MACHAZINE

Volume 24 - Issue 3
May 2020

Wiskunde Informatica Studievereniging 'Christiaan Huygens'

FUN FOR ALL, HARD WORK FOR SOME

Area FiftyLAN

CREATING A NEW SOCIAL DATING APP

Breeze

PROVIDING MRI SCANS FOR

Uganda

DREAMTEAM

Vattenfall Solar

CONTAINING:

Current Affairs | Association | Computer Science | Mathematics | Miscellaneous

Technolution

/ the right development

> Energiegebruikers controle geven over hun eigen data!

Dat wil ik!

Als je een slimme meter hebt, hebben alle energieleveranciers toegang tot jouw energie-data. Gek genoeg kun je daar zelf niet bij. In een vrije energiemarkt moeten gebruikers zelf kunnen bepalen wat er gebeurt met hun data. Wij werken er hard aan om dat te realiseren. Werk je met ons mee?

Joeri Jansen
Projectmanager

www.technolution.nl/joeri

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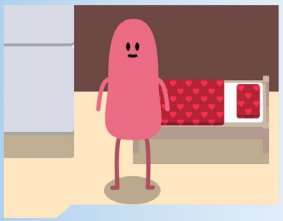
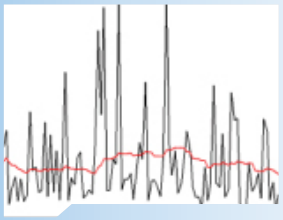


Computer Science



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MAGAZINE

From the Board

Louise Zwep, Applied Mathematics

Education Affairs

When writing this, I am already halfway through my board year. It has been an incredible experience so far, from which I would not have thought to be standing here a few years ago.

My road 'through CH' was a long one. It started out, off course, with the freshmen weekend. Here some amazing lumberjacks showed me what CH was. I was so keen about this association, I signed up to be part of the SjaarCie. This is the committee who organized Algorhythm, which you can read more about in this MaCHazine. Here I met eleven other freshmen with whom I was able to set up a great party at Proteus with the theme 'Catsino'!

I enjoyed throwing a party for CH so much that the next year I signed up to be part of the Dies committee, so I could organize a whole week of parties! This was a great new challenge. We also became very close with the committee, some are still friends that I hang out with a lot. Our theme was CHeers, and thus we went CHeerfully roller-skating, invited a CHeerleader and said CHeers to each other while riding a 'beer bike'.

In my third year, I still could not get enough of CH. That is why I signed up to do the iCom committee, which organizes trip of somewhat less than a week to a city somewhere in Europe. In my year, the trip went to ManCHester. Here my mind set about company visits. We went to a company, and over there I got inspired. There I saw how our studies were applied in real life. It is also a real nice way to get to know new people and create a network.

Doing this committee I also got way more involved at CH. I found out about all the nice things that CH offers for their students. This also brought me to the point where I am now, a board member. I am not organizing one event or a week of events, but I am running a whole association. This is a big responsibility. While doing this board year, I am learning a lot. These skills are very different from those I learned during my bachelor.

But next to these soft skills that I develop by working together in a team, I am learning a lot about the TU Delft as well. I am in charge of all the educational affairs for Applied Mathematics. When doing this, I learn about all the different parts of the faculty. For example, did you know that within the faculty we have a director of Studies ('Opleidingsdirecteur') and a director of Education ('Directeur Onderwijs') and that in Dutch the word for director is placed in different order, because otherwise the acronym would be the same (OD), which would be quite maladroit? Did you also know that it is not true that all the floors of the EEMSC building are empty? On the 16th floor there are a lot of important people of the faculty, such as Marketing and Communication, the dean and our own honorary member Ank! These are just little fun facts I learned during this year.

Now I also gained another soft skill: writing a piece for this MaCHazine. I keep on doing and learning new things this year. I hope that you, as a member of CH reading this MaCHazine, gain as much out of our beautiful association as I do!

Editorial

MACHAZINE
is a publication of
W.I.S.V. 'Christiaan Huygens'

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Advertiser index

Quite a lot of members of the MaCHazine committee have been doing their minor last half year, and we found out that we all did very diverse things. Therefore, this issue we answer the question:

'What have you done during your first semester?'

Eva - 'In September, I started with the Master Applied Mathematics. During the first semester everyone follows two mandatory courses: Scientific Writing and Ethics. Next to that, I decided to take 4 common core courses, since I hadn't decided yet which track I wanted to do.'

Louise - 'I jumped into this year by starting the multimedia track in which I followed the adjoining signal processing and image processing courses. The semester ended with a license plate recognition project which allowed us to apply our knowledge in building a real life application.'

Kilian - 'I started with my minor Finance. During this mathematical minor I learned how I can use my mathematical knowledge in the field of finance, for example how to make sure that you don't lose money on an investment. If you are interested, you can read more about my minor on page p.34!'

Maxime - 'I participated in the minor Fashion Industry at Erasmus University. I really enjoyed learning and gaining new skills from a totally different field than mathematics. On page p.34 you can read more about my minor!'

Tom - 'At the start of the third year I packed my bags and moved to Sweden. In Sweden I followed some design and networking courses at Chalmers University. Besides studying, I travelled through Sweden and made new friends from all over Europe. You can read about it on page p.16!.'

Kasper - 'The past half year has been relatively calm for me. I started my second year of the Bachelor Computer Science and I did not have to worry about BSA. I passed ADS, one of the most infamous courses of the bachelor, so I got that going for me. '

Annerieke - 'I started the second year of my Bachelor Applied Mathematics. The first semester of the second year does not have any electives so I just followed 5 mandatory courses. As usual, I liked some courses more than others, but it was a fun and interesting half year.'

Sterre - 'I hopped on a plane to the land of kangaroos and Vegemite, where I studied for roughly 10% of the semester and travelled for the rest of it. You can read about my semester abroad at the University of Sydney on page p.16!'

Hiba - 'I spent my semester in Denmark where I chose to take some courses outside of CS to broaden my horizon. I also travelled around quite a bit to explore more of Scandinavia. You can read more about my semester abroad at the Technical University of Denmark on page p.16!'

Boaz - 'In september, I started my board year for CH! The first quarter was mainly focused on learning how to run the association, and the second quarter I was working towards 'De Delftse Bedrijvendagen' which is a big career event that CH organises together with 5 other associations!'

MACHAZINE








Current Affairs

Love in the time of Coronavirus

Bhoomika Agarwal, Student MSc Computer Science

The coronavirus COVID-19 is spreading infectiously, causing panic worldwide. As a result, countries are being locked down, causing social isolation. In the midst of all of this chaos, there is one love story that has a lot of potential to grow and blossom - your love story with yourself. Yes, this article is about a journey of love but with a major twist. It is about my journey with discovering the importance of self-love in the time of COVID-19.

While the infectiousness of COVID-19 seemed like a major social issue, the strict measures being imposed to prevent the spread of the disease brought in a lot of unforeseen issues. One of the major issues for me was the depression that came in with the social isolation.

The uncertainty of the entire situation was staggering and unsettling. Also, being away from home and family made things worse. I was constantly worried about my family and vice versa. Due to the increased risk of contracting the infection during travel, I ruled out the option of going back to my home country. This left me feeling overwhelmed by homesickness but helpless as I was stuck in the cross-fire. The last thing I wanted was to be put in quarantine once I got back home.

The first day of social isolation seemed alright. I stocked up on groceries for about a week and got through the day despite a few hiccups and a lot of panic. However, with each passing day, I got more anxious and restless. This is when I learned the importance of spending time alone and loving myself. This is when I began to re-discover myself and decided to "date myself" for a while.

It all started with a single question- "Am I being too strict on myself?" When I asked my best friend this question, he vehemently answered- "Yes. You are. What you need is some self-compassion and self-love." What really struck me then was the realization that I did not know the true meaning of those words. And so began a journey of a lifetime.

A good starting point for me was the experiences and teachings of Dr. Kristin Neff about 'The Space Between Self-Esteem and Self Compassion'. Self-compassion is essentially about being compassionate not only about others but also about yourself by including yourself in the circle of compassion. We need to treat ourselves with the same compassion that we treat a good friend.

A useful trick that I learned and began implementing in my life was to ask myself if I would be okay with saying certain things to my good friend before saying it to myself. Repeatedly asking myself this question led me to realize that I have been too harsh on myself and I do need to allow myself to be nicer and encouraging. The boost in my self-image and productivity were apparent almost immediately. Another major takeaway for me was mindfulness or 'being in the present moment'. I tried to make a conscious effort to enjoy the present company and it helped me connect better with those around me.

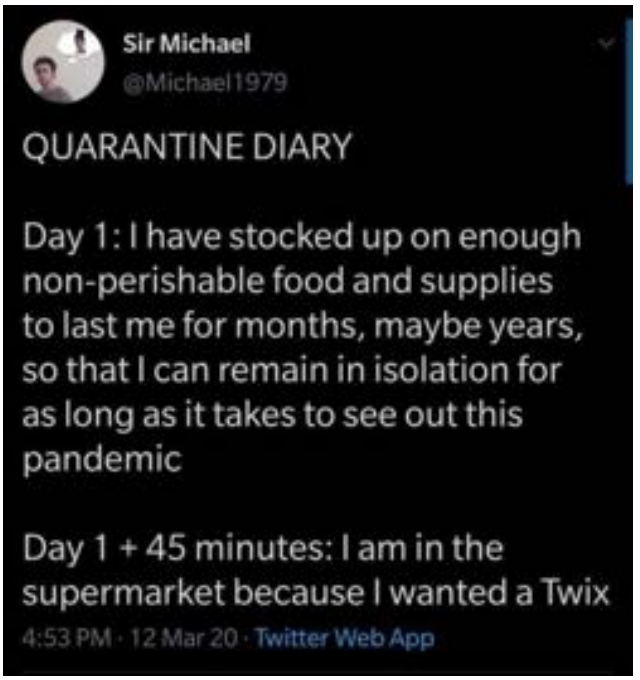

Figure 1: The struggle of social isolation

I used this time of social isolation to read a lot and to write. I also invested time in working on hobbies that I had been putting on the back seat for a long time now. Food has always been my first love. Good food is my go-to fix for any kind of mood. I went grocery shopping and decided to pamper myself with a lot of good food. I also decided to delve deeper in my experiments with food. I started spending more time cooking and tried out new recipes.

To make myself more at home in my room, I decided to decorate my room and personalize it. This is what spurred me to get back to origami. It is indeed lovely what you can do with a simple piece of square paper just by folding it up! I looked for walls and spaces in my room that I could decorate. Following this, I made origami wall decorations, photo frames, lampshades, posters and much more. In each of these, I ensured that I added a splash of color and an element of myself. I began some spring cleaning and re-arranged my room. In a week or two (owing to the online classes and heavy coursework), my room began to feel more cozy and I started looking forward to spending time in it. At the same time, I also discovered a long-last hobby that helped me get some space and also gave me a lot of peace of mind and satisfaction. It had a meditative and therapeutic effect on me.

While I was exploring a lot of new ways to improve myself, I also chanced upon the Quantified self movement [1], which believed in using data collected via sensors as a mirror to reflect inwards. I started looking at aspects of myself that I wanted to quantify and how I could use technology for self-discovery,

Figure 2: An origami wall decoration that I created

self-improvement, and self-knowledge. After all, if we want to act more effectively in the world, we got to get to know ourselves better. After giving this a lot of thought, I realized that I wanted to work on two main aspects- reducing the time I spend online on my phone, while also improving my focus and running and working out regularly.

I downloaded two apps- Forest [2] and Screen Time [3] to get started on the first goal. Whenever I had to focus and work, I began using Forest and it helped me stay focused on the goal at hand. At the same time, I began tracking my screen usage in terms of time spent and also app-wise. The constant awareness of the time I spent online helped me reduce it over time. The realization that I spent a lot of time on social media helped me divert my time into more productive apps. For the second goal, I began using a fitness tracker to become aware of how much physical activity I had during the day. This motivated me to increase it gradually. Surprisingly, it helped me fix my food and sleep cycle and fix a daily calendar for myself.

Another really interesting concept that I read about and tried to implement was Atomic Habits [4]. I was introduced to it through this talk [5] and this blog post [6] by James Clear. The core idea behind it is that if you work to improve yourself 1% every day for a year, that already makes you 37 times better by the end of the year. While we might not realize it, small habits and little choices are transforming us everyday already. Inspired by this, I began working on developing positive habits by integrating them into my daily schedule.

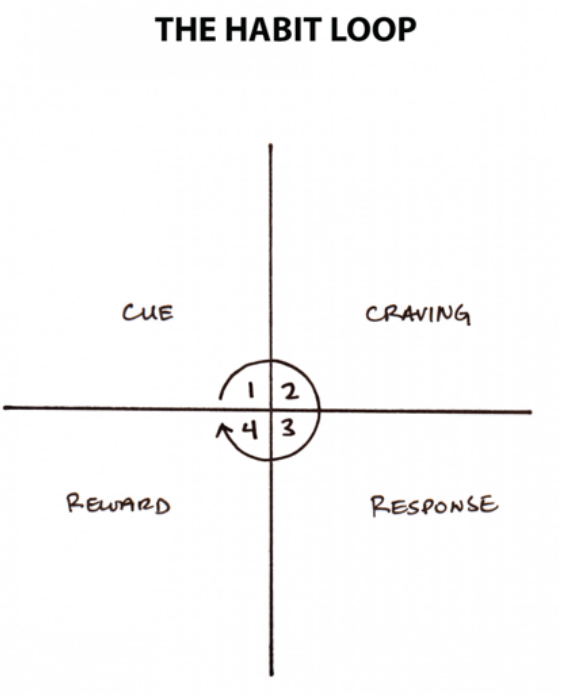

Figure 3: The Habit Loop

I started my day with some exercise and ended it with some meditation. I began keeping a book by my pillow and it helped me get back to reading. I also ensured that the habits I wanted to develop were within easy reach or prompted while I worked- plenty of water, putting away my phone, reminders for medicines and food and creating to-do lists and putting them on my wall. It was not long before these became habits and have now started becoming a part of me. To quote James Clear- "Every action is a vote for the type of person you wish to become. If you can change your habits, you can change your life."

I did my best to use this time of social isolation and quarantine by integrating more self-love and self-compassion in my life. I would strongly advise it to everyone reading this post. At the same time, it works in the best interest of public safety and helps us find ways to spend our time in improving ourselves. Stay happy, stay safe and love yourself!

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Time to Say Goodbye

Fred Vermolen, Department Numerical Analysis

I have been the author of the columns of Machazine for more than six years. Time has come to say good bye.

There is always something in society that disturbs me. Things like how the government of the European Union operates, the fact that our tax-paid institutions and our journalists cede to violent people who are yelling that the traditional Sinterklaas celebration should be abolished or altered, or the massive population growth in one of the most densely populated countries of the world, or climate change in which it is very clear that we can no longer expect proper winters that make outdoor ice-skating possible, or the government that is imposing more and more restrictions on the Dutch farmers, who are already among the most environmentally concerned of the world. Or the fact that gender has become an issue. We see this in hiring people. The university strives to have more female (full) professors. The government funds special positions for women. My goodness, this is complete madness in my opinion! In my opinion, the best, most suitable candidate should be hired. Whether the most suitable candidate is a man, women, straight, gay, lesbian, muslim, jew, christian, atheist, disabled, I do not care. I simply despise discrimination (both positive and negative) in all cases. We should be judged on our qualities and personality and not on other criteria, in my humble opinion. Well, there might be an exception, drinking capabilities matter as well of course! I have the privilege to work and to interact with a large diversity of people, from various cultures in different countries. It is a fantastic experience! I cannot say more. Furthermore, the alcohol is there to enjoy. That is the most important thing in life, is not it?

Now, February 28th, the first two individuals in the Netherlands have been infected by the Corona virus. More individuals will follow. The fact that surprised me most, is that the Corona virus has hit the Netherlands so late. We have Schiphol Airport, Rotterdam Harbour, so many different hubs where people from all parts of the world converge. Are we going to die? Of course, we are, that is for sure! By Corona? Maybe, although the likelihood that Corona will kill you is small, I guess. Of course, it is bad, no kidding (now I am not for a change). We should take precautions. Why would you increase the risk of shortening your life, or the life of others? No, I definitely wash my hands and take hygienic precautions. But, in fact, I always do. You should always do so! Ecoli bacteria can also act very nastily. However, panic is a useless reaction in my humble opinion. Do you want to understand some of the dynamics of how an epidemic evolves over time? Just consider the simple SIR model (S = susceptible, I = infected, R = resistant). The model is based on a set (nonlinear) ordinary differential equations. One can also enrich this model with a network of any topology you want to incorporate the spread of the virus over different locations. Or as a further alternative I was thinking of cellular automata type of models with different discrete states, in which the lattice represents a graph of relations (edges) between the individuals (as nodes) with the appropriate transition (infection) probabilities. If I have time to do it, I will set up a simple model, compute different scenarios and the likelihood that we are all going to be infected.

Let us hope that as few individuals as possible will be hit by the Corona virus, so that we can continue enjoying mathematics and alcohol. Every working day when I wake up, I am happy to go to work. At work I can combine the most important things in my life: mathematics and of course... alcohol. It is always a joy to work on equations, theorems, concepts and on the applications. Some of the applications are on simulating wound contraction, which is a post-trauma phenomenon where skin contracts excessively so that the patient may face disability. Other applications I am working on is on cancer metastasis and growth in the pancreas and skin. Furthermore, I work on porous media applications with saddle point problems. All these models are subject to input parameters, which are subject to uncertainty and are, in some cases, combined with stochastic processes. Fantastic! Furthermore, it is a joy to work with talented and devoted master- and PhD-students. Young people who have an inquisitive nature, as well as a creative mind, in one word fantastic. Combined with alcohol, this is even more than fantastic!

I have worked at DIAM for twenty years. I would like to thank all my colleagues and students for having had a great time in the Mathematics department. I would like to thank everyone for his/her trust in me. However, I am leaving the university. The atmosphere at DIAM has always been great and inspiring. Keep up the good work by maintaining this great atmosphere! Are there only positive things to say? Well... The working pressure is substantial. Tight deadlines are to be met. There is always a lot of work to do. I have never had a dull moment at DIAM. This is a good thing, but I would like to say that the increase of the number of students is nice, however, this increase also leads to quite some pressure on the teaching staff. This pressure may impair the quality that we want to offer the students. This worries me a little. Think of all the committees in BSc- and MSc-presentations. A large number of presentations and reports have to be evaluated. Another thing that I would say is that, at least in my opinion, the board of the university may put a bit more effort in offering more appreciation to staff members who have been there for a while and who keep the institute running. The university may lose them.

Furthermore, the Delft University wants to have more female staff. For this reason, positions for women only are offered. Is this a good thing. No, absolutely not, in my opinion. If I look at the demographic development of the student population over the recent years, then it is clear that the number of women is increasing, and by this, the proportion of women of professors will increase. Hence, in my opinion, it is silly to crease positions for women only. It is better to make working in academia more attractive for women: abolish the tenure track system, offer, for instance, new (assistant) professors a permanent contract after one year of evaluations (and not after six years), put less pressure on young professors. Look at how things evolve at the Dutch primary and secondary schools: at these schools, most teachers are female. What about increasing the number of transgender individuals? Or the number of individuals having the two-spirit gender?

Time for a change. I am going South. Yes, I can, yes, I will. Time for life with better beer, better alcohol, better chocolates, eel in green, stewed meat, and waffles.

Good bye. Hej då. Skål burp.

Association

The beginner and the advanced skiers, but both organisation

Laura Pircalaboiu, Ardy Zwanenburg, Ski Trip Committee

This years ski trip was organised by the WiFi. We were a committee with a lot of diversity in ski experience. Ardy was an expert skier and goes down the mountains like there is nothing to be feared of, however we also had Laura. Laura has never skied before. Here you read the experience of being in the WiFi as an experienced skier and as a beginner. Spoiler: in both cases being in the WiFi is fantastic!

Ardy

I have been skiing since I was 4, that is now 16 years. I have been on ski vacation 17 times. One of them was the CH ski trip of 2019, organised by the WiFi before my WiFi year. During this trip I already wanted to join the WiFi next year. This year we worked hard and then stepping into the bus was an amazing feeling. Going on a trip you and the rest of the committee organised, that feeling is amazing. We had a nice room with our committee. Laura woke up early for her ski lessons, Elise and I were as early as possible on the slopes and Max, Jules and Jaron came after us when they were ready. It was a lot of fun. As organisation we kept having contact with each other, but we had good communication so we could just enjoy skiing the whole day without having to do anything before leaving the slopes. After leaving the slopes on a nice day of skiing, you do your tasks for the organisation part, like meeting your responsible room to see if everything was okay. Thanks to being in the WiFi, I met every person that was with us on the ski trip and even made some friends.

Of course we also had the seriousness of being "sober" one night, which means no alcohol for the night, and the "day manager" jobs. However, because we were with 6 people, everyone but Max only had to be one night "sober" and 2 times "day manager", which you do with one other WiFi member. So we had to solve problems during those times, but that is also a part of what you signed up for when doing the WiFi. I enjoyed solving these problems and learnt from them.

As an expert skier I loved to organise these week and still be able to ski as much as possible. I could easily ski from 09:00 to 17:00 even though I was part of the organisation. And that was the most important in my opinion. Having a super nice holiday and being the one in the organisation.

Laura

I had never skied before I went on the Ski Trip with CH. I joined the WiFi because I wanted to do a committee, and it seemed fun and interesting to organize a trip. Overall, the trip brought me a lot closer to my fellow committee members, since we shared a room. We cooked together every night and shared stories about our experiences on the slopes. We also organized a bread delivery service for each room, and ended each day by having a drink with our responsible rooms, and going out together in the club.

My ski lessons were another fun part of the trip: starting every morning at 9:30, we were on the slope together with an instructor for a couple of hours, learning the fundamental techniques necessary for skiing. Personally, I went from not knowing how to put my shoes on, to actually taking my first steps in parallel skiing in the span of one week, and I could not be more proud of myself since I am not exactly the sporty type.

Overall, I think being in a committee made me strengthen my problem-solving skills: It's easy to feel lost when something goes wrong, but with some quick thinking, I was able to do my part to offer everyone an unforgettable week!

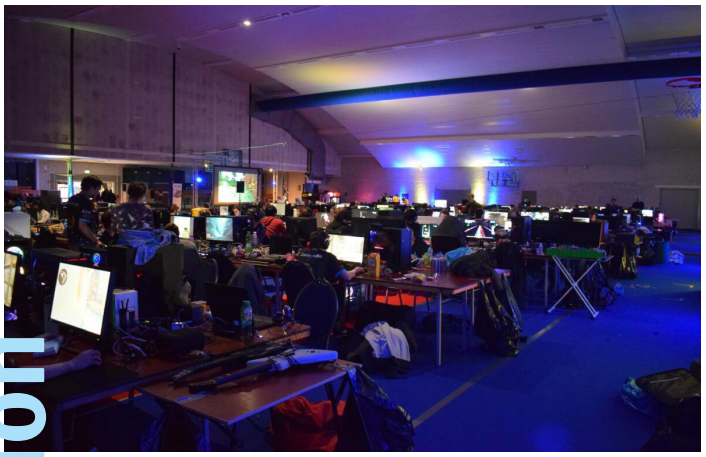
Area FiftyLAN: Fun for all, hard work for some

Bram van Kooten, Secretary of the LANcie

From Friday the 28th of February till Sunday the 1st of March, one of the big sports hall of X was unusable for sporters. This was because the hall was filled with 200 gamers. Some of you might have already heard about this annual CH event. I am of course talking about the AreaFiftyLAN!

This year the AreaFiftyLAN was organized for the sixth time. It also marked the third time that I attended the event. Two times as a participant, and this year, as part of the LANcie, I organized the event. And this year really changed my perspective on the event.

Previous years I would show up with my computer, discuss with my friends what games we were going to play during the weekend, and play them. There were times where we might have felt adventurous and signed up for one of the tournaments, like Rocket League or League of Legends. We already knew we weren't going to win of course, but that also took of the pressure and gave us the most important thing of all: lots of fun. Every now and then we would take a small break from our computers to go to the LAuNCH area and play some arcade games. There was always just an enormous amount of things to do, and most of these things I definitely took for granted.



Fast forward to this year, and suddenly I realized how much work goes into organizing an event like this. Every piece of furniture in the hall has to be rented. Companies need to be contacted about arcade machines. And every tournament requires a price, a format, and a set of rules. And then the event hasn't even started yet. Luckily, I didn't have to do this all by myself, because I was accompanied by 5 fantastic fellow committee members: Sebastien, Dante, Louise, Eva and Diederik.

During the event things were also very different. Besides all the minor problems that arose during the event, I was mostly checking out what all the participants were playing. At this point I realized that everybody really is able to play whatever they want. There were a large number of people who were playing the games we hosted tournaments in, like CS:GO, Overwatch or League of Legends. Besides this, a lot of different games were also played. I saw a lot of people playing Minecraft and Factorio, and there were even some people who brought their VR setup. This really shows that anyone can have a lot of fun at the AreaFiftyLAN. Just bring some friends and play whatever you want!

My highlight of the event happened in the depth of Saturday night: The Achtung Die Kurve tournament. During the entire event the 'ACHTUNG' chants could be heard, slowly building up towards this mainstay tournament. Finally, Sundaymorning at 3 AM it was time for the tournament. There was only a handful of people still present at the event, and about 30 people actually participated in the tournament. What followed was 90 minutes of pure chaos and randomness, which words won't do justice. I highly recommend anyone who is willing to throw away their sleep schedule to participate in an ACHTUNG tournament at some point.

Did you miss the event, or can't you wait for the next edition of the AreaFiftyLAN? Then there is some great news for you! The next edition will take place at the end of 2020, so you won't have to wait as long to participate (again). Keep an eye out on our Facebook and Instagram pages @areafiftylan to stay up to date about the next event. And maybe we will see each other there, because I will definitely be there again.

Algorythm: a golden oppertunity

George Hellouin de Menib, Cut and Paste Affairs of the SjaarCie

On February 26, the CH's own SjaarCie threw its famous party, Algorythm, golden oldies. A real blast from the past, it featured all kinds of old music and decoration that reminded us of great hits from the chrome modern all the way to the camp of disco. If you missed it, you can always try going next year, though you'll have to expect a different theme.

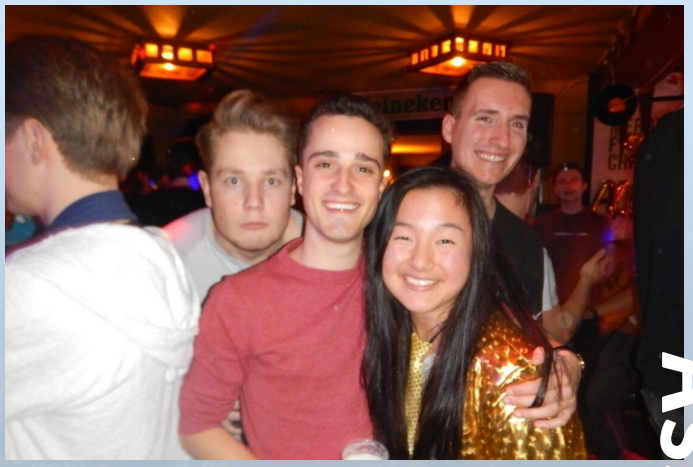
The party went from 10 pm to 3 am, featured 3 DJs and plenty of drinks. It had over 300 guests, including multiple study association boards. Going by the number of hook-ups, the mood was electrifying.

How did SjaarCie pull it off?

Part of the magic of the party was the location. Near the Train Station and the Bolk, Cafe De Tobbe was an ideal place. Easy to find and access, near the trains for those that needed to leave, and containing a strong "vintage" style, the Cafe got turned into a party ground. The SjaarCie added its own dash of gold to it to make it even more splendid.

The second most important part was music. After all, the place can look nice and all, but without funky beats, how is any party supposed to take place? SjaarCie hired three different DJs' to give the party a real crescendo of music and to appeal to all dancers! First came DJ Schatje, who started with a strong beat and quickly got the dancing started. Then, DJ PJ, a Delft favorite who mixed Dutch and English music. Lastly, DJ Dennis, a fairly obscure DJ who blew crowd expectations by relaunching the party's momentum, despite the late hours, ensuring the event did not end until 3am.

Of course, good music is nice, but how can you have a party without party goers? SjaarCie knew they had to promote the event if it really wanted the "best party of the year". If you were in the EEMCS building during lunch periods, you might have noticed some students walking by with tacky golden outfits. These were members of the SjaarCie going around generating interest for the party to any student. A golden ticket promotion was also made. One in 30 tickets had the chance of being a "golden ticket", which came with a prepaid drink. On top of that, the first hour was "golden hour", which gave a 50-cent discount on beer and nonalcoholic drinks!



AnnuCie

Pauline Huisman, Content Affairs of the AnnuCie

Dear reader,

Every year the AnnuCie makes a beautiful yearbook. This book is made for all the members, honorary members and alumni of CH and the employees of the faculty EEMCS. The yearbook is a kind of summary of everything that has happened that year at CH. This year it is our job to make this beautiful book, so that after a couple years you can look back and think about how amazing the academic year 2019-2020 has been. We are very honored to be this year's AnnuCie.

The theme of this year's Annuarium is 'Identity'. Our committee consists of seven people with several identities. With a combination of all these identities, we will make a beautiful yearbook. On the 12th of May we will present to you the greatest and most personal yearbook you have ever seen.

Of course we can't make a beautiful book without text in it. As the Commissioner of Content Affairs, it is my job to make sure that we receive every piece of text that has to be in the Annu. This means I have to contact the sister and niece associations, the organizations of the faculty, ambassadors, honorary members, Board 62 and 63 and of course the committees.

At the beginning I already thought that it would not be easy to receive all the pieces on time. But when at the date of the first deadline, from the committees I had only received the contributions of the Business Tour committee and the LanCie (well done!!), I was a bit worried.

It is not really in my identity to nag at people, so I tried to get all the contributions on time in my own way. Luckily, after 3 reminder mails most of the contributions slowly entered my inbox. But for some committees it was a bit harder, so I had to nag a little bit after all. Therefore I would like to take this moment to apologize for the many mails I send to all of you.

We would like to thank you for sending all your contributions, memes, quotes and responses to the Annuquête. We really enjoyed them!

We hope to see you all at the Annu drinks on the 12th of May to get your (very personal) Annu!

Computer Science

Volume 24 • Issue 3 • May 2020

Exchange Minor

Hiba Abderrazik, Sterre Lutz & Tom Saveur, Students Computer Science

Hiba Abderrazik

I spent last semester abroad in Denmark at Danmarks Tekniske Universitet (DTU). I am excited to share my experience with the country and my travels.

There are a ton of ways to spend time in Copenhagen. Of course, the architecture and history of the city, and Denmark in general, are fascinating and beautiful. Some museums I loved are the National Museum (if you want to learn a bit about the history of Denmark), the Design Museum, Glyptotek (for some classic sculptures) and the Botanical Garden. Apart from that I spent a lot of my time travelling in and around Denmark! I visited Mons Klint, Helsingor, Malmö in Sweden (45 minutes by train from Copenhagen), Stockholm, Oslo and Helsinki. I also became a member of ESN (European Student Network) while I was there, meaning I could join several parties and trips organized by the network.

All of these activities were even more special because I got to do them with all of the amazing friends I made during my stay abroad. I met most people at Introduction Week. After that, I just met a lot of new people through those friends, at parties and in class. Being in a foreign country by myself I discovered a whole new social side of myself. I have found other people on exchange and even locals to be very open and interested in meeting new people like myself. I am extremely pleased to have built a set of friends all over the world, as well as strengthened my academic and professional network on an international level.

Overall, Denmark and especially DTU encourages people from all over the world to study there. The facilities at the university are great, as well as the student funding and compensation from the government, healthcare, public transport, etc. There is a very realistic possibility that I would go back to do a Master at DTU or even to find a job in Denmark. I have grown to love the country and the people, even the rain and cold. Looking back on my stay abroad I learnt way more than I thought I would, in many different facets in my life. I don't believe I would have gotten this experience if I had stayed in Delft.

Sterre Lutz

After two years of serious studying in good ol' Delft, I decided that it was time to explore a new part of the world! I applied to the minor abroad program and was assigned a spot at the University of Sydney, Australia. Of course I had already heard that Australia was a beautiful country, but I figured that I would probably still have to study for most my time there, just in slightly sunnier weather. Oh boy, was I wrong..

.

If you do your minor at USYD, you usually choose four courses that last the full semester. I chose two second-year mathematics courses (Analysis and Cryp- tography), the computer science course Human-Computer Interaction, and a philosophy course called Society, Knowledge and Self. In retrospect, I chose rel- atively challenging courses compared to other students doing a minor abroad. (Protip: choose the course Outdoor Education, where you just go on hikes in National Parks and write a few reports!) I would estimate the entire semester cost me on average 25 hours per week, for 15 weeks in total. Yes, do the math, that's nothing compared to two full quarters at the TU Delft. So I'm sure you're wondering, what on earth did I do during my time in Sydney?

Travel, travel, travel! I figured that I probably wasn't going to be back in Australia for a while, so I decided to travel until time and money ran out. I drove up to the beautifully sunny Queensland coast to sail on the Great Barrier Reef, I road tripped around Tasmania to explore hidden rain forests and laugh at its peculiar wildlife, and I flew inland to hike in unforgiving heat and sleep under the crystal clear night skies of the Uluru-Kata Tjuta National Park. I know it sounds like an Australian tourism add, but truly, those were sights I will remember forever.

As amazing as it was to explore the more remote parts of Australia, it was always just as special to come back home to the hustle and bustle of Sydney. For me personally, there is just nothing quite like taking the first Sunday ferry out to Watsons Bay for a morning hike and being back in Newtown in a cute second-hand book cafe by noon. I'm certain there is a perfect day for everyone hidden in the streets of Sydney, and I highly recommend you go out and find it!

Tom Saveur

Last semester I went to a far and cold place called Sweden, where I studied in a city called Gothenburg. I did some courses in computer science, mainly focussing on design and security. And while I could bore you with anything concerning actual studying, I'd much rather tell you about all the trips I made.

Usually, I went to a pub in the city center about 1 or 2 times a week with some friends. Here we could enjoy the worst thing in Sweden: the alcohol prices. We thought this is because of the short days. In the first week, even before university started, I went with a group of friends to some islands close to Gothenburg city, where we enjoyed the view and went to a beach to swim. And don't forget the famous Swedish saunas, where you go to warm up before you jump into an ice lake.

During one visit to the city my wallet got stolen, and this event resulted in me having to take another trip. A trip to the capital to get a new ID card at the embassy. I woke up at 4 in the morning to catch the first train up to Stockholm, where I spend a lovely day trying to forget about the things that happened a couple of nights before.

And now the best trip of them all, going up to the Swedish Lappland to look at the Northern Lights and enjoy the snow. While up there it was freezing cold, about -10C to be exact, because of this there was also a lot of snow and ice. While we were there for a full week, we enjoyed many things, like looking at fjords, going to the ice hotel, going to Norway, going on a snowmobile tour, and dog sledging. The best thing of them all was looking at the Northern Lights but, unfortunately, we could only do this on one of the seven days, because of the bad weather on the other days.

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The World of Music Recommendation

Sandy Manolios, PhD Candidate Multimedia Computing Group

We all listen to music on a daily basis in a various range of contexts: to commute, to work, to exercise, to fall asleep, to cheer us up or to simply just enjoy it. However, with the increasing collections of songs, it has become complicated to navigate on our own to find new pieces we'll like. Music recommender systems emerged to answer this problem. They are widespread now and most of us use them quite frequently through services like Youtube, Spotify or Pandora. A very well-used and common approach is to compute the similarity between items (or users) and recommend you songs that are similar to the ones you like (or that people who like the same songs as you liked). It's called collaborative filtering and it is quite efficient, particularly since studies showed that a large portion of users is perfectly content with top charts recommendations.

But this approach has a few limitations as well. The most famous is known as the "cold-start problem". The collaborative filtering approach needs to compute past consumption of users or of items to function, but at the start of the system or at the introduction of a new user or item, this information is not known. This makes it difficult for the system to make good recommendations to new users or to recommend new songs.

Another issue is that the system relies on the songs you listened to to recommend similar songs, which means that it mostly reinforces your current taste for a specific category of songs and is not really helpful to discover new categories unless you already know what you are looking for. It's a bit like my grandmother who always cooks the same dish when I visit her. That's because she knows I like it and is too worried that I might not like what she made if she decides to try something else. It's a comfortable choice but it makes us miss out on a lot of new songs (or dishes) we might enjoy.

This is what my Ph.D. is about: exploring a different way to make music recommendations. My approach is to use information about you as a person and not just as a music listener to understand your musical taste better. Using this kind of information is not new: for example, there are a lot of studies out there that have tried to add information about user personality and managed to improve the recommendations. Personality is a well-known and very popular human factor that represents who people are. But I believe that personal values can be even more appropriate because they represent who people want to be, what is important for them in life on the most abstract level. For example, if they particularly care about the environment, the well-being of their relatives, being respected for their achievements, etc. Marketing research has actually highlighted the important role of our values in our consumption choices quite a long time ago and there is no reason to believe that it shouldn't impact our music preferences as well.

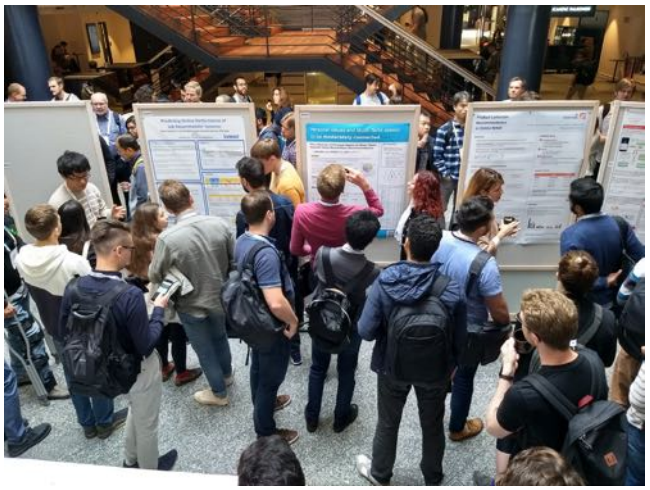
Unfortunately, while many works in the psychology of music studied the connection between personality and music preferences, values have been widely understudied in this context. I conducted my first experiment to start filling this gap [4]. It was a marketing/psychology experiment. I used a marketing interview technique called the "laddering technique" in which the interviewer helps the interviewee uncover the most abstract reasons behind their preference for specific product attributes. More concretely, I asked the participants to give me the five things they particularly like about music (and the one they particularly dislike). For each of those music attributes, I asked "what makes it important to you ?" questions until the participants couldn't answer, meaning that we reached the highest abstraction level (or value).

The results of this experiment suggest that indeed personal values have a medium connection with music preferences. I also got a lot of interesting results that might turn into future research questions, like the fact that not all values were equally represented or that nearly all of the participants mentioned that they like to use music to feel certain emotions. This will have to wait a bit though because now I am working on how to extract personal values about music from text by comparing different techniques. It's an interesting question for my research because with psychological variables it's complicated to know if you really measure exactly what you want to measure. Natural Language Processing techniques seem quite promising, maybe more than questionnaires. Some works argue that how we talk and write can tell more about us than a questionnaire can measure [2]. Plus, questionnaires can be quite tedious to fill for users and building those questionnaires is delicate because the wording of a question can influence the answers. The scalability and the validity of those questionnaires can then be a bit problematic and I hope language-based techniques are more reliable!

Indeed, reliability and validity are core components of good science. As a researcher, I care a lot about it because my main goal is to make relevant contributions to science. Therefore I try to pay a lot of attention to make my work as open and transparent as possible. It means that I try to make freely and widely available as much information as I can about my experiments such as code, datasets, etc. and of course the paper itself, as well as reporting honestly the potential limitations of my work. I believe it is very important to reflect on those topics and I am happy that there are a lot of discussions about how we can do science better in my lab. We pay a lot of attention to our experimental design and question every step, like what kind of data pre-processing to use and why or which dataset. It led to a paper in which we highlighted that those kinds of decisions (also called degrees of freedom) that may sound trivial can actually completely change the results of an experiment [3].

It can be a lot of work but it's worth it. When your experimental design is sound and well-defended, any result you will obtain will be an interesting contribution. Knowing what doesn't work is as important as knowing what works and negative results can raise interesting questions that may lead to unexpected discoveries. Studies that try to reproduce or replicate the results of a previous study are equally necessary: each study is conducted on a sample of the population (datasets are samples too) and give the mean of the sample but we need more than one sample mean to get a sense of what the real population mean actually is.

As a consequence, for me a scientist is not necessarily someone brilliant but before all someone who is both curious enough to be passionate about science and who is responsible enough to be driven to do it in the best way possible. If you are curious about the world and like learning new things, you might thrive in research. Personally, I really enjoy being a Ph.D. student. My favorite aspect of it is that I get to do many different things, not only research (even though it's a great part of the job). Sharing your research and teaching are also very interesting aspects of a Ph.D.



Sharing your research involves going to conferences or other scientific events to present your work either as a poster or a presentation. I find the presentation part the most challenging but it makes it particularly rewarding. I tend to be quite shy and honestly my own self-confidence is not great so the idea of talking about my work in front of many people makes me very nervous. I am always worried that I will say something dumb or fail to present things clearly.

When I am writing those lines, I actually just gave my very first talk a couple of days ago. I have been invited to present the work I described here at the 15th RecSysNL meet-up (RecSys stand for Recommender Systems) at Bol.com. The event was sold-out and I was a bit intimidated but it all went very well. People were interested in my topic and asked many interesting questions. Now I can't wait to have new results to present!

As a Ph.D. I also do some teaching, I am currently supervising a group for the bachelor seminar about literature reviews. I also did it last year as well as the context project. This is a great and rewarding experience because I love to share my knowledge and passion for science. In general, students are quite enthusiastic about the topics and one of the context projects even became a demo at a conference! The name of the project was Spotivibes [1], a tool allowing to tag songs with abstract colors that can represent anything the user wants or feels. Spotivibes can then make playlists based on those colors. This was a great project and I am looking forward to supervising new exciting student projects. So if you have an idea you would like to pursue, don't hesitate to contact me at S.Manolios@tudelft.nl!

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A mobile game that creates productivity habits for students

Tim Wissel, SeaAhead Studios

In the Msc CS course Building Serious Games, students are challenged to build and test a game that has a primary purpose other than just entertainment. We are a group of five students (called SeaAhead Studios) and we built a game for MeerEffect (http://meereffect.nl/). That is a company that teaches knowledge workers how to increase focus and decrease stress, by applying the Getting Things Done® methodology by David Allen (https://gettingthingsdone.com/).

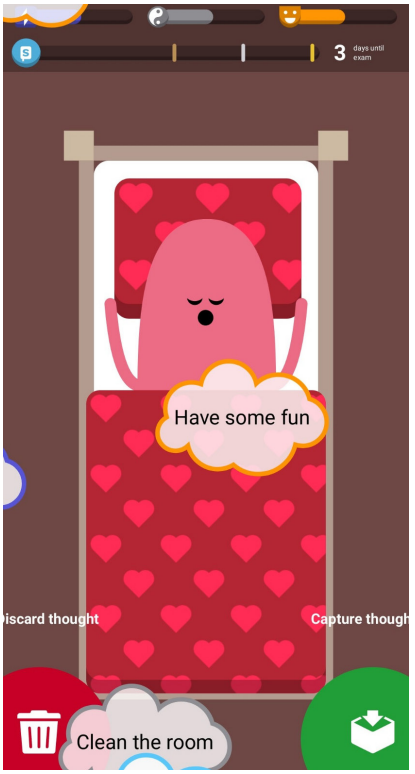
Students struggle with time and energy management, and usually struggle with keeping their mind clear with all the tasks and activities happening in their life. We built a game that reduces stress for students.

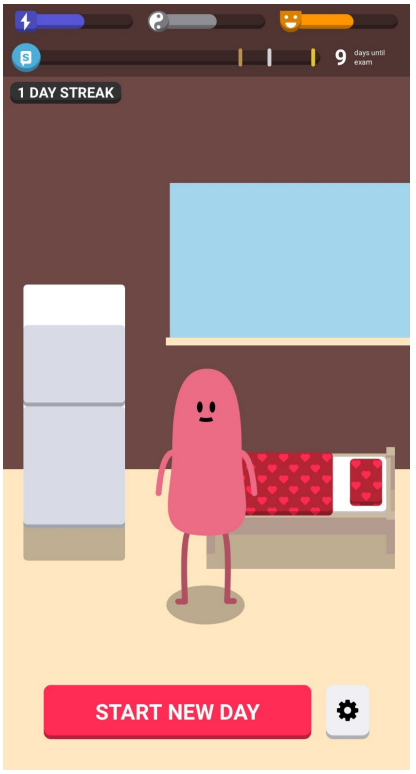
The game, called BusyBusy, applies constructivist learning theory, meaning that students gain habits from experiencing the consequences of their actions in the game, and use these experiences in real life. The goal of the game is to acquaint the player with the capturing habit as described in GTD. This capturing habit means writing thoughts in external places such as a to-do list or a calendar, instead of keeping them in your head. Thoughts can be anything from "I still have to buy milk" to "How is my friend doing? Should I call her?".

The game is inspired by the fast-paced game Dumb Ways to Die (http://www.dumbwaystodie.com/). The player goes through a collection of mini-games in which roughly each aspect of a students' life is resembled. At the same time, thought bubbles float around the screen which challenge and distract the player from those mini-games. The thought bubbles resemble the uncaptured thoughts of a student; thoughts that are in the head of the student, but are not yet captured externally. By playing these minigames, the player experiences the direct consequence of trashing or capturing the thought bubbles on the screen, as the mini-games are easier to play when there are less thought bubbles. Moreover, capturing more thoughts will allow the player to play more mini-games in a short time and progress faster.

Building Serious Games is an intensive course with quick iterations. In 10 weeks, you design and build a fully working game and test it with a large group of people. This is a challenge, but at the same time it is very rewarding to see a game idea come alive in a mobile game in a short time.

Tim Wissel
SeaAhead Studios (Together with Wouter Raateland, Konstantinos Chronas, Tim Bruyn and Bertan Konuralp)





Computer Science

Breeze

Thomas Oomens, CTO of Breeze.Social

Hi, I am Thomas, an old board member of CH during Board 60 ('Vo) and nowadays one of the Co-Founders of Breeze. A lot of you probably heard of some friend who used our service or maybe uses Breeze themselves, but just to be sure, let's start with a short explanation of what we do. Breeze is creating a dating app that arranges a fun date with someone you are attracted to whenever you feel like dating without the hassle of online chatting.

Our algorithm suggests two high match potential profiles each day at 19:00. These profiles are largely based on your past profile preferences, but also the personal information you provided. You cannot swipe but you select either "I'll go for a drink" or "not for me". When you both respond with "I'll go for a drink", you cannot chat but you fill in a date picker. The date is also organized for you at one of our partnered locations. They make sure you are welcomed, do not have to search for each other and have a fun evening.

Breeze started with the belief that the current dating apps were not working as well and no one likes chatting online. The concept seemed to work and by using a big excel file and some gut feeling we started matching people. The PDF profiles were then sent over WhatsApp asking for a yes or no as a reply. As more dates started to take place, things were automated and a website was built, which was replaced by an app in September. At this time we had about 450 registered users, which doubled in just a few weeks.

This was the moment that I joined, Breeze was growing fast and they needed someone to help them grow on the level of IT. I had finished my Bachelor in Computer Science the year before and had my own development company for about 9 years.

The app was live, the amount of users was growing, but there were only two programmers that learned programming just for Breeze. It was time for the next level. At that time the backend was built with NodeJS and the app itself was built with Flutter. While the app was already able to automatically show 2 profiles on the matchdays and let the users pick a date in the app itself, most other tasks went by hand. "You have a date on the 22nd of November, you can pick between 3 date locations, please give your preference", one of the many WhatsApp messages that were sent by hand, together with checking the preference, picking a location, informing, sending a tikkie, reserving, reminding, etc.

This was fine with a few matches each week, but the idea was to grow, time for something new. We started working on a new backend based on Golang and a PostgreSQL database. Furthermore a new design was made for the app, and all manual methods were implemented in this design. The initial idea was to create this in a short time and build further upon this. Here we made the error however on making it perfect, resulting in a development time of about 3 months instead of 1... we learned. During the last two weeks of the development of this new app, we decided to see what would happen if we would send out a press release. RTLNieuws happened, they created an article the next day that was picked up by numerous radio stations in the Netherlands, AD.nl came with a camera crew to make an item, EditieNL came by to make a video for live tv. In a week we saw a rise of users of 200% all using the old app, it would have been nice if the new app had been live. Shortly after that the new app launched, offering daily matchrounds, automatic pickers, cancellations, replans, etc. Due to a new matching algorithm created by the other Thomas (Also CH 'Vo), the media attention, the daily matchrounds and the amount of dates grew tremendously, giving us the confirmation that we had a serious idea here.

The next week came the decision, let's stop studying and all go full-time on Breeze. A lot more happened. While we are constantly working on new app releases, we have been accepted to Yes Delft, started looking for an investment and have over 8000 users and planned more than 550 dates.

Looking back on my life there are few very happy decisions, starting my own company, saying yes to doing a board at CH and especially saying yes to join this company. I am now doing my dream job at a company with a lot of potential and fantastic colleagues.

If you are into entrepreneurship or organizing things, then follow this feeling, do some committees at CH and try working on those ideas you think of, you're a programmer, you can build anything. Things will go wrong, bad decisions will be made, but you'll learn from them and end up stronger and with more knowledge.

Thomas Oomens, CTO of Breeze.Social & COI of Board 60 of the magnificent CH.

~Breeze

DSW
ictbijdsw.nl

Document Intelligence: Automated Interpretation of Photographed Invoices.

Bram Renting is a Data scientist at DSW and an Alumnus of Computer Science at TU Delft

DSW

What does DSW health insurance have to do with Computer Science or Mathematics? It is not really the first company that pops up when EEMCS students think about a company to work for. However, about 200 out of 650 employees at DSW work in IT/Data Engineering/Data Science. Why? Because we believe that digitalisation and AI (obligatory buzzword) is very effective in reducing costs in the health insurance sector, saving money for actual health care.

At the data science team, we touch many topics in ML, NLP, CV, Probability & Statistics, Graph theory, Optimization. A few examples of our projects:

- Bipartite graph modelling to detect networks of fraudulent healthcare providers or to optimise company processes.
- Predicting the topic of incoming phone calls based on a sequence of touch points in the past.
- Automatically redirecting emails to the correct address based on the content.
- Automated interpretation of phone conversations with customers to analyse both frequent topics and customer sentiment.

But let us tell you a little bit more about one of our current projects: invoices processing using AI.

Invoice processing

At DSW, we receive many (~1.300.000) invoices per year from customers that want to declare health care costs. Customers can take a picture of their invoice via the DSW app and DSW aims to reimburse customers as soon as possible. However, the manual transformation of a picture to usable data is a tedious job and, in such quantities, an expensive one as well in terms of labor. There is much information to be extracted before DSW can reimburse a customer: Who is the patient?, Who is the healthcare provider?, What healthcare is provided?, What is the cost?, What is the date of treatment?, etcetera.

About 15 years ago DSW started implementing a system to automate this job, combining OCR with good old fashion rule-based AI to automatically extract data from the invoices. This system has been manually tuned over the past years to optimize its performance, but has now hit the ceiling that we often observe in rule-based AI. Combined with the current rapid advances in ML, NLP and CV, this fact led to the decision to redesign our invoice processing pipeline.

Document understanding

So, document understanding through AI. Can't be that hard, right? Wrong...

This is a very difficult challenge that caught the attention of and is discussed during the highly popular Neural Information Processing Systems (NeurIPS) conference (should you be interested, google "Document intelligence NeurIPS 2019").

The goal is to recognize and classify named entities (e.g. total amount, street) on the invoices. This is difficult for multiple reasons:

- Every document is structured differently as every healthcare provider uses its own format.
- Many different formats exist to indicate an amount, date, phone number, and many more (see Table 1).
- There is noise induced by mistakes in optical character recognition (OCR).
- We must cope with bad quality images made by our customers phone camera.
- The amount of entities to classify differ per invoice as not all data is always present and an invoice can contain multiple treatments (sometimes across pages).

Amount	Date	Telephone number
63,00	02-03-2020	0612345678
63.00	02/03/2020	06 12 34 56 78
63.-	02-03-'20	+31 (0)6 12345678
€63,00	2-3-2020	06-12345678
63€	2 Maart 2020	+31612345678

Table 1: Example variations in entities

Approach

Using CV techniques on the raw pictures of the invoices, like convolutional neural networks (CNN), is usually one of the first things that comes to mind. CNNs are not designed to grasp the semantic and context that is present within text and is, therefore, not a decent solution. Another issue is the large amount of whitespace on invoices that needlessly complicate the model without providing informational value. However, there is visual and structural information in invoices like table lines and relative positions, so some form of CV could be useful.

A recently published approach (BERTgird) by Denk et al. combines NLP with CNNs in an attempt to overcome the shortcomings of both components. They first use OCR to extract the text from the document and then encode the words to context aware semantic embeddings (vectors that represent the meaning of words). They then rebuild a 2D grid that represents the original invoice, but replace the RGB values on the grid with the word embeddings (see the paper for further details). This grid is often smaller than the original pixel dimension of the image. This newly created representation that contains structure, context, and semantics is then used as if it is a normal image.

At DSW we went a step further by omitting the required grid-like structure as used in CNNs. Instead, we move towards a graph-like structure and replace the CNNs with Graph Attention Networks (GATs). The benefit of this approach is the absence of input values with zero informational value (the whitespace on the invoices).

Graph representation

We describe the creation of the graph representations in a few steps using a fake invoice (see images):

1. We start with the original picture of the invoice (Figure 1).
2. We let Google do our OCR step, as we will never be able to beat their accuracy (Figure 2).

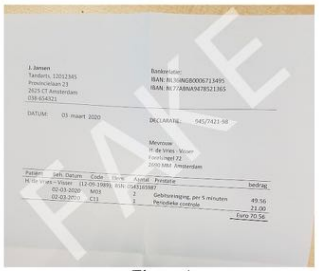


Figure 1

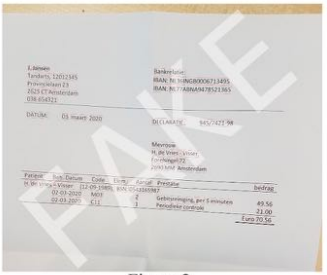
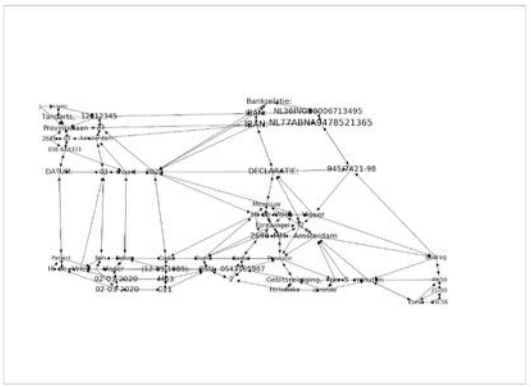


Figure 2

3. We construct a graph in which every vertex represents a word and every edge represents a directed connection to the neighbouring word (in 4 directions).



4. We create a feature set per vertex consisting of:
   a. A word embedding using NLP (for now we use the Universal Sentence Encoder).
   b. Word details (character count, frequency in Dutch, starting with capital, etc.).
   c. Size of word box.
   d. Position in normalized coordinates.
   e. (future) Include some pixels features.

5. We add labels to the graph using output of our currently used system.

Network

We are currently in the process of building the network and for now we are following the architecture of the inductive learning task of the paper on Graph Attention Networks. The input forms a list of features per vertex and an adjacency matrix that define the edges.

The idea is that vertex features are aggregated over the graph in the direction of the edges passing one edge per layer of GAT. This allows neighbouring vertices to influence the features of a vertex, which sounds intuitively right since neighbouring words can be a major indication for the potential label of a vertex (see “Datum” in front of “03 maart 2020” and “Euro” in front of an amount).

There is still much work to be done, but we expect to see our first results in the coming month. After that, we will start fine-tuning our network and input representation. Should you be interested in reading more about the techniques we use, please find a list of recommended papers below this article.

Work at DSW

The work environment at DSW is casual and non-hierarchical. DSW attempts to stay close to the frontier of innovation by exploring new techniques, actively motivating you to keep learning. There is also a brand new employee gym to get fit and a bar in the basement (to get unfit). We are located in Schiedam, near the station. It’s only 15 minutes from Delft to desk!

What we work with mainly:

- Debian Buster
- Python 3
- Git
- Visual Studio Code & Jupyter Hub

Should you be interested in working for the data science team at DSW in the form of a student job or master thesis (or of course a fulltime job)? Contact Joël Koppe, Team lead Data & Analytics at jkoppe@dsw.nl or take a look at ictbijDSW.nl

Reading list

Attention Is All You Need - Vaswani et al.
BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding - Devlin et al.
Multilingual Universal Sentence Encoder for Semantic Retrieval - Yang et al.
Semi-Supervised Classification with Graph Convolutional Networks - Kipf et al.
Graph Attention Networks - Velickovic et al.

Minor Robotics

Julian van Dijk, Student Computer Science

I have had the opportunity to join the minor robotics of 3me for my minor during the first half of the academic year. During this minor you build a robot with a multidisciplinary team of students from different bachelors.

During the first week of the minor we started off with an introduction on how the first quarter of the minor would look: A kick off with your team, meeting with your clients and some selected courses based on the bachelor you are doing. Let's start off with the team. All teams have a composition of 4 different bachelors with 6 students per team in total. Every team had 2 Computer Science and Engineering students, 2 Mechanical Engineering students, 1 Electrical Engineering student and 1 Industrial Design and Engineering student. Together we had all the knowledge necessary to build a working robot.

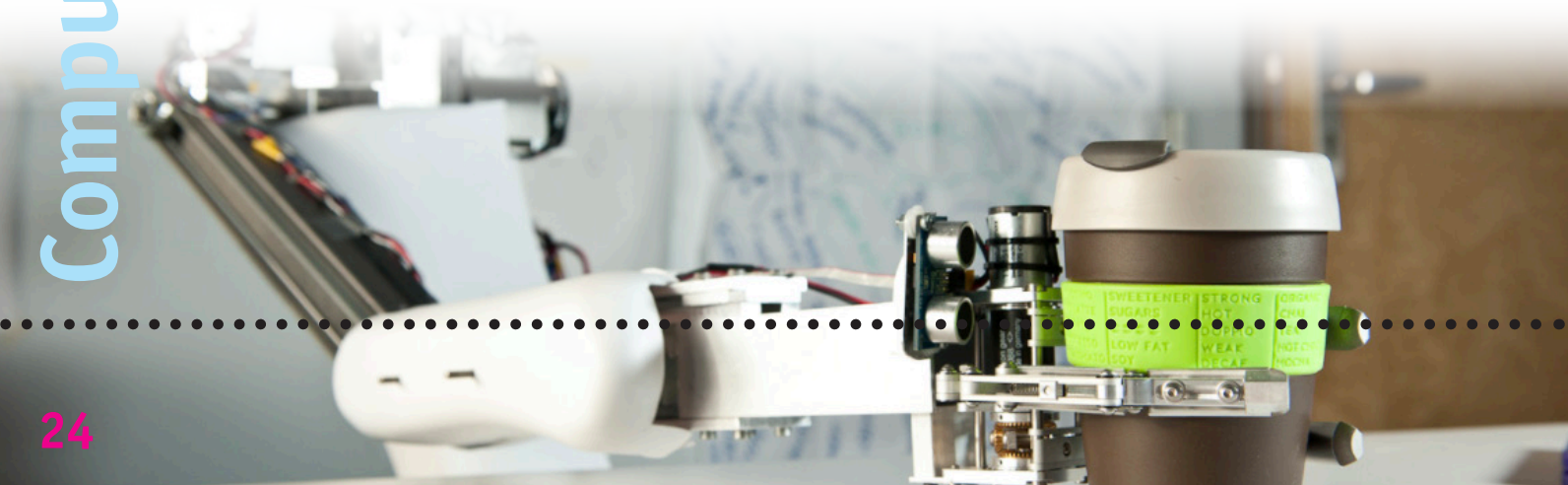
Or so we thought, because before we started with building the robot we had some courses to attend. We all had courses from the other disciplinaries. For me this meant: Circuit Analysis(EE), Statics(ME) and Introduction to ROS and Design in Robotics(IDE). The others had their disciplinary course switched to Software Engineering methods(CSE). The courses were doable, although Design in Robotics is time consuming. It was scheduled for one and a half days per week, which alternated a bit between weeks. During these courses we already started meeting with our client. They clarified what they wanted the robot to do and what the absolute no-go's were. Our task was to build a cheap and small robot bottling machine. The initial idea was to receive a pallet of boxes with empty bottles, process them and return a pallet of boxes where all the bottles were filled, capped and labelled. However one of the no-go's we received was: "You are not allowed to use conveyor belts". This meant we had to be more creative within the assigned budget. Which ended up in us deciding to tackle the single box problem first.

After deciding upon the specifics of the problem it was time to come up with a solution. Doing this is easier said than done. We had a deadline at the end of the quarter in which we had to hand in our design report. This report had to be less than 100 pages, which proved to be a challenge. We had to include our three possible designs and which design we eventually chose and why. Furthermore it had to include the entire software design, electrical design and human interaction design.

With all our time spent on brainstorming for design, creating them and actually following our courses, we were finally able to start on the report two weeks in advance. After some stress, late nights and some more stress we managed to hand-in the report 3 minutes before twelve, which meant it was time for celebration, because the time of documenting and courses was over. It was time to start on the robot! Our eventual solution was a robot arm with a smart gripper capable of grabbing bottles with computer vision and passing them through stations that would do the filling, capping and labelling.

It felt great knowing that we now had the time to start working on the robot. Parts were being ordered and the git repository was being filled with issues. We started working on getting our simulation up and running with ROS and gazebo. ROS stands for Robot Operation System and gazebo is a simulation tool that can be used with ROS. We had to build a simulation, because the physical robot would be finished around week 8. Turns out shipping parts and making sure everything works takes a long time. Eventually we got a working robot 6 days before the demo day. We needed a new robot arm that was compatible with ROS, since the one given to us was not. This meant a lot of stress for everyone since our entire system was designed for another arm, but our Electrical Engineer and Mechanical Engineers came through and modified the entire gripper to fit and work on the new arm. Now it was time for the software to work. This took some sleepless nights as well, because of the computer vision not working well with light changes. This was fixed eventually and thus we were ready for the demo day.

On the demo day itself we displayed our robot together with the others. Parents and companies came to see them and asked about functions and such. It was a great day which came with a great sense of accomplishment after seeing all the work you put in the project come to fruition. It takes a lot of time to do this minor and almost anything you do will not go as planned, but I gained a lot of experience from it. Not only from the project, but also from my team. It was great to work together with different kinds of disciplinaries and learn from their views on a problem. I would recommend this minor to anyone who wants to see further than their own profession.



Mathematics

Volume 24 • Issue 3 • May 2020

MRI for Uganda

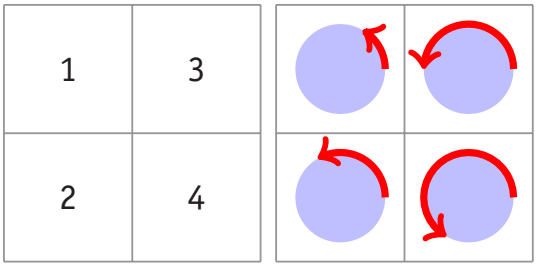
Merel de Leeuw den Bouter, PhD candidate Numerical Analysis

We are developing an inexpensive MRI scanner for Uganda, together with the Leiden University Medical Center, Pennsylvania State University and Mbarara University of Science and Technology. Our first target is to be able to aid in the diagnosis of hydrocephalus ("water on the brain") of infants.

Magnetic resonance imaging (MRI) is an imaging technique that can be used to visualize the inside of the human body. MRI scanners use superconducting magnets to generate magnetic field strengths in the order of several teslas. Such strong magnetic fields lead to images of excellent quality. However, these magnets make this technology extremely expensive. Also, they require a lot of energy. For these reasons, people in sub-Saharan Africa have very limited access to MRI technology, or no access at all. Our MRI scanners are built using permanent magnets, instead of the superconducting magnets used in conventional MRI. This makes them considerably cheaper and more lightweight. However, the downside is that the magnetic field generated inside the scanners is considerably weaker, which comes with interesting new challenges.

How does MRI work?

The majority of the atoms in the human body are hydrogen atoms. Hydrogen atoms have an intrinsic magnetic property which makes them act like very small magnets. This is exploited in MRI. By applying a strong magnetic field, all hydrogen atoms are forced to align themselves in the same direction, parallel to the magnetic field. Then, radiofrequency pulses are applied to manipulate the "magnets", such that they start spinning (also called precessing). The frequency at which they spin is determined by the strength of the magnetic field B_0: the stronger the field, the faster they spin. This is illustrated in Figure 1.



(a) Magnetic field strength (b) Hydrogen atoms and their spinning frequencies

Figure 1: The strength of the magnetic field determines the frequency at which the hydrogen atoms spin.

The spinning of the hydrogen atoms induces an electric signal in the receiver coil of the MRI scanner. The frequencies of the hydrogen atoms' spinning are equal to the frequencies that are present in the signal that is measured in the coil. By evaluating which frequencies are present in the signal and how strong each frequency component is, we can reconstruct an image. To illustrate this, we will use a very simple example. Suppose we are considering the grid of 2x2 pixels in Figure 1a, with frequencies 1, 2, 3 and 4. We measure the signal in Figure 2, which we can decompose into two signals of frequency 1 and 3.

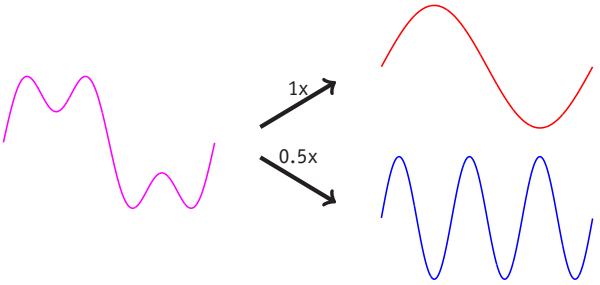


Figure 2: Decomposition of measured signal into two components.

If we compare this to the frequencies in Figure 1a, we see that this corresponds to the following very simple "image":

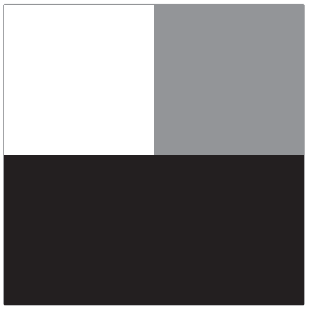
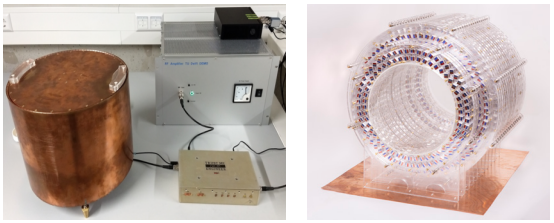


Figure 3: Resulting "image", white corresponds to an intensity of 1, grey to 0.5 and black to 0.

Obviously, this is not a realistic example because we are dealing with only 4 pixels, but this is the idea behind MRI image reconstruction.

Two prototypes

The previous example showed that it is important to have different frequencies, because these allow us to distinguish between different locations in the image. If two pixels correspond to the same frequency, it is impossible to tell their contributions apart. However, it is very difficult to generate a magnetic field which has a unique frequency in each pixel. If you apply a linearly increasing field in the x-direction of the scanner for example, it is only possible to distinguish between different locations in the x-direction, not in the y-direction. Something has to be done to overcome this challenge. We consider two approaches. The first one is to rotate either the scanner or the object inside the scanner after each measurement, repeat this a number of times, and combine the information in all measured signals.



(a) First design (b) Second design

Figure 4: Two prototypes

Our first prototype, which is shown in Figure 4a, uses this strategy. The second prototype (see Figure 4b) uses a different approach: by applying a linear gradient in the y-direction before the measurement takes place, the hydrogen atoms start spinning before the measurement begins. This means that at the beginning of the measurement, the phase (or orientation) of the hydrogen atoms depends on their y-position. During the measurement, a linear gradient is applied in the x-direction, so their frequency depends only on their x-location. This gives each pixel in the image a unique frequency-phase combination, which we can then use to determine which part of the signal originates from which pixel. We will focus on this second approach. The signal s, in discretized form, can be described as

$$s(t_j) = \sum_{p \in \text{pixels}} x_p e^{-i(t_j \omega_p + \phi_p)}. \tag{1}$$

Here, t_j is the j^{th} time sample, i is the imaginary unit, x_p is the pixel intensity (which is determined by the number of hydrogen atoms in the pixel) and ϕ_p is the phase acquired by the hydrogen atoms in pixel p before the experiment. The symbol ω_x is the spinning frequency during the experiment. Both ω_p and ϕ_p are determined by the strength of the magnetic field generated by the linear gradients. The only unknowns in Equation (1) are the x_p, the pixel intensities, because we know the magnetic field strengths and we measure the signal. Since we are dealing with a linear system of equations, we write Equation (1) in matrix-vector form:

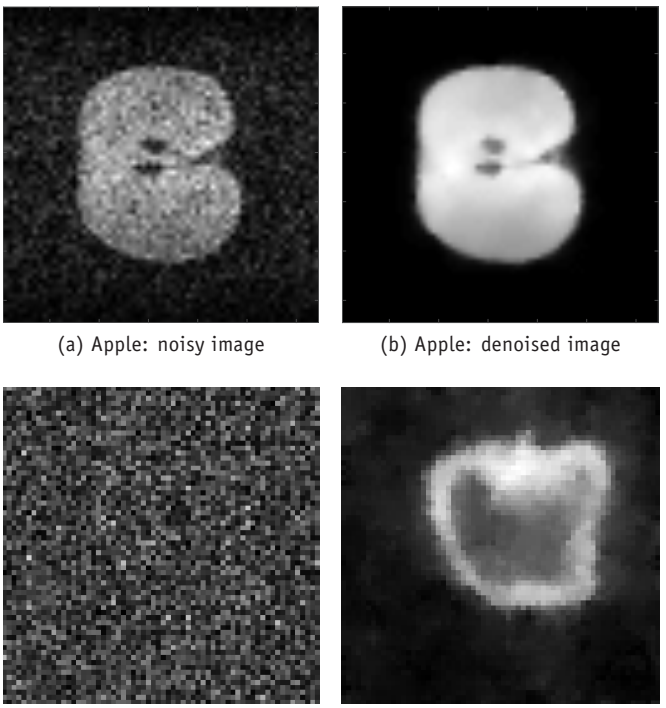
$$\mathbf{s} = \mathbf{A}\mathbf{x}. \tag{2}$$

Noise issues

As mentioned before, the magnetic field inside our scanners is relatively weak. This means that noise, which is inevitably present in any kind of measured signal, has a much stronger influence on the measured signal, and hence on the reconstructed image. We recently performed imaging experiments on different objects, including an apple and a bell pepper. If we do not use any kind of signal or image processing, and simply solve Equation (2), the images come out looking as in Figures 5a and 5c, which are very noisy, especially the bell pepper result. Instead of solving Equation (2), we can solve

$$\arg\min_{x} \|\mathbf{s} - \mathbf{A}\mathbf{x}\|_2^2 + \lambda L(\mathbf{x}). \tag{3}$$

Note that the first term is simply the least-squares form of Equation (2), which makes sure that our solution $\mathbf{x}$ corresponds to the measured data as well as possible. The term $L(\mathbf{x})$ is a penalty term. It allows us to incorporate information that we have about the solution into the reconstruction process. Often, in MRI and in imaging in general, we choose L to be an operator that calculates the size of jumps between neighboring pixels. This way, we can force the jumps to be small in general, which helps suppress the noise. This choice is motivated by the fact that neighboring pixels often represent the same body tissue, so we expect them to have the same intensity. We should be very careful with this because we do not want the image to become too smooth or blurry. That is why there is a parameter λ in Equation (3). This λ is there to ensure that the two terms are nicely balanced. We usually solve Equation (2) using an iterative procedure. The results are shown in Figures 5b and 5d. For the apple, we see now that its shape and seeds are clearly visible, and the noise has been eliminated. For the bell pepper, the result is even more impressive: where first we only saw noise, now we can see the shape of the object.



(a) Apple: noisy image (b) Apple: denoised image

(c) Bell pepper: noisy image (d) Bell pepper: denoised image

Figure 5: Results of two different experiments

Many other aspects

This is only a small part of the project. It comes with challenges with many opportunities for mathematical solutions. We are working on deep learning, machine learning and correction of the model, among other things. Another aspect which makes this project special is the multitude of both national and international partners we are working with. It is very important to maintain a strong partnership with our partners, especially those in Uganda. They will be the people who are going to use our MRI scanner. Therefore, students and team members from Delft regularly visit Mbarara University of Science and Technology, and vice versa. We are embarking on the next stage of the project, as the scanner shown in Figure 4b will be shipped to Uganda soon, for local testing and eventually clinical trials.

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Volume 24 • Issue 3 • May 2020

Are we experiencing warmer winters than a few decades ago?

David Sarkisian, Student Applied Mathematics

At the end of my third year I wrote my bachelor thesis, like everyone else at the end of their bachelors. In the last quarter of the year I analysed whether winters in The Netherlands have become significantly warmer over the past few decades.

In February we had to choose thesis topics that sounded interesting and make a top-3. The research topic that ended on my number one was also the topic I was assigned to, *"Are winters in The Netherlands becoming warmer?"*. Since climate change is a current topic this seemed like a fun project to work on. Moreover, climate change is frequently on the news and global warming seems like a logical fact. However, I have never really seen any research myself. Therefore, this seemed like the perfect opportunity to look at the facts and figures with the mathematical skills I've acquired over the past few years.

The first two or three weeks didn't go at full steam, though. As I was new on the subject of meteorology and climatology, it was hard to decide how I wanted to research climate change in The Netherlands. After all, there is a plethora of data and parameters that one can examine. So it seemed a logical thing to take a look at what data the KNMI has and how other researchers carry out their research. As I delved into the data and examined what kind of mathematical techniques are being used, my own thesis became clearer and clearer.

Eventually, I chose for the somewhat easier meteorological parameters of temperature (maximum, minimum, average) per year and the so-called Hellmann number. In addition, I also looked at the North Atlantic Oscillation index, which is some measure of the air pressure between Iceland and the Azores. This is especially interesting, because higher values tend to be correlated with warmer winters. In the end these parameters give a clear view on the results and are more directly linked with climate change. Most of the data, however, was not immediately ready to be analysed. As you can imagine the KNMI has loads of detailed data, i.e. daily (and sometimes hourly) data of temperatures, precipitation, wind speeds, etc. So, in the first weeks I was mainly trying to filter out everything that I don't need and convert data into a suitable format in Python.

The following weeks I was particularly trying to analyse the data in R. As I said earlier, I looked at different parameters like temperature and other indices. However, in this article I will focus on the *Hellmann number* in particular. The Hellmann number is a measure that takes the number of days below 0°C into account by adding up the absolute value of all subzero temperatures in a winter. So if we let n be the number of days in a period and let $\bar{T}_1, ..., \bar{T}_n$ be the average daily temperatures in Centigrade in that period, then the Hellmann number (H) of a winter is defined as

$$H = \sum_{i=1}^{n} \min(0, \bar{T}_i). \tag{1}$$

with $n = 90$ or $n = 91$ (from December 1st till March 1st) depending on whether it's a leap year. The KNMI uses the Hellmann number as a measure to classify winters on their severity. In The Netherlands we call a winter with, for instance, a Hellmann number between 40 and 100 normal. Below you can see all the classifications.

Hellmann number H	Classification
$H > 300$	Severe
$160 < H \leq 300$	Very cold
$100 < H \leq 160$	Cold
$40 < H \leq 100$	Normal
$20 < H \leq 40$	Mild
$10 < H \leq 20$	Very mild
$0 < H \leq 10$	Unusually mild

In my thesis I have analysed the winters from 1901 until 2018, which you can see in figure 1. You can see the moving average (the average of the 30 years before some given year) of the Hellmann number in red and the actual values. Analysing such graphs gives a better idea of what is happening and can strengthen the motivation of a hypothesis.

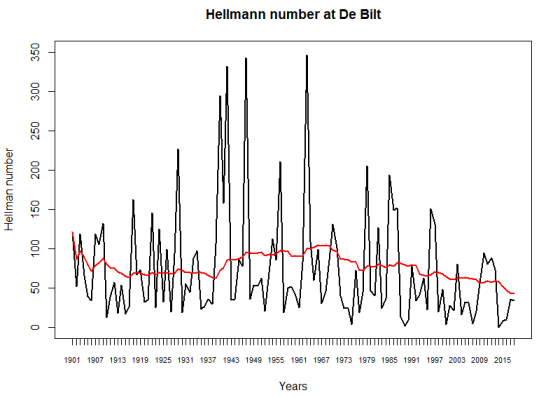

Figure 1: The rolling average of the Hellmann number over the past century

In figure 1 and 2 we can quite clearly see that winters of the last two decades tend to have lower Hellmann numbers and also tend to have less extreme values. This gave me a good starting point and stronger motivation to dig deeper and find out whether winters have become warmer. However, histograms and other figures don't prove anything, they only help you grasp the situation better. In order to say anything about a possible *trend* we have to apply statistical theory.

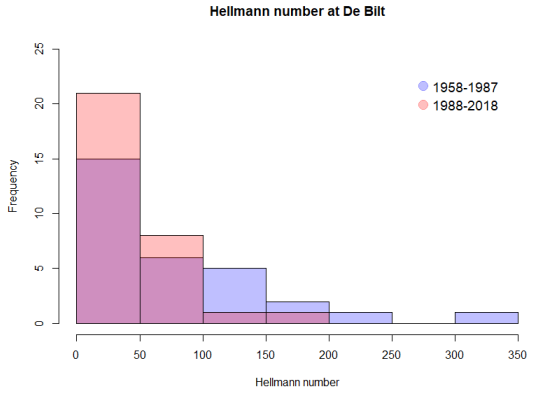

Figure 2: Histogram comparing two consecutive periods of 30 years

There are different ways to determine whether data follows a trend, i.e. increases or decreases significantly. One way to find a trend when analysing climate change, which is the technique that a lot of the researchers I have examined use, is by using the Mann-Kendall test. The basic idea of this test is to rank observations of two data sets and look at how much the ranks pairwisely tend to go up or down. In order to understand this, it is good to see an example. Say we have some fictional data that would give us, for instance, the following ranking.

Year	2011	2012	2013	2014
Rank r	4	3	2	1
Hellmann number	81	88	73	0
Rank s	2	1	3	4

To see whether there is a trend we first have to assign a $+1$ or a -1, called a *pairwise score*, to every pair of the Hellmann number ranks. After calculating the pairwise scores we can add those scores for every pair such that we get a final score which tells us something about the degree in which the Hellmann number ranking deviates from the year ranking. So for pair $(2011, 2012)$ we see that the ranking pair is $(4, 3)$ w.r.t. "Year" and $(2, 1)$ w.r.t. "Hellmann number". Since both ranks are descending, this pair gets a $+1$. If we do this for each unique pair, this would give the following pairwise scores.

Pair	Score $S_{i,j}$
$2011, 2012$	1
$2011, 2013$	-1
$2011, 2014$	-1
$2012, 2013$	-1
$2012, 2014$	-1
$2013, 2014$	-1

The score of these rankings would therefore be the sum of the pairwise scores: -4. Such a score indicates that as we continue in time, the Hellmann numbers tend to decrease. In a more formal way, this score is defined as:

Let $x_1, ..., x_n$ and $y_1, ..., y_n$ be two sets of observations. Let $r_1, ..., r_n$ and $s_1, ..., s_n$ be the rankings of some qualities A and B respectively, where we order the A-ranking like $r_1 < ... < r_n$. For each pair (y_i, y_j) define the pairwise score

$$S_{i,j} = \begin{cases} 1 & if\, s_i < s_j \\ -1 & if\, s_i > s_j \end{cases} . \tag{2}$$

The score of the rankings of A and B is then defined by

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} S_{i,j} \tag{3}$$

As you can imagine, it is a very tedious task to calculate this manually so I have calculated the scores for different parameters in R. However, knowing the score only tells us how much a ranking deviates from the other one. To say something about a *significant* deviation, a trend, we use the fact that all the possible scores have some kind of distribution $\mathcal{F}(S)$ that converges to the normal distribution. This way, the deviation of a particular score of a ranking can be compared to what we should expect (the normal distribution). However, since the distribution of the score is discrete (a sum of 1's and -1's) and the normal distribution is continuous, a slightly adjusted version of the score S is used. This correction is as follows.

$$Z = \begin{cases} \frac{S-1}{\sqrt{S}} & if S > 0 \\ 0 & if S = 0 \\ \frac{S+1}{\sqrt{S}} & if S < 0 \end{cases} , \tag{4}$$

where $S = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{j=1}^{T} t_j(t_j-1)(2t_j+5)\right]$.

In order to spot a trend, the measure Z is compared to the value of the inverse CDF of the normal distribution, depending on a significance level α, which we can denote as $\Phi^{-1}(\alpha)$. Applying these principles to the data led to the conclusion that the Hellmann numbers have indeed become significantly lower. This logically implies that winters have become less severe over the past century.

As you can probably see, I did not go into the research part right ahead. By analysing and filtering data and trying to find literature of other researchers, I slowly found some structure and was able to dig a little deeper and deeper into the theory. Of course, my supervisor Fred Vermolen also helped me a lot as we discussed my work and the course of the research almost weekly. This way, I knew what to do even if my thesis got a bit messy at times. Since he also writes articles for the MaCHazine sometimes, I assume he is an avid reader of this magazine, so I also want to take this opportunity to give him a special thanks again!

I hope everyone who is going to start their bachelor thesis this year also finds a topic that really interests them and finds their way into the last part of their bachelor; I wish you all good luck!

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Second and third year electives

Maxime Hoekstra, Lieke van der Linden, Jasper Rou, Eva Slingerland, Students Applied Mathematics

In the third quarter of both the second and third year, Applied Mathematics students follow electives. There are many courses to choose from, so it can be hard to make a decision. Therefore, we have asked 4 students to tell us more about the electives that they have followed.

Advanced Probability - Jasper Rou

In the past third quarter I followed the elective course Advanced Probability as part of my Bachelor. Advanced probability is a course where you combine the concepts of Introduction to Probability from the first year with the concepts of Real Analysis from the second year. On paper the course is a third-year elective, but it is possible to do this course once you have finished real analysis.

The course is known as a difficult one. This is partly true. The course starts with a completely different approach to probability than that you encountered in your first year. This can be very difficult conceptually. Although the word probability is in the name, the first half looks more like real analysis. I would suggest that if you liked real analysis that you consider this elective, because if you like a challenge the course can be really fun.

This year the course is given by Alessandra Cipriani. The way the course is organized is by two lectures a week and two exercise classes. During the lectures the material of the course is explained on the blackboard. During the exercise classes you can work a new exercise sheet every time and ask questions. There is also a book to read the material for yourself, but we do not do exercises from it. Also, there are two homework assignments that count for 40% of the grade. The rest of the grade is by a final written exam.

In the course you learn concepts you are already familiar with from your first year but now on a rigorous real analysis way. Sometimes this contributes to a better understanding of probability theory. Where a concept such as a random variable was quite vaguely formulated in your first year, now it is explained as a measure. Also, expectation, conditional expectation, Chebyshev's inequality and the law of large numbers are again treated but on a different level. In your first year you only did the weak law of large numbers, which implied there was a strong one. And indeed, in this course the latter is treated as well.

In the beginning I thought the course was quite abstract and therefore quite difficult. As the course continued more familiar concepts of probability came forward and I started to understand better. Despite the rough start I enjoy the course and I am glad that I chose it. I can recommend anyone that is up for a fun challenge to choose this course.

Numerical Methods 2 - Eva Slingerland

During the third quarter of last year, I followed the course Numerical Methods 2, which was given by Martin van Gijzen. I really enjoyed the course Numerical Methods 1, which led me to choose this course as an elective. It is necessary to pass the course Numerical Methods 1 in order to follow it, which is why this is a third year elective.

As the name suggests, this course is really a follow up course on Numerical Methods 1. In that course most theories and methods were explained and applied to one-dimensional problems. This course deals with two-dimensional problems. In the first week concepts like the classification of partial differential equations with boundary conditions and initial conditions and the finite difference method were repeated. Next, the finite volume method, which is basically the two-dimensional version of the finite difference method, and its properties and theorems were explained. After that, solutions to nonlinear PDE's and numerical schemes for time-independent PDE's. The course is really useful in its content. For example, it is explained how one should deal with a domain that is not a square or a rectangle.

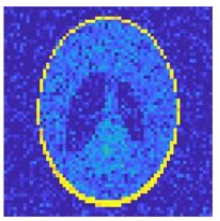

Figure 1: Noisy image of MRI scan.

Every week we had two lectures and two instruction classes. In those instruction classes, we could work on the homework, which luckily was not mandatory, or on the project. The project also really improved the value of this course. We were given a noisy image (see Figure 1 of an alternative kind of MRI scanner. Our job was to reduce the noise, but keep the sharpness of the boundaries using numerical methods. The project really applied the theory that was explained during the lecture, and it was great to see such an application. Below I have included the model image and the picture that we obtained at the end. The course ended with a short exam consisting of homework related exercises and an oral exam where both the report of the project and some theory of the course were discussed.

Figure 2: Model image.

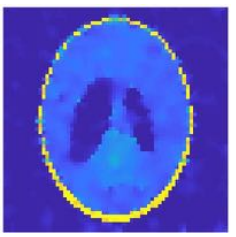

Figure 3: Our filtered image.

Markov Processes - Lieke van der Linden

Last year, I did the course Markov Processes and the MaCHazine asked me, as an experience expert, to write something about my adventure.

I chose this course as my second year's elective course. I did this mostly because it seemed like a nice way to get deep into one of the probability phenomena, and Introduction to Probability was a course I really liked from the first year. Also, this elective course was given by Cor (Kraaikamp) and he is always very enthusiastic during his lectures, so I already had fun in advance.

This course used the same book that was used during Introduction to Probability. In the first few weeks we recapped some material about probability rules. Thereby, we gathered some nice properties of the so called 'random walks' and 'Poisson processes'. These two terms are examples of a Markov Process, we later found out.

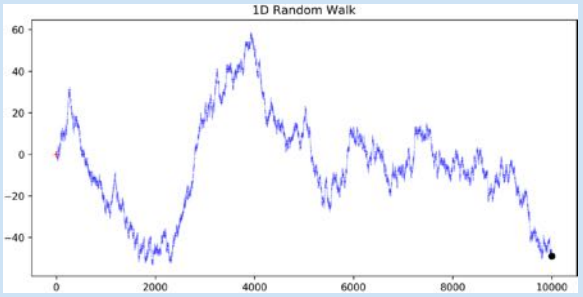

Figure 4: Example of a one-dimensional random walk [1].

A Markov process is a process where the next state something is in, does not depend on the history of states where it has been in, but only on the current state. As an simple example, we could consider a one dimensional random walk with a coin toss: You start on the index zero. If you throw heads, your index will increase with one, and if you throw tails, your index will decrease with one. In this case, you will walk randomly across the one dimensional number line. Also, the probability of getting somewhere on the line next, will only depend on which index you have currently. It does not depend on whether you have walked a hundred times back and forth already.

$$S_{n+1} = \begin{cases} S_n - 1 & \text{with probability 0.5} \\ S_n + 1 & \text{with probability 0.5} \end{cases}$$

With the skills we gained during this course, we eventually proved, for this random walk, that you will always end up in zero after some time.

This also has a nice application in the real life: suppose you are at the casino and you play heads or tails. If you throw heads, the casino gives one euro to you, and if you throw tails, you have to give one euro to the casino. Now assume that you have endless time to play and the casino has endless money (which is true in some way compared to our small amount of student loan). Now the consequence of what we proved is that if you start with finite amount of money, you always end up being bankrupt!

Markov Processes can be used to explain much more phenomena, from biology to economics. And this course was a great way to understand the properties of these kind of processes. Moreover, this course is good for my wallet, because I learned that I should never play heads or tails in the casino!

Systems Theory - Maxime Hoekstra

When I had to search for an elective course in my second year of the bachelor Applied Mathematics, the course Systems Theory sounded like a good choice for me. One reason was because it involves modelling and physics, which are the applications of mathematics that appeal to me. Also, this course involves linear algebra, analysis and differential equations, which were courses that I found interesting during my bachelor.

The course deals with modelling of systems. A system is a part of reality that can be seen as a separated unit within this reality. Everything outside of the system are the surroundings. The system is influenced by input functions and the system itself influences the surroundings by output functions. The goal of systems theory is to study and control this process. An example of a system with input and output can be found in an aeroplane: the position of the control wheel (input) has an influence on the course (output). However, a system can also be more abstract, like in economics.[2]

During the course we worked on a case study, in which we directly applied the material from the lectures to study a physical phenomenon. We had to study the double pendulum, a pendulum with another pendulum attached to its end. The main goal was to design a linear controller for the double pendulum and investigate the controllers quality. The controller should stabilize the pendulum in its equilibrium positions. This is especially challenging for the complete upward position, because only if both parts of the double pendulum are exactly vertically on top of each other, it will stay there. If one of the angles is slightly different, the position will collapse immediately due to gravity. The controller makes sure the position remains stable also when vibrations are exerted to the pendulum.

An important part of the project is generating simulations of the double pendulum in Matlab or Python. These are used to visualize what the pendulum is doing after changing parameters or applying certain designs. The project can be frustrating as well, when the simulations for instance just don't do what you would like them to do. However, I managed to make everything work and I was very proud of the end result. That is mostly why I liked this course so much. I felt like I was busy with engineering, which I haven't experienced in other mathematics courses so far.

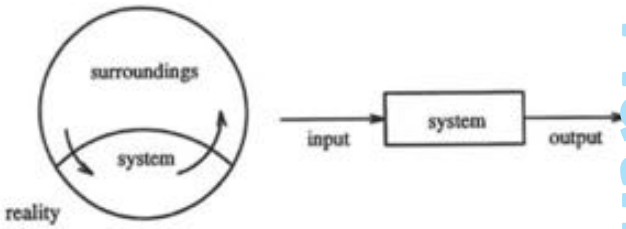

Figure 5: Example of a system [2].

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[1] https://towardsdatascience.com/random-walks-with-python-8420981bc4bc

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Minors

Kilian Buis, Maxime Hoekstra and Doris Aafjes, Students Applied Mathematics

In the first semester of the third year, students must choose their minor. Some students choose a mathematical minor, others choose to do something completely different. In this article, three Applied Mathematics students tell about their minor.

Finance - Kilian Buis

In the first semester, I did the minor Finance. Since the minor contains a fair bit of mathematics, economics and relies on multiple Matlab implementations, the minor is very interesting for both Applied Mathematics and Computer Science and Engineering students. During the minor I learned a lot, but there was one concept that took center; an option. To explain what an option is, we consider an asset with a certain initial price S_0. If you buy a *call option*, you will get the right to purchase from the seller a prescribed asset for a prescribed price (E) in let's say a year from now. If you buy a *put option*, you will have the right to sell this asset to the buyer asset for a prescribed price in a year from now. Under the influence of different parameters, the asset price can either go up or go down. Of course, if you have bought a call option, you hope that the asset price will go up to price S_T, since you can then buy the asset at a prescribed price and then sell for S_T. This will give you a value of S_T–E. In the same way, you hope for a drop in the price if you bought a put option. This gives you a value of E–S_T. However, we need to determine a price for these options (V_0). That is not so easy, and can be done in multiple ways. During the minor, you will learn that in the discrete case there is an algorithm for determining this price. In another course, we studied the continuous case. With the help of a famous differential equation (the Black-Scholes equation) we could find the price using a Matlab program. Besides studying these options, we also learned how to invest our money properly when we have the choice of multiple investments. In addition, we analyzed the risks involved in these investments. What I liked most about the minor is that although at first glimpse the courses seemed very diverse, in the end it becomes clear that they all share multiple topics. Also, all the material you learn can immediately be used in some really cool examples. For instance, we analyzed the stock price changes of some big banks and then made some predictions for the future of the banks. Especially the last I found really interesting and for this reason alone I will definitely recommend this minor if you like finance.

Fashion Industry - Maxime Hoekstra

I wanted to use my minor space for trying something completely different from mathematics. While searching for arts and culture themed minors, I came across the minor Fashion Industry at Erasmus University. I have always been interested in fashion and I was pleasantly surprised to find out there exists a fashion themed program on university level! I knew immediately that I wanted to participate in this minor. The minor does not teach fashion design, but covers the broad industry behind the fashion designers, who are only the tip of the iceberg. The goal of the minor is to show that fashion is a broad, collective process with many stakeholders involved. It provides insight into the business, historical, cultural, economic and media aspects of the fashion industry and its importance for the economy. The minor consists of three courses: economics of fashion, business history of fashion and fashion media. The first course, economics of fashion, delves into theory about supply, demand and intermediaries (people who form the bridge between the fashion industry and the customers). There was also a strong focus on sustainability in this course. For instance, sustainable production processes, ethical production and transparency of fashion companies. The course business history of fashion delves into the history of fashion companies and crucial events that determined the industry. The last course, fashion media, delves into the fashion maCHazines and other communication forms of fashion, also including new media and digitalization. All three courses use lectures, seminars, guest lectures and field trips. The assignments were mostly essays and presentations based on literature. Other assignments were more fun, for instance, we had to make a fashion editorial for a maCHazine. This meant that we had to do a photoshoot where we were the models ourselves and we wore clothes from our own closet. I also enjoyed the field trips very much. We visited the Textile Museum in Tilburg and Denim City in Amsterdam. With the latter excursion I learned about the production of jeans and Denim City's research to make this process more sustainable. We also visited two fashion exhibitions, one about fashion and dance in Kunstmuseum Den Haag and one about fashion designer Thierry Mugler in Kunsthal Rotterdam. Overall, I really enjoyed this minor and I learned a lot about what goes on behind our clothes. If you are also interested in a field outside of mathematics and computer science, your minor is the perfect opportunity to broaden your knowledge!

Journalism & New Media - Doris Aafjes

This year I am following my minor in Leiden. The minor is called Journalism & New Media and it lasts an entire year, which means 15 ECTs per semester. I wanted to do something completely different for my minor because I cannot always express my creativity in my Applied Mathematics study. I figured that journalism might be an interesting direction for me, because I am very interested in following different media types. Besides that, I have some experience in making videos and I wanted to learn more about telling stories. The program of the minor is a combination of creating and observing media. In the first semester we had three courses. In the first course we learned about the history of journalism and the media culture in the Netherlands. In the second course we learned how to write different kind of journalistic productions, such as a news article or a column. We also had lectures on how to conduct an interview and we had to do one ourselves. The third course was very different because here we learned how you can do research in journalism. We had to look for answers to questions concerning journalism, like: what is the difference between the public watching television twenty years ago versus now? Or, why do we see such a small number of women when we look at sports journalism? In the second semester there are two courses to follow. The first one is called audio-visual journalism. In this course we have to work out video concepts and edit them ourselves. We also observe documentaries, podcasts and other audio-visual productions. The second course is called internet journalism and here we make interactive productions with maps, data and timelines. I really like the second semester because we can produce a lot. The minor fits me very well because I can really express my creativity. This minor also gave me a different view on what kind of master I want to do. In the future I would like to combine science with my passion for creating. Right now, I am thinking about science journalism, but I am still figuring that out.

Miscellaneous

Dreamteam Vattenfall Solar

Pieter Tolsma, Software Engineer & Logistics

Every two years, the Bridgestone World Solar Challenge takes place. This is a solar race across the outback starting in Darwin and finishing in Adelaide. People call it the 'world cup' of solar racing since it is the biggest and oldest solar challenge in the world. Out of the 10 times that Delft has participated, we won 7 times. Last year I was part of the Vattenfall Solar Team. With a group of 16 people, we designed, built and raced our own ultra-efficient solar car against other top universities across the world.

When I started in August 2018, the pressure was on to live up to our predecessors. A big challenge to say the least, since the competition was bound to be strong this year. We had the advantage of a good history of building solar cars, but this was also our biggest disadvantage. We build upon a mountain of research already done by the previous teams, but we had to be very careful about blind spots. What if we missed something that the other teams did not? NunaX had to become the smallest, lightest, fastest solar car ever.

The beautiful thing about this project is that the goal is dead simple. Finish first, roughly meaning; make the car as efficient as possible. Unlike other competitions, we base all our decisions on this one goal. With almost every faculty represented in our team, we channel all knowledge gathered at the TU Delft and focus it on this optimization goal.

Building a solar car is more a form of art than it is an exact science. You have to be creative, especially when things do not work out as you thought they would. Seeing NunaX on the road for the first time gave us all chills, after seeing the car being built up from scratch. We joked about the fact that NunaX was our baby, but in some sense she was. We would never let strangers near the car since even a tiny scratch would impact our aerodynamic performance.

As you might know, after the most exciting race in history, NunaX did not make it to the finish line. At 08:10, the day we would finish, she caught fire due to a battery incident. As a team, we are extremely proud of what we have achieved and glad that everyone returned home safely. I hope we inspired many people, especially young kids to get into the field of engineering. As Wubbo Ockels, our first team coach, once said; "We have only one earth, there is no spare". During our school visits, we let children see the car and talked about our project. I was glad to hear that many kids were excited to study engineering because of our visit.

I feel privileged that I could experience what I did as a student. I hope the TU Delft will continue to appreciate this wonderful tradition and what kind of impact it has on individuals across the world.

Photographers:

Jorrit Lousberg

Hans-Peter van Velthoven

Historical Figure: Niccolò Tartaglia

Annerieke Ohm, Editorial Staff MaCHazine

Some scientists are very well-known because they have famous laws or theorems named after them. Others are well-known because they made a big discovery, but there are also scientists whose name might not ring a bell by as many people, but without whom those big discoveries would have never been possible. One of these scientists is Niccolò Fontana, who actually managed to figure out how to solve cubic equations and formed a bridge from the physics of Aristotle to the physics of Galileo Galilei.

Niccolò Fontana was born in Brescia, a city in northern Italy in 1499 or 1500 AD. At about the age of six, his father was murdered by robbers. Then, around 1512 AD, the French army lead by Gaston of Foix-Nemours invaded Brescia. During this invasion, Niccolò suffered some major injuries in his face. One of these severely damaged his jaw leading to speech disabilities. This is where his nickname 'Tartaglia' comes from, which is Italian for 'stutter'.

Since the family was quite poor, Tartaglia wasn't able to go to school and instead taught himself how to read and write from a stolen book. When his mother recognized that he had an unusual gift for mathematics, she managed to find a way for him to study at the university of Padua. He managed to gain enough knowledge of mathematics to be able to teach it, publicly and privately, in Verona, Vicenza, Brescia and Venice.

Around this time, scientists were desperately trying to find a way to solve cubic relations. They knew how to solve quadratic equations, so equations of the form $ax^2 + bx = c$, but no one had been able to figure out how to solve equations involving a cubic term, x^3 , yet, except for Scipio del Ferro. He had discovered a way to solve cubic equations of the form $x^3 + ax = b$. He never told anyone how to do this, except for his student Antonio Fior, who, after they got in a dispute, challenged Tartaglia to a competition where they both had to solve cubic equations. Tartaglia had already discovered how to solve cubic equations of the form $x^3 + ax^2 = b$ and in preparation for the competition he had managed to discover how to solve any cubic equation. This meant that during the competition, Tartaglia managed to solve all equations, while Fior only managed to solve the equations of the specific form. He won the competition, but didn't tell his method to anyone but mathematician Girolamo Cardano, who promised to keep it secret but published it six years later anyway, giving credit to Tartaglia.

Tartaglia also managed to make progress in the field of physics. In 1537 he published a book, in which he tried to use mathematics to explain the physical world. One important step he made in closing the gap from the physics of Aristotle to the physics of Galileo Galilei is in the field of air resistance. Aristotle claimed that air resistance was needed in order to sustain motion. However, Tartaglia came to the conclusion that air resists motion, but that there are situations in which it can be ignored. He was also the first one to say that the trajectory of a projectile is a continuous curve. However, he didn't manage to find the correct curve to calculate with yet, so he calculated with a straight line, followed by the arc of a circle, followed by a straight line. In these and some other ways, Tartaglia managed to form a bridge from Aristotle to Galileo Galilei and through that, to our modern understanding of physical motion.

During the time Tartaglia lived in Verona, he got married and had children. He died in Venice in 1557, only 57 years old. The cause of his death is unknown.

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[1] ttps://www.britannica.com/biography/Niccolo-Fontana-Tartaglia

[2] ttps://nl.wikipedia.org/wiki/Niccol

[3] ttps://www.famousscientists.org/niccolo-tartaglia/

[4] ttps://wellcomecollection.org/works/p6pm6mha

Computer Science Puzzle

Louise Leibbrandt, Editorial Staff MaCHazine

Killing Squares

Consider an $n \times n$ board formed by $2n(n+1)$ toothpicks that serve as borders of the 1×1 squares (see Figure 1 for an example). Design an algorithm to remove the minimum number of toothpicks that will break the perimeter of every square of any size.

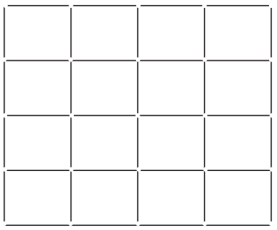


Figure 1: The 4 × 4 board for the Killing Squares puzzle.

Solution to last issues' computer science puzzle: The Fifteen Puzzle

Reading the tile numbers top down and left to right, we can associate a list of numbers from 1 to 15 with every position in the game. Then the goal is to get from the initial list

$$1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 14 \tag{1}$$

to its permutation

$$1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 \tag{2}$$

by a sequence of allowed moves.

Note that the initial and final positions have different parities: (1) is odd, and (2) is even. Let us now investigate how the parity of a permutation representing a board's position may change by the game's moves. The puzzle allows two kinds of moves: a horizontal slide and a vertical slide of a tile to the empty location next to it. A horizontal slide does not change the permutation and hence its parity. A vertical slide of a tile creates a cyclical shift of four consecutive elements in the permutation: for example, the ordering of tiles j, k, l, m in Figure 2 becomes k, l, m, j.

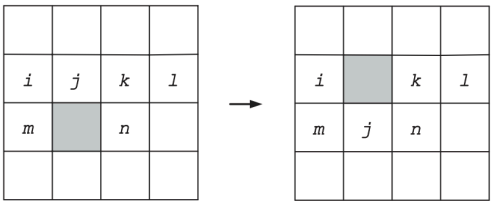


Figure 2: Impact of sliding of the j-tile down.

It is convenient to interpret the game's moves as a sequence of slides of the empty square. In our puzzle, the empty square occupies the same location in both the initial and goal positions. Therefore, the number of horizontal slides and the number of vertical slides in any sequence solving the puzzle would have to be even 231 Solutions to compensate each slide to the right with a slide to the left and each slide up with a slide down. Since neither horizontal slides nor an even number of vertical slides change the position's parity, the parities of initial and goal positions must be the same for the puzzle to have a solution. Since this necessary condition fails in our case, the puzzle has no solution.

References

[1] Anany Levitin and Maria Levitin, *ALGORITHMIC PUZZLES*, p. 68, p. 229-231, 2011

Mathematics Puzzle

Kilian Buis, Editorial Staff MaCHazine

Problem 1

Simplify the following expression:

$$\log_2(3) \times \log_3(4) \times \log_4(5) \times \ldots \times \log_{127}(128).$$

Problem 2

Suppose we have:

$$ax + by = 5 \tag{1}$$
$$ax^2 + by^2 = 10 \tag{2}$$
$$ax^3 + by^3 = 50 \tag{3}$$
$$ax^4 + bx^4 = 130 \tag{4}$$

What is the value of

$$13(x + y - xy) - 120(a + b)?$$

Solution to last issue's Problem 1

We start by just evaluating some values, starting with n = 1000

$$\begin{aligned}
f(1000) &= 997 \\
f(999) &= f(f(1004)) = f(1001) = 998 \\
f(998) &= f(f(1003)) = f(1000) = 997 \\
f(997) &= f(f(1002)) = f(999) = 998 \\
f(996) &= f(f(1001)) = f(998) = 997 \\
f(995) &= f(f(1000)) = f(997) = 998 \\
f(994) &= f(f(999)) = f(998) = 997 \\
f(993) &= f(f(998)) = f(997) = 998 \\
&etc.
\end{aligned}$$

What we see is a pattern. For every even number, we get a value of 997 and for every odd number we get a value of 998. From this, we conclude that f(84) = 997.

Solution to last issue's Problem 2

The key here is to work backwards. We do not know what the agent answers to the final question or whether he answers truthfully. But we do know that by the time Christiaan asked it, he has narrowed the options down to 2 numbers; one where the second digit is 1 and one where the second digit is not 1. We must find answers to the previous questions that lead to just 2 possibilities.

Of the three questions, the one that narrows our options down the most is if the number is a perfect cube. That leaves us with only 8 answers between 13 and 1300, namely 27, 64, 125, 216, 343, 512, 729 and 1000. So let's assume the answer to the third question was a truthful yes.

Now let's look at the second question. If the agents answered yes to the number being a perfect square, it would narrow Christiaan's options to just 64 and 729, the only numbers in our range that are both a square and a cube. But neither of these has a 1 as their second digit. So the given answer to the second question must have been no. That also means that we can eliminate 64 and 729 from the list, leaving only 6 numbers.

If the agents answers yes to the number being less than 500 we would have 4 options (27, 125, 216 and 343). However a no leaves us with two options (512 and 1000), one of which the second digit is a 1. We do not know which of these two numbers Christiaan thinks is correct, but that does not matter, since his conclusion was based on lies.

We, on the other hand, can now construct the truth.

- The agent said that the number was greater than 500, but he lied, meaning it is actually less than 500.
- The agent said that it was not a perfect square, but lied again, meaning the number is indeed a perfect square.
- The agent also truthfully confirmed that it was a perfect cube.

As we have already seen, the only number less than 500 that is both a square and a cube is 64. And that is exactly the number that we needed to find.

Science Trends: The Mind and Happiness

Akash Singh, MSc Computer Science

On this page you will find some brief information on recent scientific breakthroughs or interesting news. Whether they're big or small, if we think they might interest you, we will mention them here! Do you miss a certain trend or want to inform your fellow readers of an interesting innovation? Feel free to contact us.

Humanity, over its time on the planet so far, has progressed in leaps and bounds when it comes to economy, civilisation, and science. But how much have we progressed in understanding and implementing happiness? As a species, have we grown happier over time in proportion to the progress we have made, if at all? Latest research in Neuroscience promises an optimistic perspective on this question.

"The mind can be our greatest friend, or our worst enemy"

Imagine the last week before exams – there are more project deadlines than you like, you are less prepared for the exams next week than you would have liked, and that YouTube video with a dude burning thousands of matchsticks is suddenly so interesting. You know you really shouldn't but you go down that rabbit hole and before you know it, three hours have passed and you have watched through a ton of goofy videos and memes. The stress shoots through the roof and it becomes much harder to focus now. Caught in a wild snowstorm of thoughts about life choices, mathematical equations, dropping that one particularly gnarly course, and burning matchsticks, you soldier on and keep studying and suffering. Exam time can feel like dying.

I ask you to consider a grimmer scenario now – think back to a dark time of your life. Loss of a loved one, failure in something one truly cares about – events like this turn our mental landscapes into a place of gloom where the sun never shines and the darkness seems to just last forever. Eventually, most people manage to climb out of such depressive episodes but some, for many physiological and psychological reasons, cannot and run the risk of being diagnosed as depressed. And even the ones who do, have a terrible time dealing with the grief while it lasted. It is never easy for anyone.

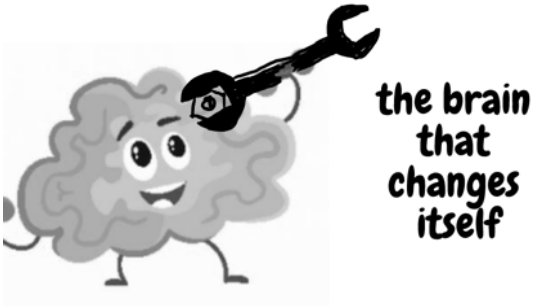
In both of these situations, we find ourselves in a situation where we're experiencing something which we would rather not. Depending on how badly we want to get out of such experiences, our own mind can begin to feel like a prison. Which is such a strange idea, right? Isn't the human mind supposed to be the greatest achievement of evolution which gave rise to science, civilisation, and YouTube? Turns out, the human mind is a double-edged sword which also has the potential to inflict terrible damage to a person. This is obvious now more than ever with the unprecedented rise of mental health issues globally. According to a report by WHO, "by 2030 depression will be the leading cause of disease burden globally" [1].

Stanford professor Robert Sapolsky quoted in a great talk [4] on clinical depression, "It's a biochemical disorder with a genetic component with early exposure experiences that makes it so someone can't appreciate sunsets".

He goes on to explain how depression is a chaotic phenomenon of hormonal and psychological imbalance within the body. Difficult day-to-day experiences are understood by medical science in terms of a physiological phenomenon – being too depressed to do anything is called psychomotor retardation and being too anxious to sit still is called hyperactive stress response. The point is, these seemingly ethereal experiences of sadness, anxiety and so on are in fact complex biological phenomenon which science has finally begun to understand. In other words, it is the super-complicated dance of chemicals and electricity within our bodies which determines whether or not we will find that sunset beautiful. Clearly, it is not the sunset's fault. But we all want to appreciate sunsets, right? There must be some way to do so. Sure, but before we get there, a disclaimer:

This article is not a guide to cure clinical depression. That is a medical condition deserving of as much respect (if not more) as something like diabetes.

A common reason of suffering in almost everyone's lives is the difference between expectation and reality. We really expected to have that grade, that interview, or that date but were denied and enter some bluesy mood which makes life a little difficult to enjoy. As explained by the studies done in extreme cases like clinical depression, our emotional state emerges from the underlying biological activity which our mind interprets as being gloomy, anxious, et cetera. We observe our reality through the looking glass of our mind, a simple word for which is perspective. It is common knowledge that perspective can be the difference between being nauseatingly anxious and super stoked before, say, a skydive. Modern research in neuroscience reveals that these differing perspectives on the same situation are literally represented by the difference in the neurochemical pathways inside our brains. So the next time we find ourselves dealing with a challenging emotion, remember that it is a result of the unique manner in which your brain is wired. Of course, some amount of suffering is inevitable in life. But we all end up being more offended, more nervous, or more devastated about things than we would like to. So if our mind governs our perspective about things, and if perspective makes us feel happy or sad about things, should we not try to 'craft' our perspective so that we suffer as little as possible? This is where a recent discovery by neuroscience comes into picture – neuroplasticity. Neuroplasticity is the ability of the mind to keep reshaping itself over the course of an individual's life.



Why is this interesting?

One major principle in neuroplasticity is that the neural-pathways we use constantly are strengthened, the ones we don't are lost. Example of a complex task which we humans do effortlessly? Communicating in our mother tongue. Simply because we have practiced this skill consistently for many years. This applies to the case of emotional response to situations as well [2] – we become a better procrastinator every time we give in to exam stress and, well, procrastinate. This might sound like bad news but there is an exciting silver lining here - the limits of the human brain's ability to rewire itself is still unknown, despite all the recent findings [2]. Recent studies have unearthed the mind's astounding ability to rearrange itself in all aspects, from the brain regions controlling major motor actions to major personality reorganisation of an individual.

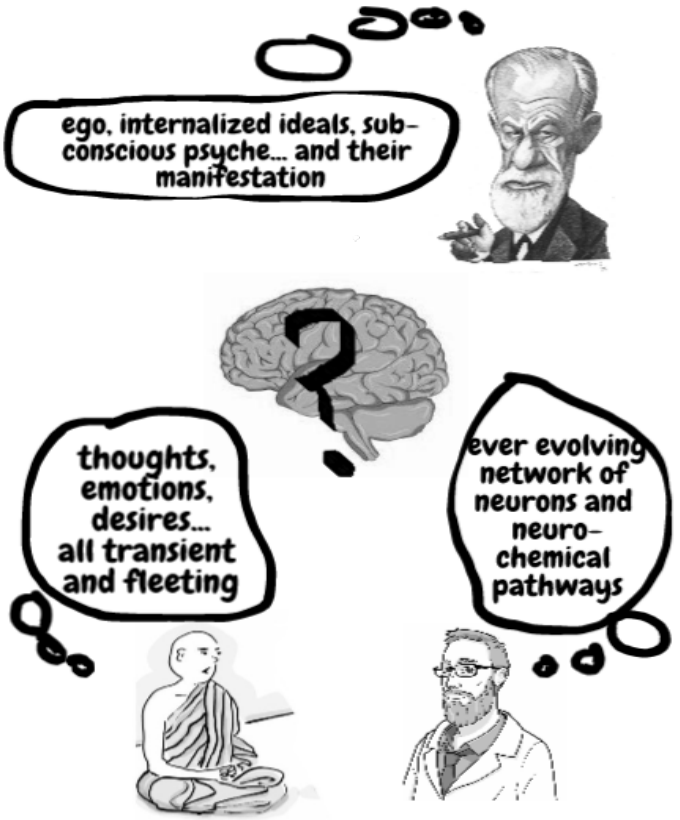
In his book, The Brain That Changes Itself, Norman Doidge presents case studies of stroke patients suffering massive loss of motor control. Through a set of targeted therapies, these patients regained significant amounts of their motor control, even when these patients were from ages deemed too advanced for the brain to rewire itself. Turns out, the stroke lesion in their brains which caused the initial paralysis was still there, but other regions of the brain had re-learned the motor tasks as the patients were exposed to targeted activities.

In another chapter, Doidge presents Dr. Jeffrey Schwartz's work in treating extreme cases of OCD simply by using "mindfulness". Mindfulness, an important term in meditation literature, means observing your mind as it is, without judgement, resistance, or action. In his work with OCD patients, Dr. Schwartz helped them to step back from their compulsive thoughts. By not acting upon those impulses, the patients weakened the underlying neurochemical pathways, which in turn led to weakening of their compulsions over time. Through many such case studies Doidge demonstrates that the brain, which controls all of our experiences from birth till death is an ever evolving system of neurochemical pathways instead of the rigidly fixed tissue it was once thought to be.

In a journal of his life's work, psychiatrist Peter Michaelson talks about the psychological core of human beings which is made of certain emotional patterns which we learn during our childhood which becomes second nature as we grow up [3]. Nucleus Basalis, a group of neurons responsible for sustained attention in our brains is extremely active during childhood which makes children capable of effortlessly learning anything, be it a musical instrument or destructive personality traits - it's all the same for a hyper-focused child's mind. Therefore, it is this early period of life which sets the tone for our personality (things which offend us, excite us, or make us anxious) in life. Through his case studies, Dr. Michaelson illustrates how these personality patterns may be reversed through deliberately being aware of one's emotions, similar to how Dr. Schwartz treated OCD patients using mindfulness. There is much to be said about the fine details of the practice of mindfulness, simply a Google search away for the motivated ones.

A scientific perspective would define happiness as a highly desirable state of a system of non-trivial complexity (the mind). Another perspective might call happiness as the ability of the mind to not be overwhelmed by "unhappy thoughts". More importantly, happiness seems to be less about the external world and more about the internal design of the mind. But if it was that easy to be happy, why does everyone not achieve perfect happiness? Because of the principle of neuroplasticity stated above – if you've been unhappy one way or the other for a long time, your 'unhappy' neurochemical pathways are really strong and deep. And yet, it is possible to sculpt a happier mind. It just takes time and patience, like learning coding.

Psychology, philosophy, and neuroscience, all offer different takes on the nature of the mind. But understanding it seems to offer a chance to understand it's fundamental role in our perspective on life, actions determined by that perspective, and our updated perspective based on the outcome of those actions. This feedback loop is what we all perceive as "reality" for the entirety of our lives. So there is some significant merit to Stephen R. Covey's words, "we see the world, not as it is, but as we are".



It is worth pointing out that genuinely happy people, ones who seem to have a cheerful outlook despite any situation seem to be doing it effortlessly. It almost seems like a superpower! The simple explanation is their 'happy' neuronal pathways are really strong, and the 'unhappy' ones are weak. Which means happiness is simply a skill we can work on and develop over time. It might sound unnatural but happiness is not that different from learning a language – it seems difficult initially but you get better at it with time. One of the finest guitarists of our time, Guthrie Govan, has said:

'Whatever you've learned becomes truly useful only once it becomes second nature'.

Does happiness as second nature sound a worthy objective in life?

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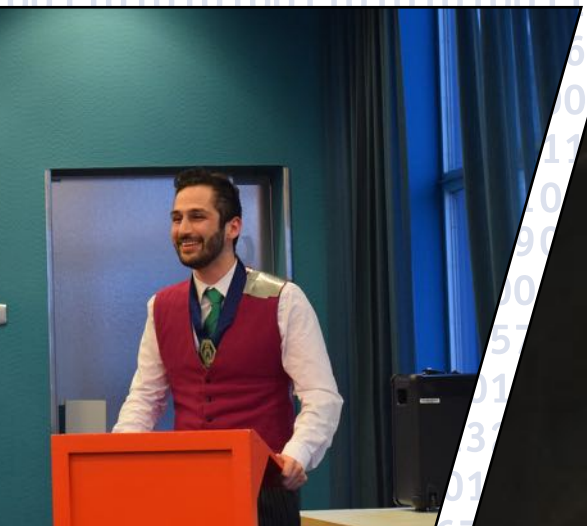

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