actief.net](mailto:goodidea@inter-actief.net).

ding an email to [goodidea@inter-actief.net](mailto:goodidea@inter-actief.net).

I hope to see you soon!

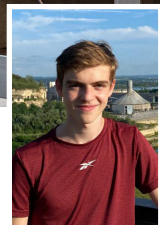
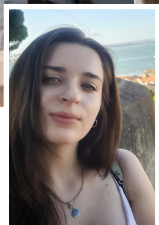
## About Thijs

Thijs was born in a beautiful town called Raalte more than 20 years ago. Before he came to the University of Twente he first graduated from Carmel College Salland. He has almost finished his second year of TCS now, and he has been active for Inter-Actief for more than a year already. During his activism, he has been part of the GameCie, aXi, PromCie, RIAly and Kick-IT, and now he is ready to become the next chairman and officer of internal affairs for Inter-Actief. Next to being at Inter-Actief almost all day, you might find him at one of the afternoon drinks or playing hockey at DHC Drienerlo.



## Ecare

## Interview with Emiel



By: Anamaria Ceban  
& Xanti Luki Lizanzu  
Editors I/O Vivat

Emiel Hollander  
Software Developer @ Ecare



**E**miel is a software developer at Ecare, where he is part of the so-called infrastructure team. This team creates the building blocks that other teams can use for the various products at Ecare. Emiel works on the design system as a front-end developer, together with a UX designer.

## Ecare: Healthcare technology

"At Ecare, we make software that supports professionals in home, residential, disabled and mental healthcare. The aim of our software is to make work processes and administration easier and more efficient for healthcare professionals. This way, they can focus on what they do best: providing the best possible care for their clients.

Our approach revolves around supporting healthcare practitioners with our software. They are the experts in their field, equipped with the knowledge and skills to treat clients effectively. Our applications aim to maximize practitioners' time with clients, putting the responsibility squarely in their hands. Unlike systems that dictate step-by-step procedures, our software provides reminders without taking control away from healthcare professionals.

In our development process, we always prioritize this principle. For instance, in our automatic measurement detection, which - through a machine learning algorithm - detects certain indicators in

written text, the system then seeks confirmation. As such, we always make sure that the practitioners remain in control - information isn't automatically integrated without their approval. This commitment to putting healthcare professionals in charge is a constant consideration in our innovations."

## Company structure (or lack thereof)

A noteworthy detail about Ecare is that it is a holacracy-based company, meaning that there are no managers or

other forms of hierarchy. Each team is independently functioning and responsible for what they do. To keep different teams going in the same direction, there are company-wide strategy statements that teams can use as a guideline.

Employees also do not necessarily have a single role, but can assume multiple roles at the same time. For example, Emiel has the role of *front end enabler* next to being a front end developer. For this role he helps other teams with their front end questions, keeps track and

shares new developments in front end technology. Although teams are free to choose their preferred way of working, most teams in Ecare work according to scrum, so next to developers there are also testers and product owners. The scrum master role is usually an addition to the role of developer.

One other surprising fact about Ecare is that they have a four-day working week, meaning everyone is free on Friday. Emiel feels like this really helps in motivation and creativity. After three days of weekend he is looking forward to going to work again.

## Design system

The *infrastructure team*, where Emiel works as a front end developer, is responsible for the design system within the company. The design system is a set of guidelines and components that the other teams can use to quickly build their applications. It is a library of React components together with its documentation, as well as a set of guidelines on colors, fonts, what texts to put on buttons, and error messages. Since the building blocks in the design system are used all over Ecare, automated tests are an important part of the project. Before the introduction of the design system, various product teams independently implemented similar features, but now they are adapting to the design system.

The infrastructure team does not completely invent everything themselves: the system is built on top of pre-existing research. The team combines several research sources to come up with their own rules suitable for healthcare. In some cases, the rules go further than things like Material Design from Google, and in some aspects they go less in depth. For example, there are clear guidelines on how to label buttons. Ecare's software is in Dutch, so buttons are labeled first with the object that the button will interact on, and then the verb, making it more clear for Dutch speakers. That is a guideline that Material Design does not include.

The infrastructure team tries to make components look nice, but also to assure accessibility. For example for keyboard users and people with eyesight problems. One example of where accessibility was improved is the tooltip

component. This component is usually an "i" icon that serves as a tooltip that you can hover over to get some additional information. This is not very user friendly, as with smaller screens, the tooltip can open out of view, which cannot be rectified by keyboard users. The infrastructure team created something new for that, and encouraged all the teams to use it instead of the previous version. The component shows the same "i" icon, but instead of a tooltip, it expands underneath. You can click on it once or press spacebar on it, and it shows up, remaining visible for as long as you want. A simple change, but very important for accessibility.

A challenge that the infrastructure team faces is the search for new components and guidelines. Since they are not working on products directly, requests for functions always have to come from other teams. However, this introduces a new challenge to be taken into account. When a client needs a new function, it could be implemented for a specific product only, while it might be useful for all products. The infrastructure team thus tries to keep up with everything that is happening inside the organization, for example visiting reviews of all the teams. In this way something that might be useful as a component or guideline and can be discovered.

## PUUR: Smart electronic client file

When visiting the website of Ecare it becomes clear that PUUR. is at the core of all their products. PUUR. products are smart electronic client files, meaning that healthcare professionals can keep track of client data through a digital system. It started from what is now one of Ecare's biggest clients: Buurtzorg. They wanted to reorganize the way that they gave care to the clients. Seeing that many available healthcare applications were aimed at step-by-step procedures and they wanted to give back the responsibility to the caretakers. The system was developed inhouse and later on, other healthcare companies became interested. Ecare was created as a means to build and maintain the system. From there, it grew as there was a demand for this innovative approach.

## Students and Ecare

"We offer internships, master's assignments, and bachelor's assignments. These assignments vary wildly, so we have some UI/UX, back end, front end, all kinds of assignments. We usually have three or four interns/graduates walking around here."

An example of a recent project is from a master student studying Creative Technology. She researched if it would be helpful to have to give caretakers a smartwatch to record reports so they can leave the laptop at home. Whenever they are with clients they can just click and talk. Then at the end of the day, when they get back home, they can look at their laptops and see what they filled in.

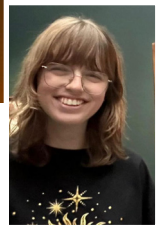
To get in touch with us, students can look at our website: <https://ecare.nl>

We have a separate website for job openings and internships, which includes contact details: <https://werkenbijecare.nl/>





# Art and AI



By: Jeske van Hijum  
Editor I/O Vivat

A year ago, a man by the name of Jason M. Allen entered the Colorado State Fair with a beautiful art piece. The juries were all over Allen's artwork and awarded him the blue ribbon for emerging digital artists. Unbeknownst to the other participants, however, Allen didn't create this artwork himself. This work was created by the Artificial Intelligence program made by the research lab MidJourney, which can create hyper realistic images of whatever prompt you give this machine. Allen took this victory to Twitter, where he received both praise and backlash from artists, leading him to hit the artist with a tweet: "Art is dead, dude. It's over. A.I. won. Humans lost." But has A.I. really taken over our art already? Is there no sense in us humans creating art anymore? Have we really lost to the machines in this area of our lives already?

To start off, let's look at the inner workings of an art AI. Developers of an art AI generally use certain datasets to train their models, which is very similar to how other artificial machines get trained. The dataset used for the model depends on the developer, causing the generated images to look different depending on which art AI you use for your prompt. These data sets consist of general stock photos of things like cats and trees, but also of other people's artwork so that the art AI will be able to create prompts in certain artists styles,

like the distinct style of Van Gogh, or certain time periods of art, like the Renaissance.

Through deep learning, the AI will learn to separate different objects from each other by comparing them on a huge space of variables. To illustrate this learning process a bit better, let's say that the AI wants to differentiate between a rugby ball and a football. The AI will read the pixels from both the images with footballs and rugby balls and will come to notice that footballs are significantly rounder than rugby balls are. It now knows that footballs are rounder than rugby balls,

but what if the next picture is a black and white balloon? This object is round and could be by the knowledge of the AI be classified as a football, which we know isn't the case. This means that the AI

needs more variables to be able to differentiate between this balloon and a football, and even more variables to be able to differentiate between a football and an elephant. These variables are what are being formed in the process that we call deep learning, leading to an AI correctly being able to not just identify objects, but also styles, color schemes and time periods.

With these variables, the AI creates a dimensional space with more than 500 dimensions, meaning that each point in there representing an object is a point with 500 coordinates. When generating an image, the AI will trace the words from the prompt to a point in this huge 500-dimensional space and with this try to form a picture that is coherent to the human eye.

An interesting study into the attitude of

humans towards AI-generated art has shown that we as humans have quite the prejudice toward art made by AI. In this particular study researchers had a group of people judge 30 artworks: 15 of which were created by humans and 15 of which were created by AI, or so the participants thought. Unbeknownst to them however, all the artworks were created by an AI by the name of Artbreeder. The artworks the participants thought were made by humans scored significantly better on fields such as beauty and worth, while the participants seemed to dislike the AI-generated ones quite a bit.

I think it's possible to confidently say that we as humans have a natural prejudice towards AI-generated art, which isn't all that weird in the end. New technologies come with new fears; people see their jobs disappearing right before their eyes, since the new cool machine can now do what they have done for years, except a thousand times faster and sometimes even better.

On one hand, we find it amazing that new technologies can make things like art so much more accessible to people who have never learned to draw and paint before. It opens up a whole new type of creativity where people can think of the weirdest and most complex things and actually very accurately visualize this within seconds. On the other hand, we should ask ourselves if we can even begin to call this art. It is absolutely undeniable that the piece made by Allen is stunning, but isn't there a huge difference between typing a few words into a text bar and taking hours to create a painting or a sculpture?

Artists have come forth to say that they feel like AI-generated art "is the exact opposite of what they believe art to be", which is very understandable, also looking back at the response of the people from the study into our attitude towards AI-generated art. We as humans feel as if art isn't real art without emotion or meaning, because it's exactly that emotion and meaning that makes a painting or sculpture mean so much to us.

One of my personal favorite art pieces is Anguish by August Friedrich Schenk, since I feel like it is a beautiful portrayal of grief. We can share this emotion with the artist and relate to them, while AI has nothing in common with us: it's a machine devoid of any emotion. Seeing your own emotion replicated in a painting knowing that the artist has felt the same way as you did once is a feeling that an AI will not be able to replicate.

So, was Allen right in saying that art is dead? It's an impossible question to answer factually, but I personally don't think it is. I think people value the connection made with the artist through art way too much to accept that AI has the potential to create everything we want and replace artists. Humans are quite conservative in that way: art is something that has always been used as a tool of communication between humans, so no technology should have to interfere with that. But will we eventually stop caring and still let AI take over? That's something only the future can tell.



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## Symposium Hephaestus

What did you miss?



By: Jelle Maas  
Editor I/O Vivat

One of the most prominent traditions of Inter-Actief is the Symposium. Every year, Inter-Actief organizes a Symposium; a day centered around a chosen domain from the vast world of Computer Science. The goal of the Symposium is to give students a more in-depth look into a specific part of the world of Computer Science, as well as get them into contact with companies that specialize in the domain, which can give them insight into the different career paths that are at work in the sector.

During the day, several speakers talk about topics relevant to the chosen theme, and students have the opportunity to engage with multiple companies that work in the field between the lectures. Those companies are present to have one-on-one conversations with students, to explain what work they do in the sector, and often about the career opportunities they can offer those interested.

This year, the symposium, named Hephaestus after the ancient Greek god of blacksmiths, fire, metallurgy, and metalworking, covered the theme of Robotics & IT. Hephaestus, renowned for his craftsmanship and innovation, is a fitting namesake for a symposium dedicated to exploring the intricate relationship between IT, machines, and robotics. The symposium was held on the 27th of February, 2024, at Schouwburg Hen-

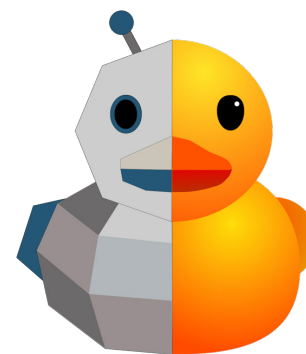
gelo, and it aimed to inform attendees about the latest advancements in these fields and their applications in various industries.

Hephaestus had his own palace on Olympus, containing his workshop with an anvil and twenty bellows that worked at his bidding. He built so-called "automatons" of metal to work for him or others, including tripods with golden wheels and golden maidens to serve him. This mythological background provided an inspiring framework for our discussions on how modern technology is creating autonomous machines to assist humans in various tasks.

The symposium featured a series of talks from distinguished speakers who shared their insights and expertise on topics related to Robotics and IT. Jens Kober, an associate professor at the Cognitive Robotics department of TU Delft, Netherlands, was one of the

keynote speakers. Kober's research is at the intersection of machine learning, control, and robotics, with a focus on learning motor skills for robot arms. He and his group have developed learning techniques that enable robots to have complex interactions with their environment and humans. A recent focus has been on rendering the learning process efficient and effective by leveraging interactions with human teachers. His research spans fundamental research to applications in agriculture, manufacturing, care, and retail.

Another notable speaker was dr. ing. Matthias Grote, Technology Manager at Rosenxt. Mr. Grote has been with the ROSEN Group for over a decade, developing new technologies for future market needs. For more than five years, he has been intensively involved in applications and developments for autonomous robotics and is responsible for the associated technology field at Rosenxt.



Matthias shared insights into the development of solutions for new markets and the future of autonomous robotics.

Mihnea Răzvan Petrea, the Technical Manager and part of the Mechanical Engineer sub-team of the 8th generation of RoboTeam Twente, also presented at the symposium. RoboTeam Twente builds autonomous robots that play soccer at the international competition RoboCup. The main goal of the competition is to have, by 2050, a fully autonomous team of robots that can defeat the human world champions. Răzvan, a Mechanical Engineering Bachelor student at the University of Twente, shared his experiences and challenges in preparing the team for RoboCup 2024.

Nathalie Geerlings, Lead Robotics Engineer at Riwo Engineering B.V. in Oldenzaal, discussed her work in setting up a robotics team at Riwo. After earning a bachelor's degree in Advanced Technology at the University of Twente and a master's in Biorobotics at TU Delft, she focused on building generic software modules for various robotic projects. These projects range from apple-picking robots in orchards to waste-sorting systems for recycling firms, demonstrating the diverse applications of robotics in dynamic and noisy environments.

The symposium also featured insights from Voortman Steel Group, with presentations by Arie Riezebos and Paul Hentschke. Riezebos, the Software Tech Lead from the Robotics team, talked about software development within their robotics team, including the challenges and future prospects. Hentschke, the Director of Engineering, provided an overview of the organization's current status and future direction, emphasizing the influence of software development on their operations.

Edwin Dertien, a robotics enthusiast with a background in academic research and hands-on DIY art projects, concluded the series of talks. Dertien's journey in robotics includes internships at the Shadow Robot Company, involvement in energy-efficient actuation in walking robots, and participation in RoboCup. His PhD focused on pipe inspection robots, integrating rapid manufacturing techniques like 3D printing. Edwin's current research interests lie in social robotics and wearables, and he also co-founded the ASSortiMENS foundation, which supports individuals with autism through FabLab workshops.

Symposium Hephaestus brought together experts and professionals from the fields of robotics and IT to discuss the role of technology in advancing these areas. It provided a unique opportunity for students and professionals to learn about the latest developments, network with industry experts, and gain valuable insights into the future of robotics and technology. As the annual symposium of Inter-Actief concluded, it left attendees with a renewed perspective on the impact of IT on robotics and our society, inspiring them to explore new possibilities in these dynamic fields.



## Symposium

We are currently looking for committee members for the 2025 symposium. If you're interested in joining a larger committee at Inter-Actief and organizing one of our most engaging study and career-oriented events, we invite you to email us at [board@inter-actief.net](mailto:board@inter-actief.net).

Even if the committee is already complete, you can still express your interest. There may be opportunities to assist in the preparation as a committee member, or you could become an activist on the day of the event.



# From the Programme Director



By: Vadim Zaytsev

Programme Director Technical Computer Science  
Associate Professor Formal Methods and Tools

**B**efore I joined UTwente as a professor in 2020, I was working at a company in Belgium called Raincode. The official job title was “analyst/developer” — I have also reached the level of the Chief Science Officer, but now’s not the time to talk about executive functions. As a developer, I was writing code daily — mostly in C#, sometimes in other languages, like domain-specific languages that I created myself or helped co-create, like Rascal made by CWI in Amsterdam in 2010 onward. As an analyst, I did some interesting stuff analysing entire codebases of very large companies I am not allowed to name now.

The biggest codebase I have seen with my own eyes and hands, had about 250 million lines of code. If you write a hundred lines of code a day — quite a respectable number, I might add — this will take you about 7000 years to accomplish, even by some miracle you would know what you are doing. That codebase was a decades-old system of an entire bank, and they guarded it like it was their most valuable treasure — because it was! It was a Spanish bank, not the largest there, but the fourth largest. Sometimes I still wonder how much code did the largest bank in Spain had then...

However, the largest problem was not the size but the complexity. Diversity, so to speak. Usually, the codebase would be delivered to me on a flash drive, ac-

companied by all kinds of advice to be very careful with it, for it contains the “business logic” of the company, the dreaded crucial piece of algorithmics

of files residing in one folder. The files would have no extension. There would be thousands, hundreds of thousands of those, all next to one another, all

## “Greeting, humans!”

that, if stolen, would allow the competitors to do mean things to my customers. Obviously, I didn’t want that. At first, I opened those flash drives with hopes to find a nice hierarchical structure, with packages, modules, and whatnot. I was gravely disappointed if I expected any of it.

The code was delivered as a collection

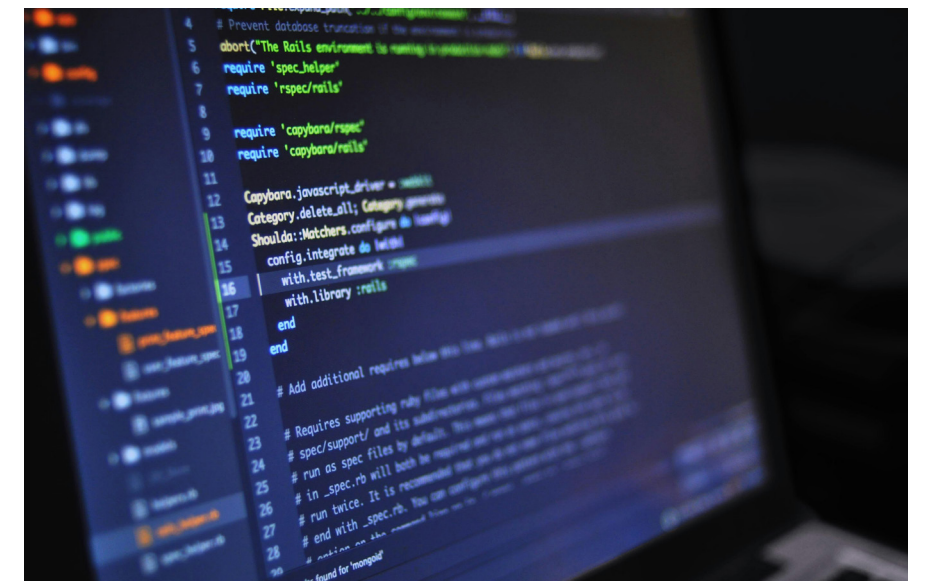
looking similar, until you take a closer look. A lot of that code was in COBOL — which is typical for the banking sector — and unless you have followed my MSc CS course on Software Evolution, you might not even have heard of that language. It wasn’t a problem, really, we had our own COBOL compiler since it was in high demand, and Microsoft appreciated us having it (targeting their

.NET and Azure) so much that they gave us, a tiny club of compiler nerds, the Gold Partner status. We could handle that. Occasionally I would find other languages, and we had to deal with those somehow as well.

However, a part of the codebase was inevitably written in assembler. Have you seen assembler? It is the lowest level programming language possible, besides perhaps pure machine code, and why would you even use it to make anything like banking software? Could it be performance? No, actually, that was not the main reason, as I found out by talking to very senior software engineers. The actual reason was that assembler was free — and when they started decades ago on their banking system, they basically could not afford a real compiler.

We bit the bullet and wrote our own assembler compiler. It sounds crazy to normies’ ears: an assembler is something making machine code from low level programs, and a compiler is something making lower level code from higher level code, this is how it has been since the first compiler was conceived in 1958, before my parents were even born.

Our assembler compiler pretended that assembler was a high level language, and translated each instruction into native .NET code or to some C# simulation code. It was a revolution after I had completed it, since it allowed our customers to preserve their old code exactly the way it was running for generations



of programmers, until the renovation activities were complete. (I never claimed it was a good idea to keep it forever, but being in VS/VS Code gives you opportunities you might not have had on older machines, and those help you in testing and replacing it further). We have received an award from Microsoft for technology renovation or some such, it was a huge round thing proudly displayed at the entrance of the company — it is probably still displayed there till this day!

I wrote some papers about its design and moved on. Now I use it occasionally as an example in my lectures — it made a difference for our customers back then, still does, and it can make some impact on today’s students as well. After all, computer science is all about changing the world for the better with the power of technology!



Collectively as humankind, we have created a lot of legacy, and we can also own up to it by facing the consequences and dealing with it with the same technology we claim to have under our grasp.

## About Vadim

Dr. Vadim Zaytsev finished Telematics, which now has been absorbed into the CS master as “Internet Science & Technology” specialisation, at UT as his second Master degree. He got his PhD title at the Free University (VU) in Amsterdam. Besides teaching, he has been an active researcher, and published many academic papers on topics such as software engineering and modelling, modernisation and migration of legacy software, transformational and generative techniques, and software languages and grammars, earning the nickname “grammarware”. He worked several years in the industry, developing new compilers, some of which were acknowledged by Microsoft Tech awards.

Since 2020, Vadim is back at UT as an associate professor of software evolution. In 2021, he also won the Inter-Actief Decentralised Educational Award (IDEA). Vadim has a cat named Viking.



# A Wheelchair-Accessible Web

## How the Government works on Digital Accessibility and Inclusion



By: Niels de Groot  
Alumnus

Even if you are not wheelchair-bound, you may still take notice of the presence (or absence) of accessibility options around you. Last November, I gave a presentation on digital accessibility and inclusion to my colleagues at the town hall. I asked whether they were aware of accessibility options in or around the building. They quickly summarized the ramp next to the stairs at the entrance, the numerous elevators, broader doorways meant for wheelchairs and some even mentioned the hearing loop for hearing aids users in the chamber of the Municipal Council. We can easily imagine what it takes to be wheelchair-accessible in the physical space, but what does it take to make the online world accessible for everyone?

For those new to the term: digital accessibility refers to the possibility for everyone to use digital tools, online websites and apps, despite a disability. You will find it is quite similar to accessibility in the physical space around you, although up until recently significantly less rules were in place to enforce online accessibility. The EU has been one of the driving forces behind web accessibility. The Web Accessibility Directive (EU2016/2102) [1] has been in force since 2016, which was one of the reasons behind a temporary decree (*Tijdelijk besluit digitale toegankelijkheid overheid*) [2] issued by the Dutch government in 2018. This temporary decree was permanently written into law by means of the Digital Government Act (*Wet digitale overheid*) [3] in 2023.

Although the law only came to guarantee the right to web accessibility recently, the United Nations Convention on the Rights of Persons with Disabilities (2006) already discussed commitment to “taking appropriate measures to ensure access for persons with disabilities (...) to information and communication technologies and systems”. Digital accessibility is an important human right, as it is a gateway to basic participation in society for people with a disability. And the group of disabled people may be larger than you think.

Foundation *Accessibility* calculates that there are anywhere between 2 and 4.5 million people in the Netherlands with some form of disability [4]. Among them are visually and auditory impaired, people with a mental disability,

but also millions of dyslexics, low-literate and elderly people. Up to 25% of Dutch citizens are affected in their use of digital communication with the government. Furthermore, not every disability is permanent, and accessibility may also be useful to the non-disabled in other scenarios as well: think of watching a video without sound but with subtitles on public transport.

### Digital Accessibility 101

So, what does the law entail? Well, the general demand is to continuously improve accessibility by ensuring disabled people can access digital resources with the same ease as anyone else. The Ministry of the Interior has, as part of the “*Digitoegankelijk*” programme, devised a dashboard where you can check the accessibility status of government organizations [5]. To receive a status, an accessibility audit has to be conducted by an independent organization, such as the earlier mentioned Accessibility Foundation, for example. Concretely, your website or app will then be checked based on the Web Content Accessibility Guidelines (WCAG).

Those guidelines consist of numerous criteria for accessibility, ranging from the presence of alt text for images (for visually impaired users with screen-readers) to the ability to use the software with only a keyboard (for the physically impaired who cannot use a mouse). After the audit you receive a report which can be used to create an accessibility

declaration (*toegankelijkheidsverklaring*), which is obligated by law, even if it states you do not (yet) comply. Based on the declaration, submitted to the *Digitoegankelijk* dashboard, you receive a status. If you meet all of the WCAG criteria, you are awarded an A status. If you do not meet all of them, but have conducted an Audit, you receive a B status. The C status can be awarded if steps are undertaken to conduct an Audit, but it has not yet been conducted. The A, B and C statuses are all compliant with legal obligations, although that does not mean you are off the hook just yet.

Remember the *continuous* improvement obligation mentioned earlier? If you are awarded a B or C status, you are compliant, but only temporarily. You will have to keep working towards an A status eventually. Naturally, this takes time and effort and results in costs. Therefore, government organizations may make trade-offs. Additionally, the awarded status is based on an accessibility audit report, but there are many more facets of accessibility that matter.

### The many facets of online accessibility

In addition to a website itself, many different forms of content may be published online. These contents should also adhere to accessibility rules. Word documents, PDFs, infographics, audio, video: in the best scenario all of these are accessible to everyone. In many cases, it is very important to ensure correct metadata is embedded in the docu-

ment. This means that elements such as titles, subheadings, etcetera, should be properly labeled by the creator of the document. If this is not the case, it becomes increasingly hard for screen reader software to properly relay the documents contents. Infographics contain an additional problem: the visual elements are often positionally and thereby also convey meaning to the user. For audio and video, transcripts and subtitles are effective tools, but creating them can be time-consuming, although artificial intelligence is starting to improve this process significantly.

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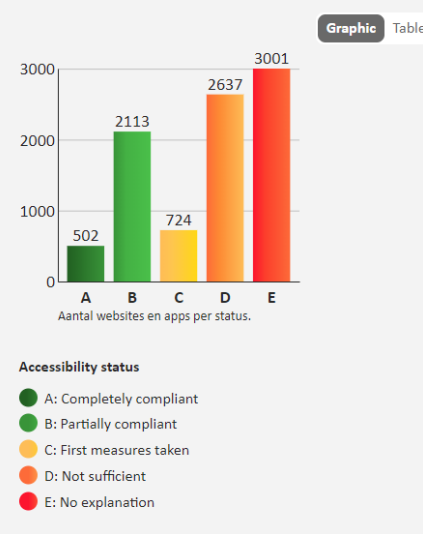
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The Dutch government is responsible for **8977** websites and mobile apps

**37% of websites and apps comply with the legal obligation**  
These are all websites and apps with Status A, B or C.

[More about the legal obligation](#)

**6% of websites and apps meet accessibility requirements**  
These are all websites and apps with Status A.

[More about the accessibility requirements](#)

Figure 1: Digitoegankelijk dashboard for all Dutch government organizations (May 23, 2024).

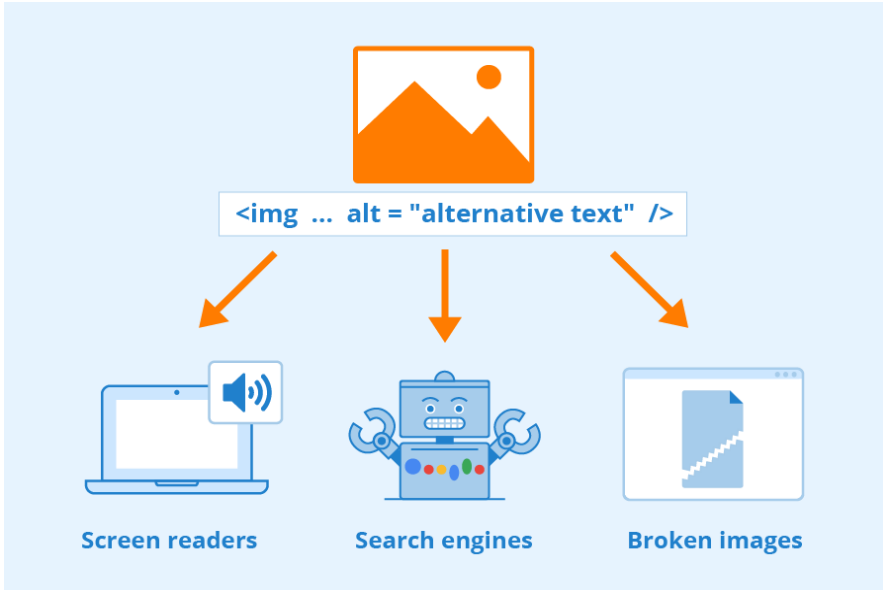


Figure 2: Alt text can be immensely helpful for visually impaired users, but also has other benefits. Image Source: [9]



The future and the role of the government

From my experience at the municipality, I believe the challenge of maintaining accessibility amidst the vast volume of government content is widespread. Ensuring new content meets accessibility standards may not necessarily be a problem, but you have to imagine the vast amounts of archived (but still publicly accessible) content the government is maintaining. In a report by the Advisory Board on Public Access and Information Management of last September, the advisory board concludes “the government’s information management is far from in order” and draws particular attention to the sustainable accessibility of digital documents [7]. Not a new feat, because worries about information management date back decades [8].

Looking ahead, however, the future of

online accessibility holds promise, particularly with the increasing technological advancements and the adoption of design principles like “Accessibility by design”. By integrating accessibility considerations into the initial stages of development and content creation, it will be much easier to provide large amounts of content in an accessible way. Additionally, new opportunities created by the advancements in artificial intelligence may also enable us to provide content in an accessible way more rapidly.

The government is certainly not the only one working on accessible design. However, I feel that it is one of the driving forces behind progress made. Recognizing its role in serving the public cause, the government has - in my opinion - a fundamental responsibility to ensure that everyone can participate fully in society, regardless of their physical or cognitive abilities.

Leading by example and prioritizing accessibility in its own digital initiatives can be important in setting a precedent for other organizations.

Nonetheless, we must remain realistic: the challenges mentioned earlier may simply mean that it will take some time before we have truly made the digital world as accessible and inclusive as possible for everyone. Even in the physical space, it is not yet always the case that you can get everywhere by wheelchair. Still, I am confident that even digital staircases can give way to a digital ramp.

About Niels

Niels is a UT alumnus and completed a bachelor’s degree in Business Information Technology (’22) as well as a master’s degree in Communication Science (’23). His strong interest in politics and public administration and his desire to contribute directly to society in his work made him want to work for the government. He currently works as Advisor Digital Government for the Municipality of Oldenzaal.

Board of ENIAC

Start of your career

By: Koen Braham  
Secretary ENIAC Board



Starting a new job might be an exciting move. Who will be your new team mates? Who do you ask questions about in your practice? How do you build friendships with your new team members? All of that comes into play when you are leaving the UT or starting a new job. Sometimes you get plenty of support, perhaps even a week-by-week activity list to take your first steps.

One of the fun parts of starting to work is a new challenge. Often you have puzzles to solve, but what kind of puzzle do you take on? Do you like a technical puzzle to create a solution for a given problem? Try to learn from an expert in your team. Do you like to organize and manage a team? Have a chat with your scrum master, product owner or team leader. Do not be afraid to introduce yourself to all members of your team, it will make collaboration easier and grow trust in your team. Additionally, by putting yourself forward into the spotlight, you introduce others to the challenges you face, as well as shine a light on your ambitions. This might sound hard at first, but in the end humans are very eager to help others.

Keen to learn more from alumni who have been through the journey of starting their career? One place to surely find support is ENIAC, the alumni association of Inter-Actief. By joining activities such as regional drinks – which ENIAC organizes every 2 months – or the larger ones as zoos and theme parks you will find alumni that can help you. Feel free to ask questions on their start, difficulties they had to overcome or tips to grow in your current position.

Often you are assigned a coach to help you get started and ask any questions you may have the first weeks. Try to socialize with all team members to get to know them. This may take some caution, as some members might be pressed on time and stressed to finish something in a project. See what moment is opportune to have a chat. People love to share what they have done and accomplished in their job, this may help you find what is important for them and how you can help the team grow.

As a fresh start you bring new knowledge into the team. Share your acquired knowledge from university courses and try to apply them in practice. As you are getting up to speed on the new project, you can use this time to understand what the required domain knowledge is and what opportunities for innovation are available. Do not push your agenda as that may hinder sharing knowledge, try to solve challenges they present using innovative methods or practices you master. During this time I created Python scripts to analyze data more efficiently on a target system, reducing the time required to create bug reports and investigate the observed behavior. As others saw the time saved and new tools to investigate problems they adopted this. Over time, based on this work, I created a challenge for new starters to learn domain specific knowledge in an interactive way. This visualization of data eliminates the need for mastering the system to gain basic information.

In a few years you will be the mediator to guide and mentor new colleagues. One easy route is to start supervising graduate students. Why? They bring new knowledge to your team! And you can help them get started with their practice.

What information did you wish you had when you started? By supervising you learn how to share knowledge, whilst the student is still semi-autonomous as required for graduation. This is a great way to start your mentoring skills. Keen to start supervising? Join one of the ENIAC Speeddates as a company to find graduating master students. During this evening you will participate in 5 minutes of one on one chats with students to quickly find potential students to join as your team member.

ENIAC

The ENschedese Informatica Alumni Club - ENIAC - is the alumni association for computer science, business information technology and related fields of the University of Twente. The ENIAC board of 2024 consists of Josje, Koen and Kevin.

Are you about to graduate but not yet a member of ENIAC? Membership starts from only € 5,- per year. As a member you will receive the I/O Vivat published to stay close to your academic roots and Inter-Actief. You are invited to all organized events. Most of these events are free to join for members and you are even allowed to bring friends outside of ENIAC/Inter-Actief. Even more important, it helps you stay connected with your roots and students from your time at the University of Twente!

Designing for users who are deaf or hard of hearing



Do...

Don't...

write in plain language

Do this

use complicated words or figures of speech



use subtitles or provide transcripts for videos



put content in audio or video only



use a linear, logical layout



make complex layouts and menus



break up content with sub-headings, images and videos



make users read long blocks of content



let users ask for their preferred communication support when booking appointments



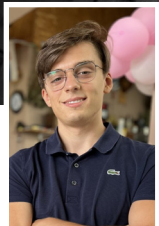
make telephone the only means of contact for users





# Cryptocurrency

## Why is it safe and how does it work?



By: Filip Karkalasev  
Editor I/O Vivat

**What makes cryptocurrency different from traditional money? What it boils down to: cryptocurrency requires trust in certain algorithms rather than in a central authority, like banks. But why would we want to use this and are these algorithms really that safe?**

### Decentralization

One of the main ways in which crypto differs from banks is that the ledger (the list of account balances) is not recorded at the headquarters of a bank, but everyone stores a copy. In addition, every transaction is broadcasted, so anyone can verify it.

Wait, but how can everyone store a copy of everyone's balances, and should transactions not be hidden from everyone to see? The way in which the blockchain is designed to be decentralized will be discussed later in this article, but let us first look at one of the key building blocks of cryptocurrency: *hash functions*.

### Hash functions

A basic refresher: how do hash functions work again and how are they made safe?

Firstly, take the following functions:

$$10x \bmod 27$$

$$x^2 \bmod 14$$

These are examples of functions that follow three of the requirements of a hash function  $H(x)$ :

- 1) It has a fixed-length output.
- 2)  $H(x)$  is relatively simple to calculate for any given  $x$ .
- 3) The output is deterministic, meaning that each time you calculate  $H(x)$  with the same  $x$ , the same output is recorded.

However, this is not enough. Another key property of hash functions is that, given some  $y$ , it is hard to find an  $x$  such that  $H(x) = y$ . This is called collision-resistance. In real life, hash functions

are preferably built so that it would take millions of years to crack them, that is, find a collision. That is what constitutes their safety. So how do we make hash functions that are good, or 'collision-resistant'?

### Collision-resistance

Making cryptographic hash functions is something that experts experiment with a lot. The key features that lead to good hash function security are:

- The output appears completely unrelated to the input;
- Changing one bit of the input can

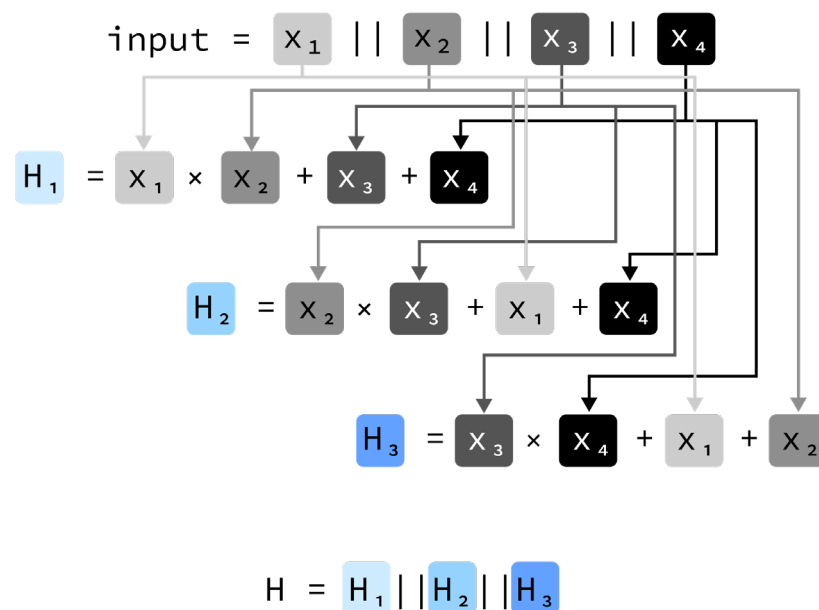


Figure 1: Example hash function H.

completely change the output;

- The hash function must be hard to invert.

If that last requirement is not met, one can relatively easily find an  $x$  that collides with the target, that is, produces the same hash output. For example, take hash function the following parameters:

$$H(x) = (3x + 8 \bmod 20)$$

$$H(x) = 4$$

Then:

$$x = (H - 8) \times 3^{-1} \bmod 20$$

$$x = (H - 8) \times 3^{-1} \bmod 20$$

$$x = (4 - 8) \times 3^{-1} \bmod 20$$

$$x = 6\frac{2}{3}n - 1\frac{1}{3}, n \in \mathbb{Z}$$

Any of these values of  $x$  will produce hash output 4.

Long story short: hash functions that consist of merely sequences of arithmetic operations (adding, subtracting, multiplying) can be inverted relatively easily by doing the same sequence of inverse operations. So what do we do to make our hash functions hard to invert?

### Layers upon Layers-resistance

Consider the example hash function  $H$  in Figure 1:

Let us fill in this function and see what happens to the output:

$$\text{input} = 00000010 \ 00000000 \ 00000010 \ 00000100$$

$$H_1 = 2 * 0 + 2 + 4 = 00000110$$

$$H_2 = 0 * 2 + 2 + 4 = 00000110$$

$$H_3 = 2 * 4 + 2 + 0 = 00001010$$

$$H = 00000110 \ 00000110 \ 00001010$$

Now suppose an attacker who knows the algorithm would like to find a collision (an input that hashes to the final  $H$ ), and makes the following random guess:

$$x_1 = 00000001$$

$$x_2 = 00000110$$

$$x_3 = 00000101$$

And then calculates  $x_4$  by:

$$H_1 = x_1 * x_2 + x_3 + x_4$$

$$12 = 1 * 6 + 5 + x_4$$

$$x_4 = 1 = 00000001$$

However, this combination of values will not produce the correct result:

$$H_2 = 6 * 5 + 1 + 1 \neq 00000110$$

Therefore, the attacker has to guess  $H_2$ . The same holds for  $H_3$ . So the chance that both are correct is (approximately)  $1 / (2^{16})$  (given a length 8 bits for both). This is a step in the way of collision-resistance, since the attacker now has no better strategy to find a collision than guessing. However, we may want to add other operations than just mod, such as the following:

- register shifts
- bitwise logic operations (OR, XOR, NOT, etc.)

Through layering of different types of operations, increasing the length of the hash output and adding more rounds of operations, our hash function can start to be harder and harder to find a col-

lision for, getting closer and closer to a complete, mingled randomness, which is exactly what real hashing functions achieve with a lot of layers of operations and rounds.

### The blockchain

One of the key ideas in the data structure of the blockchain is the use of hash pointers: hashes that point to a block of information. These are useful so that we can find out if the actual block of information is in some way tampered with. Because every block contains a hash of the previous block, the blocks are said to be linked in a chain. If any item in the chain is changed, the changes in the hashes of the next blocks will propagate through the chain.

### The future of cryptocurrency

Now that we have established the basics of cryptocurrency, you may think: "If cryptocurrency were to replace central authorities in the future, what would change?". Firstly, the operation of the system would no longer be merely the responsibility of a central authority, but of all participants. There would be networks of thousands of people maintaining a copy of the blockchain on their computer. In addition, people would need to be able to participate on a smartphone, so participating should not impose unreasonable storage and computation requirements.

Such requirements and many more are already functionalities of many digital currencies today, and will be improved upon in the years to come, where emphasis will be placed on security. Although it is hard to predict where the technology will take the world, cryptocurrency is headed to have a fundamental impact on the way money is globally stored and spent.

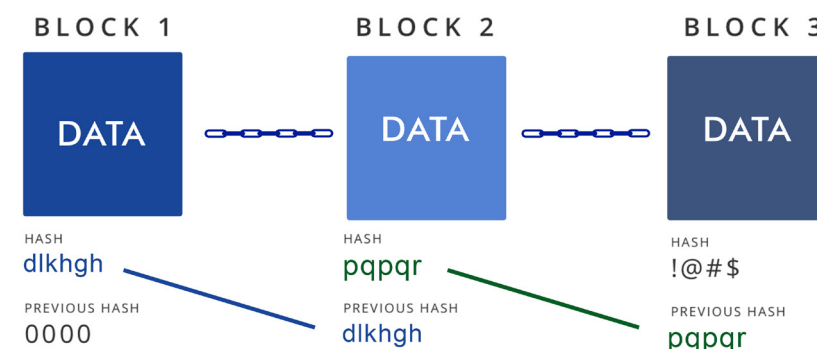


Figure 2: Blockchain example.



# Competitive Pokémon AI



By: Erjan Steenberg  
Editor I/O Vivat

Welcome to the world of Pokémon! These games have been a staple in people's childhood, and maybe still are nowadays. The franchise attracts such a wide audience: From collecting every Pokémon to becoming the ultimate Pokémon trainer, it is no surprise that so many people have fallen in love with these creatures.

It is not so weird to think that, given that most games are about battling trainers, a big portion of the audience likes to test their skills on other players. This community of competitive battlers have developed simulation software and ranking systems so that it is possible to differentiate the masters from the trainers. Because of this, it has made a name for itself among the giants of 1v1 strategy games, like chess and Go.

However, there is one thing that makes competitive Pokémon stand out from other 1v1 competitive games: there are no bots. AI has been a great tool for learning and improving in chess and Go, but why is that not the case for Pokémon?

### Why is it so difficult?

The reason why AI works so well in chess and Go is that both games are perfect information games. This means that all players are completely informed of all features. For example in chess, both

players can see all of the pieces on the board at all times. For computers, the world of perfect information is a Valhalla; since everything is known, they can easily calculate the best possible move.

This is the main problem for AI in Pokémon. There is a significant amount of imperfect information in this game. It can be best compared to Poker: As a player, you don't know what hand your opponent has, thus there is rarely a 'perfect' move.

To try to put it into perspective, it is important to know the basics of Pokémon's battle mechanics. A battle consists of one, two, or even three Pokémon on each side of the field. Additionally, there are Pokémon in reserve, which can be switched in. For each of these Pokémon, the player can choose its item, ability, four moves, and a 'spread', that determines which statistic is increased or decreased further. At the start of each game, these things are unknown to the opponent.

Both players act simultaneously during a turn, so they both have to predict what the opponent will do. They can either choose one of the four moves from their current Pokémon on the field or switch it out for another Pokémon in their reserve.

Currently, there are over 1000 Pokémon, 300 abilities, 1500 usable items, and 900 moves. This means that it is nearly impossible to determine a Poké-

mon's set from the start.

Additionally, research has shown that looking deeper into a game tree does not necessarily increase the quality of a decision, which is called 'game tree pathology'. [5] This is especially the case for Pokémon. Every turn, you not only need to predict the move of the opponent but also always guess the hidden information and take the random number generator (RNG) into account. This is why infinitely looking ahead will hurt decision-making.

Even if there is an AI that manages to master the current meta, it will most likely stumble down the ladder because of the ever-changing meta. Every year, new Pokémon, items, abilities, and moves get introduced to the game. This is hell for AI, since playing in a format, where it does not know half of the things, makes it a lot less successful, as it determines its choices on its old environment.

### Has it been done before?

There have been numerous attempts to create a bot that can successfully win against the top players in Pokémon. The first few attempts used AI models that were known to be successful in games like chess but were unsuccessful in Pokémon battles, like MinMax and Q-Learning. [2][6][7] Sarantinos gives three main reasons why these models failed to be successful: [3]

1. The battle mechanics are very complicated, thus the total number of possible game states is enormous, a lot bigger than Go's 10172 possible states, as seen before.

2. Training neural networks using past battles will result in inaccurate decisions, as every Pokémon battle can be set in a unique environment and will seldom be the same.

3. Since moves have accuracy, RNG plays a vital role in the game. The same move can have different outcomes. Using traditional reinforcement learning, where points are awarded for each successful outcome would not be optimal.

With these ideas in mind, Sarantinos created his own AI agent, Athena. It managed to reach the 33rd spot in the world, which AI has not been able to achieve since.

Another quite popular AI is called 'Future Sight', which is a play on words, as there is a move called Future Sight in the games and it explains how the AI functions; by looking ahead. This AI almost managed to get itself into the top 500 of the world. However, this model is a bit different from Athena. The Athena AI only played the 'Random Battles' format. This format gives both players a random team. Future Sight on the other hand played some of the most popular format battles where you need to build a team on your own, which it also did it-

self. According to the author, it was not anything fancy, but it still managed to build a balanced team based on current popular teams.

Future Sight also had an interesting 'feature' where the bot supposedly would play to its opponent's skill level, as it had a 50% win rate across all levels of play. This might be considered a bug, though it could be really useful as a practise bot for someone's respective 'rank'. Not only that; integrating this method into official Pokémon games may make them a lot more enjoyable for more experienced players.

A reason for this AI's popularity is that the creator developed an extension, where players can see the probability of winning for every move. You can see an example in Figure 1.

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As you can see there, clicking U-turn for the Cinderace has the best probability of getting that player to win. This model ended up being extremely accu-

rate; it was able to accurately predict the winner of the match 81% of the time. Sadly, the extension has not been updated since 2021 and does not work on the current popular formats.

### How can we make them better?

We have realised that it is incredibly difficult to create an AI for a game that has imperfect information, introduces new features every year, and is extremely complex. Despite this, Pokémon nerds have been able to get exceptionally far in creating a competent computer-controller Pokémon trainer. Will we eventually have helpful practice bots like chess, or do we still have to wait for new technologies in the future to be able to create such a tool?

## References

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[4] [https://cs230.stanford.edu/projects\\_spring\\_2022/reports/127608668.pdf](https://cs230.stanford.edu/projects_spring_2022/reports/127608668.pdf)

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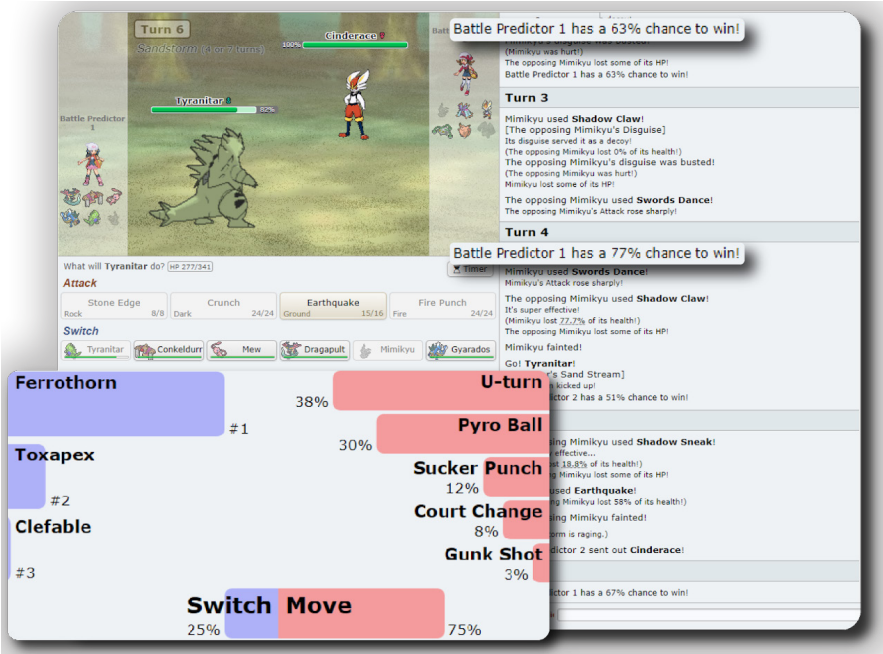


Figure 1: AI extension helping in deciding the best move.



## Pandora

## A unique puzzle adventure at Inter-Actief



By: Jelle Maas  
Pandora Committee 2024

**I**n the bustling academic realm of the University of Twente, an extraordinary event unfolds, captivating students' minds and challenging their intellect in ways they never imagined. Welcome to Pandora, a five-day puzzle hunt orchestrated by the Pandora committee at Inter-Actief. The event is always recognized by many students, staff, and professors because people walk around with pool noodles and PVC pipes (better known as blowpipes by the participants).

Much like the old mythical box of Pandora, it holds within its confines a world of mystery, intrigue, and exhilarating challenges. It is not merely a game but an immersive experience where participants delve into a realm where every corner of the campus becomes a stage for their adventures. The aim? To solve puzzles, outwit rival teams, and emerge victorious in the quest for glory.

At its core, Pandora revolves around teamwork, strategy, and cunning. Teams of intrepid individuals gather to embark on a journey filled with cryptic clues, enigmatic puzzles, and unexpected twists. The setting? The sprawling expanse of the University of Twente, transformed into a playground of intellect and skill. There are limits, such as barbed wire fences, and other obstacles that are marked as restricted areas. Luckily, the 1.4km by 1.25km campus has enough space to hide the puzzles.

Pandora starts the moment the theme and committee are revealed at the Pandora Hype Drink, a small event, but at the beginning of the event already. Here, amidst the buzz of excitement and anticipation, participants register and engage in the pregame—a tantalizing taste of what awaits them a month later when they will be puzzling five days straight from the moment the sun goes down on Monday until it comes up on Saturday morning when the brains of the participants are fried and cannot see puzzles until the year after.

As the clock strikes Monday evening in the week of the event, Pandora ignites into full swing with its inaugural meeting. Here, teams gather to receive their weapons, crucial tools in their quest for dominance, and their mission for the week is explained. But Pandora is not merely about brute force; it is about wit and cunning. Armed with their arsenal,

participants set forth to decipher the puzzles scattered across the campus, each one a breadcrumb leading them closer to victory.

Central to the Pandora experience are the nightly meetings, where the narrative unfolds, and new challenges are unveiled. It is here that teams receive vital clues to aid them in their quest, and where the battle between rival factions intensifies. The story progresses with each passing day, weaving a tapestry of intrigue and excitement that keeps participants on the edge of their seats.

This year's Pandora was again not without perils. The pirates of Baratria Bay had some rival teams lurking in the shadows, ever ready to thwart the progress of their adversaries. Here, the concept of "kills" comes into play—a strategic maneuver that can turn the tide of battle in an instant. Armed with their per-

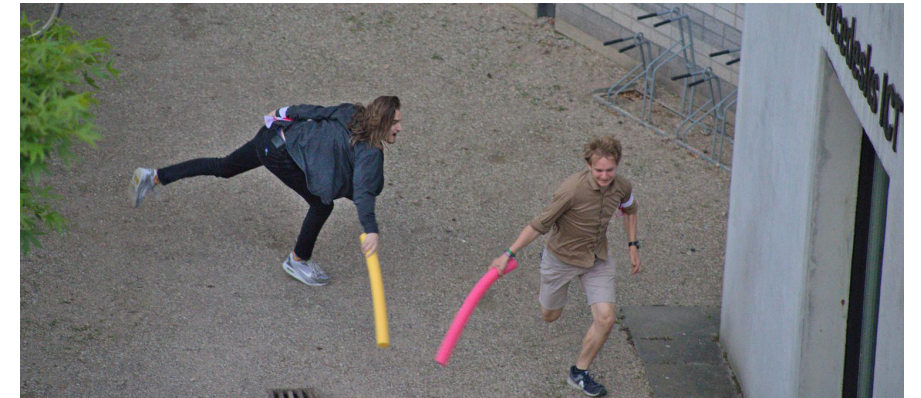
sonal kill codes, participants engage in tactical skirmishes, eliminating opponents and bolstering their own chances of success.

Yet, amidst the chaos and competition, Pandora offers moments of respite and camaraderie. The Cake Drink, a beloved tradition, brings participants together to indulge in sweet treats and friendly competition. Here, culinary prowess is put to the test as homemade creations are shown for possible rewards and the recognition of the tastiest and prettiest cakes.

As the days pass and the challenges mount, teams must rely on their ingenuity and teamwork to overcome obstacles and emerge victorious. Bonus puzzles and weapons add an extra layer of complexity to the game, rewarding those who dare to think outside the box.

In the end, as the final drink approaches, participants gather to celebrate their achievements and honor the victors. It is a time of reflection, camaraderie, and triumph—a testament to the spirit of collaboration and competition that defines Pandora.

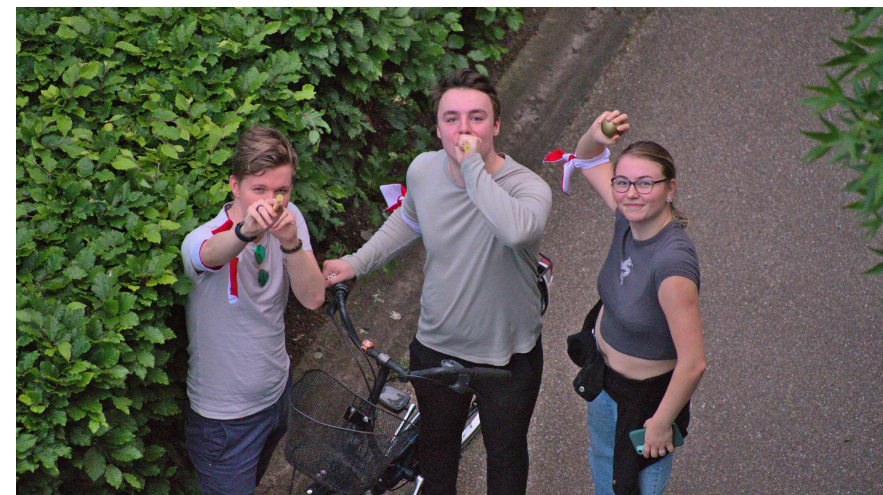
This year the theme was pirates, and most people expected to see Pirates of the Caribbean, but they got the less-known Barataria Bay which is located in near New Orleans in Louisiana. The pirates that joined with their pirate crew did get a different Pandora than the previous years due to the absence of Pro Deo, the committee had to think of other options and how to entertain 150 students in the lecture halls. But with variances of story, duels, and the program taskmaster it all went smoothly while some people might have yawned



in the back from the sleep deprivation that got the better of them.

While the committee was with fewer people than normal there were enough surprises this year. The Pandoradio was brought back to life after an absence of 6 years and all pirates enjoyed sending us commercials that were played on a real 'pirate station'. Besides the commercials being played on the radio there was also live commentary on the events which was the most professional set-up where committee members called each other and put the phone against the microphone. This gave quality news about people swimming in different locations on campus (while they did not even have to do that). A lot more happened during this year's Pandora, but sometimes pictures say more than a thousand words, so check out the pictures.

In the annals of university life, Pandora stands as a testament to the power of intellect, teamwork, and imagination. It is more than just a game; it is an experience that bonds individuals, challenges minds, and creates memories that will last a lifetime. So, dear reader, will you dare to unlock the secrets of Pandora and embark on a journey like no other? The adventure awaits.



## Pandora

Since the start of Pandora in 1999 with the James Bond theme there have been 25 years of Pandora, and with the arrival of ChatGPT and Google Lens, the game has changed a lot. However, everyone still likes to play the ever-changing game that is called Pandora. This leaves me with two questions if you know more information about the names, puzzles, or anything related to Pandora's that were held around the year 2000 please let the Pandora committee know via [iapandora2024@gmail.com](mailto:iapandora2024@gmail.com). And for the generation that is still studying and wants to organize the most iconic activity of Inter-Actief please sign up via [ictsv.nl/joinpandora](https://ictsv.nl/joinpandora).



# THE DATA LANDSCAPE

