

Volume 24 - Issue 2  
February 2020

Wiskunde  
Informatica  
Studievereniging



'Christiaan  
Huygens'

THE AFTER STORY OF THE

## GALA

.....

A NETWORK DATA PERSPECTIVE TO

## Recommender Systems

.....

SURVEY SAMPLING AT

## Statistics Netherlands(CBS)

.....

SCIENCE TRENDS: ALGORITHMS AND

## Genome

CONTAINING:

CURRENT AFFAIRS | ASSOCIATION | COMPUTER SCIENCE | MATHEMATICS | MISCELLANEOUS





# Editorial

## MACHAZINE

is a publication of

W.I.S.V. 'Christiaan Huygens'

### Chief Editor

Eva Slingerland, Marjolein Leegwater

### Editorial staff

Daniël van Gelder, Kilian Buis, Maxime Hoekstra

### Art Directors

Annerieke Ohm, Kasper Wolsink, Louise Leibbrandt, Tom Saveur, Boaz van der Vlugt

### Contact address

Mekelweg 4, 2628 CD Delft

E: machazine@ch.tudelft.nl

T: 015-2782532

### Concept and design

G<sub>2</sub>O Kesteren

### Publisher

BladNL

### Cover

<https://www.pexels.com/photo/sunset-on-rain-forest-1125776/>

### Cooperating on this issue:

Arian Joyandeh, Bhoomika Agarwal, Fred Vermolen, Srinath Jayaraman, Adeep Santosh, Daniël de Weerd, Jasper Rou, Kasper Vaessen, Anwesh Marwade, Kilian Buis, Louise Leibbrandt, Hiba Abderrazik, Sterre Lutz, Wim T. van Horssen, Isa van der Bent, Janne Heslenfeld, Annerieke Ohm, Ruth Koole, Frank van der Made, Timo van Asten, Akash Singh, Daniël van Gelder, Maxime Hoekstra

### Terms and Conditions

The MaCHazine-committee and the Board are responsible for the content within this MaCHazine, in such terms that the opinion of a writer is not (necessarily) a reflection of the opinion of the committee or association. All rights reserved. No part of this publication may be reproduced, stored in a (retrieval) system or transmitted in any form or any means, electronic, mechanical, photocopying, recording, scanning or otherwise, without the prior written permission of the committee or association.

### Advertiser index

BLIS	16-17
Technolution	Back Cover

The life of a student can be busy with lots of opportunities to broaden one's horizon besides studying. One famous Delft saying is: "Studeren is combineren" (Studying is combining) referring to the stress that comes with having too many things to do! Having said that, this issue we'll ask the members of the MaCHazine committee:

### What do you do besides studying?

Eva - Right now, I am in the Master Applied Mathematics. Within CH, I'm part of the MaCHazine committee, the LANcie, the FlitCie and I'm a bartender in the /Pub. Furthermore, I'm also in the Faculty Student Council. I'm also singing in Vocalzz, the acapella jazz choir of Groover, and I'm playing floorball with the Blue Falcons.

Marjolein - This year, I started my Master Applied Mathematics. Besides that, I spend most of the time with my friends and roommates. Also, I play tennis at the Students Tennis Association Obvius, which I enjoy a lot. Right now I only have training once a week but I would like to start playing competition in the spring as well.

Kilian - Currently, I am in doing a Finance minor in my Bachelor Applied Mathematics. Besides the MaCHazine committee, I am also part of the GalaCie and the ICom committee. Furthermore, I am playing football every Sunday in The Hague and I like to spend some time chilling with my friends.

Maxime - Next to my Bachelor Applied Mathematics, I am mostly dancing. Every Wednesday evening I have dance training with the X Dance Team of TU Delft, which I enjoy very much. I also practice ballet on pointe shoes and I am planning to be more active at the association SoSalsa next period. Besides dancing I draw comics for the MaCHazine.

Daniël - Besides the MaCHazine, I am also part of the Symposium committee. While I do spend a lot of time studying for my Master Computer Science, I also like to spend time hanging out with friends, my girlfriend and my roommates! I am currently also looking for a side job next to my studies in order to find out what kind of work I would like to do later.

Tom - Other than studying Computer Science and working on the MaCHazine I do MMA, in which I am trying to work towards doing official competitions. I also teach Judo and other Martial Arts at schools if I have the time. During the weekends I either relax or do my job, which is looking after people with disabilities.

Louise - Within the study association of CH, I am part of the MaCHazine, the LANcie and the FilmCrew committees. When I'm not busy with my Bachelor in Computer Science courses, I can be found as a bartender in the /Pub, or at the student association Virgiel having a drink with my 'club'.

Boaz - This year I don't study at all as I'm on the CH board! Other years, however, I like to watch movies with my housemates or have a drink with friends at my student association Virgiel. I also do some DJ'ing in my spare time!

Annerieke - I am currently in my second year of my Bachelor in Applied Mathematics. I just started in the MaCHazine committee. Besides my study, I'm a member of Proteus, where my team and I try to train about twice a week. Unfortunately, we are mainly training indoors right now, because the sun sets so early.

Kasper - I play sunday league soccer and go to the gym which I really enjoy! Next to that I spend most of my free time on electronic music production, mainly techno and house. On tuesdays and thursdays I usually hang out with my friends at Virgiel and the remaining time I waste watching (very interesting) youtube videos.





# Table of Contents



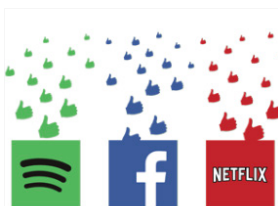
## Current Affairs

From the Board	2
Here comes the sun!	4
Protesting Farmers in the Netherlands	5
TU Delft News	6
Faculty Student Council 2019-2020	7



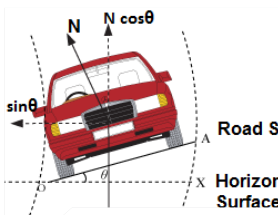
## Association

Committee Kickoff	10
Finance Dinner	11
Sinterklaaslunch	12
Festivities Event	12
Yearbook Pages Through the Ages	13
After Story Gala	14



## Computer Science

A Network Data Perspective to Recommender Systems	18
Spotivibes: revibe your playlists	22



## Mathematics

On one dimensional wave equations and the formula of d'Alembert	24
Freshmen elective courses	26
Survey sampling at Statistics Netherlands	28
The Plank Problem	30



## Miscellaneous

Hyperloop	32
Computer Science Puzzle	34
Mathematics Puzzle	35
Science Trends: Algorithms and Genome	36
Historical Figure: George Boole	38
Strip	39



# From the Board

Arian Joyandeh, Treasurer

When you are reading this, the second quarter and therefore the first semester of the academic year, has already gone by. For me personally this quarter has been in the theme of getting comfortable in my position as a board member. I think this has been a tendency in my student life in general. The first quarter of the academic year is all about exploring the new challenges that come on your way and in the second quarter you start to learn what your preferred way of dealing with these challenges is.

Exploring new challenges and finding how you deal with these kind of challenges, is an amazingly instructive experience. What is even more informative, is to see how different people tackle different challenges in their own way. Sometimes it is a good idea to take a step back and evaluate why you like the things you like and how that influences the decisions you make. This awareness of oneself is one of the many things I have learned as part of the Board of our amazing association.


When I started studying, I would have never expected that I would spend a full year leading my study association. During my first freshmen weekend, I had an amazing time and met a great group of friends that still holds a special place in my heart. There was one thing that was bugging me though: Where are the teachers that have organized this whole weekend? My brain could not understand that people who were just a couple years senior to me, could organize such a grand event.

At the end of my freshmen year I was asked to join the FaCie-committee and therefore to be a small part of the Freshmen Weekend, which I have so many fond memories of. I loved every second of this experience. Not only did I get to know a lot of great people, but I also learned that it is not that hard to actually organize (or in our case, create) something with a group of dedicated people.

Noticing the amount of personal growth I had after doing any committee, I continued doing committees. As my committee count grew, my interest in the inner working of our association did in the same fashion and at some time, spending that full year on leading our association did seem like a great opportunity, which I luckily got to take.

After half a year of leading our association, I can say that I am happy with where I am right now. Sometimes the things you expect the least, can be the things that you appreciate the most.

With kind regards,

Arian Joyandeh 





# Current Affairs





# Here comes the sun!

Bhoomika Agarwal, Student Computer Science

**There came a day during my first winter in Delft in 2019 that I finally understood the meaning of the song 'Here Comes the Sun' by the Beatles. Prior to this, I always wondered how sunlight made anyone so happy and affected their mood so profoundly. I finally began to comprehend what seasons are and how they can affect my mood.**

I come from a city in India where the temperature variation is between 10-35°C at all times of the year. I was so used to seeing the sun every single day that I began to take it for granted. The sunrise is what began my day and the sunset is what ended it. The time variation in these two processes was almost negligible back home.

As an international student who is experiencing seasons such as autumn and harsh winters for the first time in my life, I can vouch that it isn't easy coping with any of it. The lack of sunlight and the gloomy weather made my mood take a huge dip. I became increasingly lethargic and inactive as the autumn set in. I began feeling hopeless and spent most of my time indoors without seeing the sunlight or meeting any people. Little did I know that this was a real issue until I heard about 'Seasonal Affective Disorder' or SAD and connected it to everything I was experiencing. I started looking into it and the results took me by surprise!



During my search for answers, I learnt that exposure to sunlight can trigger more physical changes than I could have imagined. Research has shown that moderate exposure to sunlight can boost the levels of serotonin produced in the human body. Also known as the 'happiness hormone', serotonin can improve one's mood and focus dramatically. I experienced this when the sun peeked out from behind the clouds after a long, gloomy week and I found myself smiling! I immediately began feeling cheerful and happy and got a considerable amount of work done on sunny days. The warmth of sunshine spread all the way to my heart.

Being used to a fixed sunrise and sunset, coping with the changing daylight timings really affected my sleep cycle and made me restless due to lack of sleep. There were entire nights when I just lay in bed, wide awake as sleep continued to evade me. This lack of sleep made me highly irritable and affected my

studies. I was unable to focus on studying - either in classes or at home. This was when I found out that exposure to sunlight also has an effect on the body clock, or the circadian rhythm. The melatonin produced by the human body at night is directly proportional to the amount of sunlight exposure during the day. It dictates the circadian rhythm in the body by improving the amount of sleep and reducing stress levels. With changes in the period of daylight exposure, my natural circadian rhythm was disrupted - causing side-effects such as depression and hopelessness.

Lastly, sunshine has a major effect on the 'sunshine vitamin' or Vitamin D. This realization struck me when my academic counsellor advised me to take Vitamin D supplements and explained the reason behind it to me. Vitamin D promotes calcium absorption and is required for bone growth and formation. Exposure to the sun helps to convert inactive Vitamin D levels to active. At the same time, I was curious about why I kept catching colds frequently and why they refused to leave my body for a long time. The winter had just begun and I was well-aware that the temperatures were going to dip further. It was high time for me to brace myself and strengthen myself. Another surprising and less known correlation that I learnt about was between the levels of Vitamin D in our body and our immunity. It acts as an important trigger to the immune system when present in sufficient amounts. With lack of the 'sunshine vitamin', my immunity took a dip too.




Retrieved from: [images.8track.com](https://images.8track.com)

"Little darling, it's been a long cold lonely winter  
Little darling, it feels like years since it's been here

Here comes the sun (doo doo doo)  
Here comes the sun, and I say  
It's all right

Little darling, the smiles returning to the faces  
Little darling, it seems like years since it's been here"

The lyrics of the song "Here Comes the Sun" by the Beatles now play in my head on every sunny day during these long and cold winters in Delft. And I finally understand the reason behind the happiness and the warmth that sunshine brings along with it. 





# Protesting Farmers in the Netherlands

Fred Vermolen, Department Numerical Analysis


**The farmers started protesting in the Netherlands. Are we going to have a revolution?**

At October 1 the Dutch farmers started protesting. Their first protest rally was on the Malieveld in The Hague (Den Haag). Farmers drove all the way from different parts in the Netherlands to The Hague, where the Dutch government is based. The farmers' protests are directed against the 'ever-lasting changing of the legislation by the government'. Besides this reason, the farmers want more respect and understanding for their work and working conditions. The farmers' actions are coordinated by associations like *Farmers Defense Force* and *Agractie*. In principle, these associations, and most farmers, refrain from using violence. The protests were triggered by Tjeerd de Groot's proposal to reduce the livestock to 50% of the current livestock. Tjeerd de Groot is in the Dutch Parliament on behalf of the left-wing party D66. Furthermore, a pig farm in Boxtel, in the province of Brabant, was attacked by animal activists. The attack was a result of the negative image of farmers that has been broadcast by the main stream media. Reducing the livestock by 50% will cause bankruptcy for many farmers in the Netherlands. During the past decades, many farmers already left The Netherlands because farmers in Holland have to adhere to increasingly strict legislation. Many Dutch farmers have moved to Canada, Denmark, Germany and Poland. Many other farmers, such as a good friend of mine, have given up farming, and are doing alternative jobs, or they have transformed their farms into camping sites or solar energy parks, or they have just sold their premises. There is no denying that many Dutch farmers are having a tough time currently. The Netherlands is one of the most populous countries in Europe, so Dutch farmers have been trained to use their equipment, resources and territory efficiently. Despite our country being so populous, we have very strict environmental legislation. In my opinion, this is a good thing to preserve the environment. However, most farmers already adhere to this strict legislation.

Let us have a look at this matter from a government's perspective. Climate is changing, globally and also in the Netherlands. Summers are getting warmer and drier, winters become milder and wetter. Warm, dry summers are nice for tourism, and also for me! Because I can enjoy more beers during the warm afternoons and evenings in the summer. Winter is getting milder, hence fewer problems on the highways with traffic jams, and fewer problems with trains that are cancelled or delayed. So this is also a good thing. It is a pity for me that winters are wet because I can enjoy fewer beers outside, but I can still keep on drinking whiskey, cognac or rum during the dark and windy winter evenings. So my consumption of alcoholic beverages does not suffer from any reductions! As long as I can drink alcohol, I am happy and I will not protest, because, as you all know, alcohol is all I need in life. But nature is more than alcohol, sorry I meant climate. Despite the high population density, the Netherlands has some relatively large natural areas, such as the Veluwe, Utrechtse Heuvelrug, Weerribben, Waddenzee, Holterberg, etc. These areas are worth visiting, and there are many more nature areas worth visiting that I did not mention, like Tiengemeeten, which is close to Delft. Of course, these natural areas cannot be compared to what you find in countries like Sweden, nevertheless, diversity of animals is increasing: wolves have returned to the Netherlands spontaneously, otters are thriving and sea eagles have returned to different coastal regions. In this sense, nature is thriving in the Netherlands. But is there only a success-story to tell? Apparently, there is not: the emissions of nitrogen-based compounds are

large in the Netherlands. These emissions are caused by engines (such as cars, aircraft), factories, and allegedly by agriculture. These nitrogen compounds precipitate in the natural areas, which may cause a reduction of the biodiversity of plants and animals in the long run. This problem is also known as the 'nitrogen crisis'.

Therefore, the government has announced the following measures: adaptation of the nutrients for livestock; reduction of the maximum speed on highways; reduction of the number of pig farms by buying farmers out. But there is more: the nitrogen crisis also urged to cease many building projects. Due to immigration, the population is growing rapidly in the Netherlands: about 130,000 people per year are welcomed to the Netherlands. These newcomers need housing, hence many new houses need to be built. However, building these homes will also give rise to emissions. For this reason, many building projects were paused. This made the contractors protest. The government almost immediately withdrew the restrictions for the builders. Because the government does not want to stop economic growth and development of the Netherlands and they do not want any social unrest if the people cannot have their homes. The farmers, ..., well, the government wants to build houses, so the government wants the farmers' land. So the government is very happy if farmers stop their business. Building homes does not generate any flow of money to The Netherlands. Reducing agriculture, in fact, makes less money flow from abroad into The Netherlands, because eight percent of our export originates from farming. Of course, animal rights activists will be happy. However, they do not realise that people keep on eating meat and that this meat will be produced in other countries. The EU has implemented special agreements with Ukraine, where animal rights have not developed the way they developed in the Netherlands or in the EU. So in fact, and counter-intuitively, animals will face the negative consequences of our animal-friendly politicians.

Well, this situation made the Dutch farmers upset. They massively protested in several parts of the Netherlands. The vast majority of the farmers was nonviolent and cooperative, which made most of the Dutch people support them. Some small incidents happened, like a soft, harmless collision between a police horse and a tractor and another one in which the farmers tore down a door of the City Hall in Groningen when they were denied entrance. The police maintained a zero-tolerance policy and several farmers were arrested. Personally, I think that the farmers are crucially important for the Netherlands. They produce our food and food for our neighboring countries, which makes money flow into the Netherlands. Of course, nitrogen may be an important issue (although I am not familiar with the biological aspects regarding this crisis). Biodiversity matters. Hence something should be done. However, I think that the government should allow and help the farmers to look for alternatives. Research should be done and another matter is that according to the NO<sub>2</sub> map of Europe, one can see that there are peak values in the Randstad Holland (Netherlands), Ruhrgebiet (Germany), London (UK), see [1]. But these regions are all urban, and no agricultural areas! So it seems that the Netherlands has a different problem. Well, I have bored you enough. Time for good quality and even better quantities of alcohol. *Skål* 

## References

[1] European Environment Agency. <https://www.eea.europa.eu/themes/air/interactive/no2>



# TU Delft News

Srinath Jayaraman, Student Computer Science

**The Delft University of Technology is the biggest and oldest public technical university in the Netherlands, established by King Willem II on January 8th, 1842. But what is currently happening in and around the TU Delft? This article will list the most important events of the recent months.**

## *New housing scam affects TU Delft Students*

The issue was first noticed when Mike (not his real name) was scammed out of 1,000 EUR. Mike came across a nice apartment on the website [www.kamernet.nl](http://www.kamernet.nl). He reached out to the landlord who introduced himself as Nigel Andres Boon. The next day, Nigel arranged a viewing for the apartment which was located on Mijnbouwstraat, near the Faculty of Architecture. Mike liked the apartment, so Nigel presented him with a contract. This is when Mike first noticed something odd - when he went to transfer the 1,000 EUR deposit, the bank information did NOT show Nigels name. When he pointed this out to Nigel, he responded by giving Mike a key to the apartment and told him to go and check it out the next day. Indeed, when Mike went to the apartment the next day, he was able to enter it with the key Nigel had given him. Things in the apartment were exactly as they had been the day before. Mike was satisfied and thus transferred the deposit money. This is where things went south very quickly.

The next day, Mike reached out to Nigel, but to his shock, found that Nigel had blocked him on WhatsApp. He panicked and went to the apartment, and was relieved to see he could still open it. But his relief was short-lived as a man was standing in "Mikes" living room. This man informed Mike that it was actually HIS house, and that he had been away for a while on a trip and had just gotten back. The man even told Mike that he wasn't the first person to enter his house that morning and that a few things had even been stolen from his apartment. At this point, Mike left and contacted the police, who took a statement from him and informed him that he wasn't the only person to file a complaint of this nature. Luckily, Mike had some good friends who helped him get a room and provided emotional support as well.

The police warn all students to be watchful and to always carry out a back-ground check. Students should always ask for identification. Scammers are always reluctant to hand over personal information as they prefer to be anonymous. Once you get their identification, you can check with the municipality if a property is registered to the person you are in contact with.



Figure 1: As reported by [www.delta.tudelft.nl](http://www.delta.tudelft.nl)

TU Delft has a few important pointers on its website regarding rental frauds:

- NEVER trust an owner that is too good to be true; it most likely is.
- NEVER trust people who claim not to be able to arrange a viewing.
- NEVER send landlords/ladies a copy of your passport, unless you have checked their identity thoroughly and you have marked the copy for this special occasion ("for rental contract only"). This makes it much harder for fraudsters to misuse your identity.
- NEVER pay money to 'lawyers' or obscure agencies.
- NEVER transfer money to Western Union, PayPal accounts or to foreign accounts.
- ALWAYS check the address that is on offer.
- ALWAYS ask the person offering a room to provide a telephone number after the initial email contact.

I would like to add a personal anecdote to this article. I was unable to get housing through the student housing platforms such as DUWO or XIOR. I was thus forced to look on other platforms for housing. One of those platforms (websites), was [www.rooming.nl](http://www.rooming.nl). I saw a house listed on the site with the address Harmenkokslaan 22. If you look it up on Google Maps, it says this house is 2.5 km from TU Delft. I was ecstatic! Finally, after searching for more than 2 months, I had gotten a house so close to the university! However, when I reached out to the landlord, I noticed that she did not have a number registered in the Netherlands, it was a UK number. This was a red flag. Upon reaching out to her, she said the house was rented out through Airbnb. Another red flag. She also mentioned that she would be unable to schedule a viewing as she was away from the country. This was the final red flag, upon which I blocked her and reported the property on [rooming.nl](http://rooming.nl) as a fraud, as it seemed too suspicious.

I eventually ended up getting good accommodation in The Hague. A friend at the university was telling me about his difficulties in obtaining housing, and as it turns out, he had ALSO run into the SAME scammer mentioned above! He had also blocked her and reported the listed address as a possible fraud. Fun fact, while doing the research for this article, I came upon the SAME address listed above on a section of the TU Delft website, quite appropriately titled "rental frauds".

I believe the best advice one can give to incoming freshmen who are looking for student housing is to reach out to students who have already been here at TU Delft, and ask them for advice directly. Before I came to the Netherlands, there were groups on WhatsApp and Telegram where seniors often helped us out with questions that we had about housing, student visas, travel, etc. It might sound a bit ambitious, but if TU Delft itself were to start forums online for students, it would certainly lead to a drop in international students being scammed out of their hard-earned money, since they would now have an official source that could answer most (if not all) of their questions, thus leading them to make wiser choices.

## References

- [1] <https://www.delta.tudelft.nl/article/new-high-profile-housing-scam-affects-tu-delft-students>

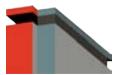




# Faculty Student Council 2019-2020

Adeep Santosh, Faculty Student Council Chamber Electrical Engineering

## What is the Faculty Student Council?



The Faculty Student Council or FSC is a legally elected student body that is involved in the decision making in the faculty. The council, depending on the matter at hand, has the right of consent or right of advice. This gives us the chance to be involved with the key decision making bodies inside the faculty. The FSC of EEMCS represents all students from Electrical Engineering, Applied Mathematics and Computer Science. We as the FSC have internal meetings every week where we discuss the key issues that we come across inside the faculty. Once a month the FSC takes part in an OV where we meet with the decision making bodies within the faculty and discuss with them the key issues that we come across during our internal meetings. The FSC also takes part in the budget allocation within the faculty and has a right to advise on how the money is spent. The FSC of EEMCS, along with other FSC's and Central Student Council (ORAS and Lijst Beta), strive to make the faculty a better place to learn and grow for the students.

## The Four Chambers of FSC

The FSC is divided into 4 chambers that each represents a particular section of students within the EEMCS. The total number of seats which are up for election every year are as follows:

Chambers	Seats
Electrical Engineering Chamber	4
Computer Science Chamber	4
Mathematics Chamber	3
Sustainable Energy Technology Chamber	1

This year post-elections students were chosen who would represent each chamber and as a whole body would form the Faculty Student Council of EEMCS. The following are the students who got elected into each of the chambers:

### Electrical Engineering Chamber

- Philip Groet
- Adeep Santosh
- Stefano Roos
- Jippe van Dunne

### Computer Science Chamber

- Bart Cox
- Nadyne Aretz
- Vera Hoveling
- Yorick de Vries

### Mathematics Chamber

- Bastiaan Bakker
- David Sarkisian
- Eva Slingerland

### Sustainable Energy Technology Chamber

- Saumitra Wagh



Figure 1: Group picture with part of the FSC.

## What are we up to now?

The FSC is currently working in full force to make the faculty better for everyone. Some of the topics that the FSC is currently looking into are as follows:

- To make the faculty better for studying by checking if the silent rooms are actually silent and if there is enough study space for students.
- Working towards making the online course evaluation more effective.
- Getting to know about the renovation works being carried out in the faculty and suggesting areas which would need further renovation.

## Would you like to join the FSC

As I previously mentioned, FSC is an elected body and the student who wishes to join the FSC needs to get elected into it. Every student can sign himself up as a candidate at their study association and write a pitch about themselves. This pitch will then be displayed on the election website. Post the election days the candidates with most votes are elected into the respective chambers.

## How to get in touch

As the FSC we would love to hear from you on how to improve the faculty and the difficulties you are facing. This would help us in taking steps which benefit you and the faculty as a whole. We organize a coffee moment every quarter to talk to students and conduct a survey. We would be placed in the entrance of the building with free coffee, you can come and talk to us and fill the survey about the difficulties you face in the faculty. This helps us in getting a good picture of the major focus points that need our attention. In case you can't attend the coffee moment or need our attention on something immediately, send us a mail at [fsr@ewi.tudelft.nl](mailto:fsr@ewi.tudelft.nl)! You can also follow us on our Instagram @fsceemcs.



# AREA 51 LAN

WHAT:

Gaming Event

WHERE:

X (Unit Sports and Culture)

WHEN:

28, 29, 1 Feb/Mar 2020

PRICE:

€40

GET YOUR **TICKETS** AT  
[AreaFiftyLAN.nl](http://AreaFiftyLAN.nl)

INFO:

- MULTIPLE OFFICIAL TOURNAMENTS
- LOUNGE AREA WITH CONSOLES
- ARCADE GAMES
- OFFLINE BOARDGAMES
- MEALS AND STAY INCLUDED



# Association





# Committee Kickoff

Daniël de Weerd, Member of the AkCie

Every year, CH organizes the Committee Kickoff: an event where all members of the newly formed CH committees can get to know each other while enjoying fun games and great food. As a member of the fresh AkCie, I got to enjoy some competitive games of pool and a table full of delicious gourmet food.



We met at Pool and Billiards Delft, where all the committee members were greeted by the board after they had biked through the soaking rain. Then we quickly gathered into groups, so that we could create a strong committee bond while attempting to defeat each other in either eight-ball pool or darts. Perhaps to the benefit of the safety of my fellow committee members, I opted not to play darts and played a game of pool with my fellow AkCie members instead. We took turns playing and chatting and had a lot of fun despite our collective lack of pool skills. The atmosphere in the game hall was very upbeat and pleasant and it was clear that everyone playing darts or pool was having a lot of fun.

When our time at Pool and Billiards was over, we got on our bikes and cycled to 't Karrewiel, a restaurant near the city center. There we were served a delicious serving of raw meat and vegetables to gourmet ourselves, combined with a nice portion of fries. At my table, we mistakenly and unfortunately did not realize that we could ask for more meat and vegetables. This made us a bit hungry after we finished the first serving, but we eventually saw our mistake and ordered more food. The quality of the food was very good and we all enjoyed our roasted veggies, baked meat and crispy fries. To top it all off, there was a short speech by the board in which all of the committees were named.

The Committee Kickoff was a great opportunity for all the new committee members to meet each other: I'm certain that everyone took advantage of this chance and had a great night. Let's hope that CH keeps up the tradition every year! 🏆







# Finance Dinner

Jasper Rou, Bachelor Student Applied Mathematics and Applied Physics


**On Monday the second of December, the Finance Dinner took place at 'Het Vermeertje' in Delft. Here, thirty students who are interested in a career in finance had the opportunity to meet companies in an informal setting. The dinner was free, so the first smart financial decision had already been made.**



The two companies present were IMC Trading and Zanders, two consultants in treasury and risk. Both are Dutch companies that are less than thirty years old. IMC Trading is a market maker: they buy and sell financial products with the use of highly-automated systems and advanced technology. Zanders is an independent consultancy company for treasury, risk and finance.

The evening started with a pitch from both companies in which they introduced themselves. They also gave a little history lesson about the VOC and the beginning of the finance world: this used to be something for businessmen but is now the domain of mathematicians and computer scientists. Afterwards, the luxury three-course dinner started. The seating was organized such that at every table there were five students and an employee of one of the companies. After each course the employees switched places. In that way students were able to talk to different people from both companies.

The employees had different positions at the companies and had studied in different fields. Therefore, the students could talk to people with an engineering background and learn how to apply mathematics and computer science at those companies, but there were recruiters present as well. So, there was the opportunity to get to know the company on different levels. Naturally there was not only business talk that evening: fun stories were shared as well and both students and companies had a nice evening.

In the end the students went home with a nicely filled stomach, insights in career opportunities and some cool gadgets the companies handed out. Some business cards were distributed, so some perhaps left as future employees of Zanders or IMC Trading. 



# Sinterklaaslunch

Kasper Vaessen, Member of the AkCie

The AkCie is back again this year, and better than ever. We present: PrAkCie! This committee consists of the following members: Jorian Faber (Chairman), Darwin Liu (Secretary), Daniel Wolff (Treasurer), Stefanie Morshuis and Margot van de Klok (Promotional Affairs), Femke Brouwer and Barber Vos (Decoration Affairs), Frederique Hemler and Kasper Vaessen (Purchase Affairs), Julian Kuipers (Peer Pressure Affairs), Reno Welleman (Music Affairs) and of course Daniël de Weerd (Ice Affairs). We can't forget our QQ'ers Boaz van der Vlugt and Diederik Heijbroek.

The AkCie is the activity committee of CH. We organize the typically Dutch 'Sinterklaas' Lunch, which you have already been able to enjoy. We also organize ADSL which stands for 'Algemene Docenten Studenten Lounge'. Which is 'General Teacher Student Lounge' in English. In this activity students and teachers are able to have a drink together. But there's a twist! Teachers are able to order free drinks and the students are not. So if you want to get a free beer you will have to go talk to a teacher. It will be a lot of fun, so be sure to be there!

Last but not least, we organize the AkCivity! For now we can't tell what it is, but you sure want to be there!

On the 4th of December we organized the Sinterklaas lunch. Here everyone was able to enjoy a nice lunch while being accompanied by each other and even Sinterklaas stopped by! The pieten heard some people were good and some a little bad this year, so Sinterklaas came to talk to them and even give them a little gift. The lunch was a great success and we are very happy about how it turned out.

We started off with a mysterious message from the 'Wise Owls'. We had to come to the top floor of the faculty. Here we got to accept our spot at the AkCie. The first meeting was about two weeks later. Here we got to meet each other for the first time, we discussed the basics such as dividing the individual tasks and coming up with a committee color. This all went pretty quickly. The next meetings we started to talk about the first activity. We also came up with our theme for this year: PrAkCie. Which comes from the Dutch verb 'prakken'. Which is 'to mash' translated to English, hence the potato masher as logo.

We are really looking forward to the rest of the year and really hope to see you at the rest of the activities. 🍷

# Festivities Event

Anwesh Marwade, Member of the ComMA

This December, the Committee for master's activities (or ComMA as they are lovingly called) provided an exciting introduction by organizing the International Festivities Night for our master students. A hearty holiday themed dinner coupled with an activity fitting for the festive season, gave the students an opportunity to socialize and even make some new friends while enjoying a relaxing break away from an otherwise monotonous study schedule.

As a part of the activity, everyone was handed a certain piece of cultural trivia from across the globe. The ComMA had planned this event as a way of engaging the students and instigating interaction by linking up with another fellow student holding the answer to their trivia! A great way to exchange cultural niceties and also learn about the festive traditions of the Dutch. It was great to see everyone leaving with hand-written greeting cards and a chocolate letter in their hands.

The satisfaction was evident on the faces of the ComMA committee members as their jovial idea worked to a tee. It all started almost a month ago when the team met up for the first time, taking over from last year's committee. Although a diverse and quite international group of people, this year's ComMA is brought together by their collective desire to bring all master students together by way of organising more of such exciting and fun events throughout the academic year. Matea, Cecilia and Simon are from the Master Applied Mathematics, Anwesh and Andrew are from the Master Computer Science while Akshit is studying the Master Embedded Systems. Matea will be leading this year's committee as the Chairperson, Cecilia is the Treasurer whereas Akshit will shoulder the role of Secretary. Anwesh, Andrew and Simon will be acting as Commissioners responsible for organisational and logistical duties. Together, we are the ComMA team for 2019-20! 🍷





## Through the Ages



*Het bestuur op een van hun meest nuttige en productieve momenten.*



## Ank Voets

Illusie, illusie, wat moet je nu toch met illusie? Het is echt een illusie te denken dat er een verhaaltje met het thema 'illusie' te brouwen is. Maar zo zijn er veel illusies in het (TU-)leven:

- de *list* die je te een tijd al kan hebben;
- de *list* die men op tijd moet op een vraag, brief, noem maar op;
- de *list* die een vergadering niet te lang zal duren;
- de *list* die alles afleest alles afleest alles afleest heel goed;
- de *list* die notulen drien niet een vergadering worden uitgewerkt;
- de *list* die je teken keers vroeg kon beginnen met het voorbereiden van een document;
- de *list* die je nermund hebt vergeten in de uitnodigingslijst voor een receptie;
- de *list* die je alles wat je voor die dag hebt gepland ook al zal krijgen;
- de *list* die je een keer begrijpt dat je het ook druk hebt;
- de *list* die in een nieuwe organisatie alles op rolletjes loopt;
- de *list* die netwerken (P's) in een technische omgeving altijd werkt;
- de *list* die je nieuw informatiesysteem binnen de kortste keren juist juist ingevoerd;
- de *list* die je leuks op een pasfoto staat;
- de *list* die je in ten minuten besprekingen kunt doen (jezelf zijn voor de laatste schiet al zijn langzaam op de dan andere rijen);
- de *list* die je heeft schoon bijt, omdat je je toch bijna nooit moet;
- de *list* die de informatie vanuit komt als je maar lang genoeg wacht;
- de *list* die je niet moet denken dat het niet meer zal plaatsvinden;
- de *list* die de griep(epidemie) aan je voorbij zal gaan;
- de *list* die een jaarboek (niet) moer zal zijn van de voorgaande;
- de *list* die...
- de *list*...

Zo kun je nog wel een paar pagina's vullen, maar een zinnige verhandeling over illusie zit er voor mij niet in geloof ik. Het verbaast mij altijd weer waar columnisten toch de inspiratie vandaan halen om weeklijks een leuk en/of interessant verhaal af te leveren. Ik buig dan ook deemoedig het hoofd en laat het hierbij, in spanning afwachting wat anderen over illusie naar voren hebben gebracht, want dat er een mooi jaarboek zal komen, daar twijfel ik niet aan.

Met niet-illusoire groet,  
Ank





# After Story Gala

Kilian Buis, Commissioner of Promo Affairs of Gala Committee

**On Friday the 13th of December the Gala of Christiaan Huygens took place. While the date seems pretty sinister, the Gala was a great success! Starting with a good composed 3 course dinner, followed by an amusing band and 2 DJ's that played 'hitjes' till 3 am, suddenly the night ended and everyone went home.**

Something that sounds so fun, must be easy to organize right? Well, no. As part of the GalaCie committee I can confirm that organizing a Gala is really fun, but also pretty stressful on the day itself. But more about that later. First something about ourselves. Our committee consist of 5 people, our Chair(wo)man Nienke, our Secretary Vera, our Treasurer David, our Commissioner of Music Affairs Doris, our Commissioner of Promo Affairs Kilian (me) and our QQ'er Marleen.



Organizing the Gala started for us in April. After looking at a ton of locations and requesting multiple proposals (well, some of us did), we eventually found our location; Het Koetshuis. A lovely, chic location, near the center of Rotterdam. In November, we visited Het Koetshuis to get an expression of the location. It turned out to be very nice and we as a committee got even more excited for the Gala. The location even fitted exactly with the theme of the Gala, Galaxy, since it was a place where we could enjoy the whole night without any limits, even the sky was not the limit.

Meanwhile, the ticket sale had already started and the tickets were selling quite rapidly. The dinner got sold out in only a few days and in the beginning of December, also the Gala was completely sold out. 240 tickets were sold! Some say this was due to the marvelous promo of the event, mainly consisting of a lot of posters hanging at CH.


One of these posters explained the etiquettes for a Gala, since this is not always clear to everyone. First of all, everyone had to bring a date. For some, it was quite stressful to find a date, but in the end nobody was alone. Secondly, the dress code. It is customary for boys to wear a tailcoat with a bow tie, while the ladies usually wear a long dress. Luckily, everyone had read our posters and everyone was looking beautiful.

Enough now about the organization and etiquettes, let's talk about the evening itself. The evening started at 19:00, and we enjoyed a lovely dinner, consisting of 3 courses and more than enough beer and wine. At 21:30 all the tables and chairs were removed (resulting in a little bit of stress) and a few moments later the big party could start, with quite a good line-up.

For the first act of the evening, we contacted a music band, part of Groover, which turned out to be a really nice band that everyone really enjoyed. After playing for 2 hours, it was time for two DJ's. First DJ Struikrover played the perfect hits to dance 'the stars from the heaven' and following him, J'oak played some nice hits till the end of the evening.

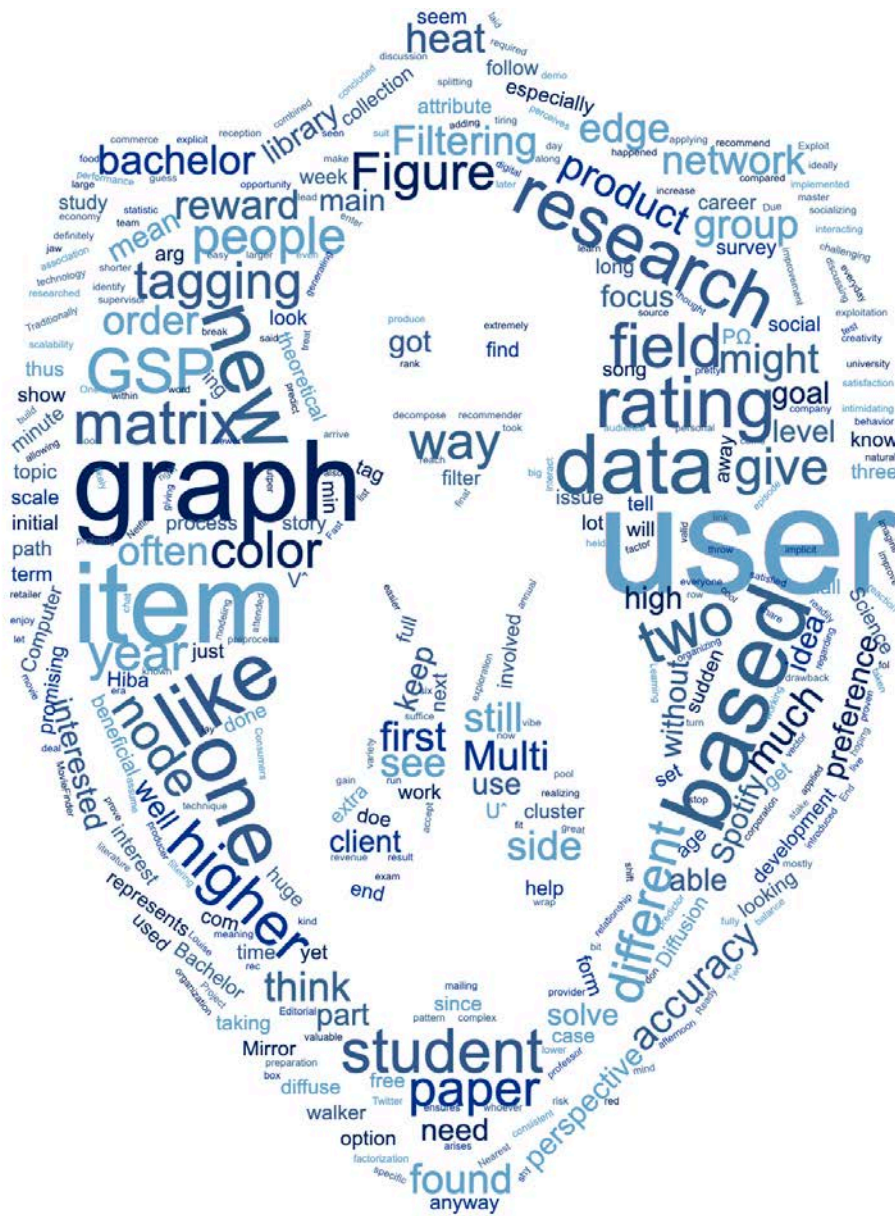
During the night, we arranged an open bar for everyone and that did not go unnoticed. Enough was drank during the night, and there was even taken care of some bitterballen and other snacks. What also did not pass unacknowledged was the photographer. In long lines people were standing, waiting to get that picture, that if they find it back in a few years, it brings back all the memories of an amazing gala...



Because an amazing gala it was. So amazing, that I am sad that it is now over, that all the hard work is over now and that we must wait 2,5 years for a new gala. Although I am not organizing that one, I am sure I will be attending that one, since I do not want to miss such an amazing night. 



# Computer Science





# BLIS Digital

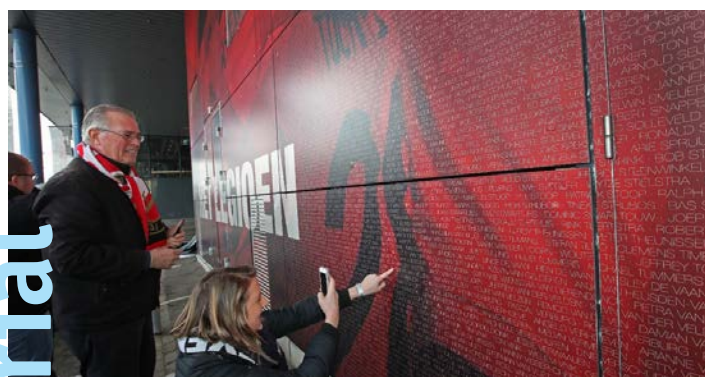
As a former member of Christiaan Huygens I have been asked to write an article for the MaCHazine about my work at BLIS Digital. Considering the fact that I have already worked at this company for more than 13 years now, it will come as no surprise that I am absolutely enthusiastic about it. 😊

During the first year of my study I started working for BLIS in the capacity of a job on the side for 8 hours per week. These 8 hours rapidly became 16 hours and after 3 years I found myself fully employed as a developer at BLIS. At first my work consisted of building and maintaining websites with PHP. By now I have been working at BLIS for more than 13 years and have grown into the position of lead .Net developer and together with my team I create web- and mobile applications in the cloud for customers such as KPMG, ProRail and Feyenoord.

I would like to single out two interesting and challenging projects that I have been working on the last couple of years.

## Feyenoord Legion wall

For quite some years now BLIS and its subsidiary B.made have been a supplier for Feyenoord in the field of web- and mobile applications. In honour of the 10th anniversary of The Legion, a wall of the Maas Building, which is a part of De Kuip stadium, was renamed into Legion Wall in 2018. This 5x16 metres wall is covered by a visual containing the names of 10.000 Legion members.



For this wall we created a special web application enabling people to look for the position of a name on the wall. This project had some nice challenges:

### *Determining the position of names*

Before a decision was made to build the web application, the design of the sticker had already been sent to the printer. So we had to come up with a way to determine the location of names in the visual. As a starting point we had the gigapixel picture with a size of 500 MB and the list of names (in the correct order).

In order to determine the x- and y-coordinates of the names in the picture we first marked the 'dots' that separated the names with a distinctive green colour that did not occur in the rest of the picture. By writing a script that scans the picture pixel-by-pixel for those green pixels, we could easily determine the coordinates of these delimiters. By combining this list of coordinates with the list of names the positions of names could be determined in advance. Subsequently this list of names and coordinates were stored in a database thus facilitating a search by name.

### *Gigapixel picture of 500 MB*

The source picture was over 500 MB and as such we could not use it within the web application. We started looking for a solution based on the technique that is also used in Google Maps and OpenStreepMap. The gigapixel picture is cut up into smaller segments, tiles, of no more than 256 by 256 pixels. As a result each tile is only a few KB.

With the help of a script we scaled the original gigapixel picture into different resolutions and cut them up into tiles of 256x256 pixels.

As a result the first tile at a low zoom-level looks like this:



And at the highest zoom-level this first tile looks like this:



In the end this results in 15 different zoom-levels with in total almost 10.000 small pictures. Using the open source viewer OpenSeadragon this has been made into a zoomable picture which has been used in the web-application.





## Hosting

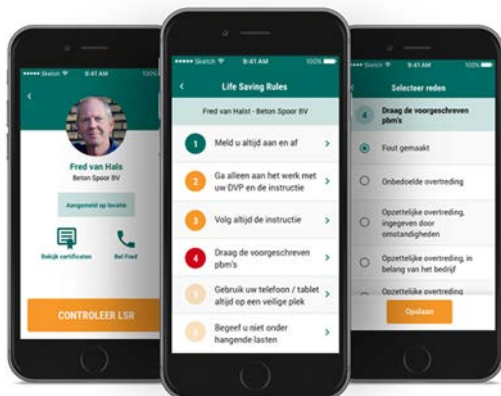
As thousands of people should be able to look for their name on the wall at the same time, the application had to be able to cope with large peak traffic. Therefore we decided to make the web application as static as possible which would allow us to use the Amazon content delivery network. This made it quite easy to deal with the peak traffic without burdening the application servers too much.

The application can be found at: <https://acties.feyenoord.nl/10jaarhetlegioen/>

## Digital Safety passport

In 2013/2014 we created the Digital Safety Passport for RailAlert. The Digital Safety Passport is used by all people who work around the railway tracks in the Netherlands and is specifically intended to improve the safety around the railway tracks.

The Digital Safety Passport is a 'digital fence' around the railway track which makes it clear for everyone which certifications are needed and to be obtained in order to be allowed to work around the railway tracks. And therefore also as an indication whether or not the employee in question complies with these requirements. The system consists of a web-portal, a physical pass and a mobile ScanApp.



Interesting challenge within this project was the development of the different interfaces with the systems for personnel administration, training centres such as VCA and the interface with a pass-printer.

Today this application is already in use by 5000 organizations and 75.000 users daily for working safely at the railway tracks.

In 2015 we won the Dutch Interactive Award with this application and also today this application is still developed further.

## BLIS Digital

For me the great thing about working at BLIS is the perfect combination of challenging projects and plenty of time for fun and relaxation. Annually a couple of trips are being organized by colleagues, such as the BLIS bike challenge. With a group of colleagues we face the challenge of cycling in

the European mountains during an extended weekend. In the period that I have been employed at BLIS we conquered a.o. the Mont Ventoux, Passo dello Stelvio and the Alpe d'Huez.



In addition to the cycling trips also a fantastic yearly Snow-week is organized during which we go skiing and snowboarding with a group of colleagues.



Interested in doing a challenging internship with us or would you like to work at BLIS, feel free to contact Linda Pardon (06-81116660, [hrm@blisdigital.com](mailto:hrm@blisdigital.com)).

# A Network Data Perspective to Recommender Systems

Louise Leibbrandt, Student Computer Science

In preparation for the Bachelor End Project taken by each Computer Science and Engineering bachelor's student, students are required to follow the Bachelor Seminar course. Whilst following this course, students conduct a literature study in a group of students on a specific topic related to computer science. In the second quarter of this year, a group of students and I were asked to write a survey on the topic of "A Network Data Perspective to Recommender Systems".

## Why Recommender Systems?

The digital age has brought us into an era of abundance. As consumers we are free to choose between a magnitude of different products and services, and producers are able to offer a wide selection of products matching a variety of user preferences. This shift from industrialization to an economy based on information technology has sparked interest of retailers to invest in the idea and application of *Recommender Systems* (RS): systems that "analyze patterns of user interest in products to provide personalized recommendations that suit a user's taste" [1, p. 1].

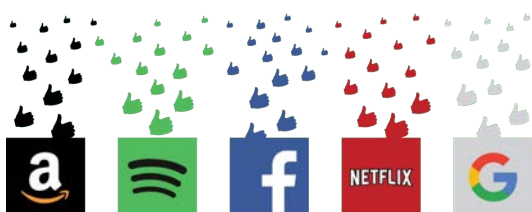


Figure 1: Well-known Recommender Systems

Such models can improve user experience and thus generate revenue for many e-commerce providers. RS have proven to be especially beneficial in the entertainment sector as one movie, song or episode is consumed by many, and each consumer is likely to interact with several different items. Consumers are also willing to indicate their level of satisfaction on the usage of these items. Due to these factors, a huge amount of data is available to analyze and process to produce accurate predictions for valid recommendations.

## Taking a Network Data Perspective

Modern data sets are often composed of more than just user ratings. User data and data inherent to the item being recommended are often readily available. As one can assume that "similar users or items will share similar attributes" [2, p. 1], it can be concluded that incorporating side information (gender, age, social networks, etc...) into RS can lead to more accurate predictions. The natural question is how to exploit this information so that the increase in accuracy outweighs drawbacks introduced by the incorporation of extra side information.

One way one could think about this problem is by modeling the problem as a network graph. As similar users or items exhibit similar attributes, these would be highly linked inside this graph.

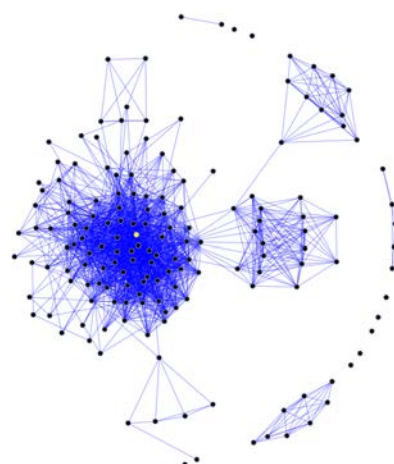


Figure 2: Example of side information in the form of a social graph

## Fields

The majority of the papers we found discussing a network data perspective to RS can be categorized into the following three fields: *Matrix Factorization* (MF), *Multi-Armed Bandits* (MAB) and *Graph Signal Processing* (GSP). We chose these three as our main focus as the first two have been researched for years and are used in many existing systems like Amazon.com, eBay and MovieFinder.com, while GSP is relatively new. The latter shows great promise by adding several new methods that prove to have a high level of accuracy.

### Matrix Factorization (MF)

*Matrix Factorization* is a collection of algorithms that decompose the ratings matrix into two lower-rank matrices, as shown in 3. By doing this splitting we gain information on typical users and items, and their relationships. It is thus possible to predict the full ratings matrix, which can be used for recommendations.

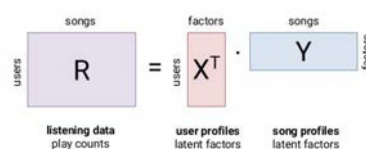


Figure 3: Data modeled as product of latent vectors

The problem of matrix factorization is formulated by (1) and the goal is to create a method/algorithm to solve this.

$$\hat{U}, \hat{V} = \arg \min_{U, V} \frac{1}{2} \|P_{\Omega}(R - UV^T)\|_F^2 + \lambda(\|U\|_F^2 + \|V\|_F^2) \quad (1)$$





When incorporating graph information, the problem is now reformulated into (2). Through conducting our research we found that ADMM [3], GRALS [2] and HOFM [4] are methods that can be applied to solve the problem formulated by (2).

$$\hat{U}, \hat{V} = \arg \min_{U, V} \frac{1}{2} \|P_{\Omega}(R - UV^T)\|_F^2 + \lambda(tr(U^T L_r U) + tr(U^T L_c V)) \quad (2)$$

The ADMM method lays a lot of the theoretical groundwork for later methods and reaches higher accuracy faster on small datasets, but scales poorly. GRALS applies a different technique allowing it to achieve much higher performance on large datasets. HOFM is unique as it is able to capture higher order implicit information alongside the explicit graph information. This means it outperforms both ADMM and GRALS in terms of accuracy. Unlike ADMM and GRALS, it does not perform a scalability test.

### Multi-Armed Bandits (MAB)

The next field is the *Multi-Armed Bandit*, which focuses on the *Explore-Exploit Dilemma* from *Reinforcement Learning*. It can be visualized through the following example; imagine you have a row of gambling machines which give a consistent reward when played. The goal is to maximize the reward, so you need to balance exploring to find out the reward a machine gives, and exploiting the machines you know give high rewards. In Recommendation Systems, exploration is learning about user preferences and exploitation is recommending items based on these preferences.



Figure 4: MAB visualized

The MAB methods we found can be grouped by how they use graphs: *clustered* methods cluster the user graph to find similar users to base recommendations on; *random walkers* use transition probabilities to arrive at an item to recommend. In general, clustered methods are good when you don't need fully personalized recommendations (since recommendations are based on clusters), and walkers provide more customization.

### Graph Signal Processing (GSP)

A relatively new way of looking at the matrix completion problem is in terms of Graph Signal Processing. With this approach ratings are seen as signals from a node, on a user- or item-based graph.

5 shows an example of a user-based graph for one item. Each red bar represents a rating of that user, and each edge represents a link between two users. The shorter the edge the more similar the two users are.

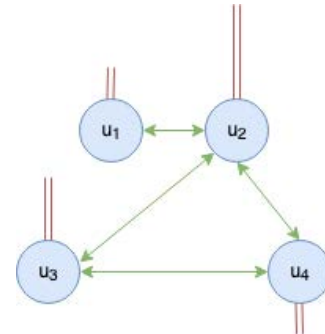


Figure 5: GSP visualized

*Mirror Filtering*, and *Diffusion Filtering* are two promising fields within the GSP method. Both preprocess the matrix, by filtering out edges such that the graph can help identify similar users. *Mirror Filtering* does this by using higher order *Nearest Neighbour* predictors as band-stop graph filters. Two of these filters, one item-based one user-based, are combined for optimal results. *Diffusion Filtering*, on the other hand, treats the ratings as heat sources; the higher the rating, the hotter the node. The heat of the nodes is then let to diffuse along the edges, the more similar two nodes are the easier it is to diffuse heat. This ensures nodes that are similar end up with a similar heat level.

As GSP is a relatively new field, these methods have not been directly compared in the papers and surveys found.

### Concluding Thoughts

The current state of the network data perspective to RS looks promising. *Matrix Factorization* and *Multi-Armed Bandit* are both well-established fields, still actively being expanded with new methods and research. The much newer field *Graph Signal Processing* gives a new and interesting perspective to the problem and still has opportunities for improvement.

### References

- [1] Yehuda Koren and Robert M. Bell and Chris Volinsky, *Matrix Factorization Techniques for Recommender Systems*, IEEE Computer p. 30-37, 2009
- [2] Nikhil Rao and Hsiang-Fu Yu and Pradeep Ravikumar and Inderjit S. Dhillon, *Collaborative Filtering with Graph Information: Consistency and Scalable Methods*, 2015
- [3] Vassilis Kalofolias and Xavier Bresson and Michael M. Bronstein and Pierre Vandergheynst *Matrix Completion on Graphs*, 2014
- [4] Vatsal Shah and Nikhil Rao and Weicong Ding *Matrix Factorization with Side and Higher Order Information*, 2017
- [5] Tinghui Zhou and Hanhuai Shan and Arindam Banerjee and Guillermo Sapiro *Kernelized Probabilistic Matrix Factorization: Exploiting Graphs and Side Information*, 2012











# Spotivibes: revibe your playlists

Hiba Abderrazik and Sterre Lutz, Students Computer Science

**A lot of us have certain predefined expectations when it comes to what we think our bachelors experience will be like, especially when starting your studies in Computer Science. Maybe you are hoping to become a master coder and design cool software, or maybe you do not have any expectations at all. I was definitely leaning more towards the theoretical and research side of things, which is why I was kind of disappointed at all the software development projects we were doing, where the main focus was mostly on the final code. I thought that the second-year software project would be no different, but it was. Fast forward six months, I am still involved with this project and I am excited to tell you a story about how this project turned out to be way more than our team could have expected.**

As a part of the second year CSE curriculum, we took part in a 10 week software engineering project. As a matter of fact, this is the first project in our curriculum that is designed and implemented for an actual client, which in this case is a TU Delft professor. The client's problem is related to their research, and is asking us to develop a software to help solve their issues.

In our case, our clients were Cynthia Liem and Sandy Manolios. The problem they presented us with was regarding music recommendation, which we had not yet worked with at that point. Our goal was to capture a user's personal reaction to music. In order to use algorithms to organize music on a larger scale, we first need to know how we should organize it in the first place. During this process we would like to consider how a user perceives and experiences their music collection. Traditionally this would be done with tagging, but verbally tagging music can be challenging and tiring on the users part, and words might not even suffice to capture these complex associations. Another issue that arises is how to keep our user engaged. Maybe they'll tag some music for us once, but ideally we would like them to do this more often in order to build a better dataset.

This is why we came up with Spotivibes, a color-based music tagging system. Spotivibes allows you to connect your Spotify library and tag a small set of your music with colors based on what colors you associate with the songs. Based on this initial tagging it predicts colors for the full library, giving the option to generate playlists that fit a certain "vibe", as well as recommends new music you might enjoy. We see that Spotify users are interested in music recommendation all the time, so by providing them with a high-quality service for finding new music as well as organizing their current library, we give them incentive to keep using the service and therefore keep generating data we can learn from. Another option is to get insight into the color tagging behavior through some basic statistics. Again, we see this being successful, look at the Spotify annual wrap-up for example, and letting your users in on what you are actually doing with their data is not often done in research. Doing so adds an extra layer of engagement with your user that can be beneficial in the long run.

After 10 weeks of meeting everyday and slaving away at this music organization and recommender system, the supervisors were pretty satisfied with our work. Cynthia and Sandy suggested writing a paper about our research and project to send into some conference. Wrapped up in other work and exams,

and without thinking about it for too long, we agreed. It did not seem like a conference would accept a second year bachelor student software project anyway. You can probably guess what happened next: we got accepted. We still did not think much of it, it did not seem like that big of a deal. The initial idea was for Cynthia and Sandy to present the paper, since they were going to be at the conference anyway, but it turned out that the conference was taking place in Copenhagen and one of our group members was going to be doing a Minor Abroad right there in Copenhagen. "That means I can do the presentation!", Hiba said, without realizing what she was getting herself into. Let me tell you a bit more about RecSys 2019: it was held in the Scandic hotel in one of the fanciest neighborhoods of Copenhagen and more than 900 people attended this conference, with over 70% being from industry. This means that there were people from companies like Google, Netflix, Twitter, Hulu, Amazon and SPOTIFY. All of a sudden the stakes were that much higher for us. Our presentation was Thursday afternoon, but there was a welcome reception for the conference on Monday. Ready for an evening of socializing, networking and free food, I decided to join after class. As soon as I walked in my jaw just dropped, all of a sudden I was interacting with amazing people working at huge corporations, getting involved in interesting discussions and presenting myself and the project to whoever wanted to listen. This throw into the deep end of the career pool was intimidating, but most of all it was an extremely valuable and educational experience.



On the day of the presentation our project gets 6 minutes, meaning I have to pitch this whole project in 6 minutes without time for questions. The amount of engagement we got from the audience was amazing, people came up during the break for a chat and to see a live demo, Sandy was keeping up a mailing list for everyone interested in the project and I was shocked at all the interesting and positive feedback. We did not make this project with something like this in mind, so to see people from different career paths be so interested in the whole idea behind it was amazing.

I was not looking forward to another group software development project, yet by doing our research and thinking out of the box we were able to turn this project into something way more, something that got to be published as a paper and presented at a massive conference. The main takeaway from this story is that you should not shy away from taking risks and applying your creativity during your bachelors. It might be easy to follow the path laid out for you, but there are way less boundaries than you might think, which is the beauty of being at university.



# Mathematics



# On one dimensional wave equations and the formula of d'Alembert

Wim T. van Horssen, Mathematical Physics Departement

In this note it will be shown how characteristic coordinates, or equivalently how the well-known formula of d'Alembert, can be used to solve initial-boundary value problems for wave equations on semi-infinite intervals or on fixed, bounded intervals involving non-classical and nonlinear boundary conditions. For students in mathematics it will be immediately clear how effectively some of the methods as treated in the bachelor course on partial differential equations and in the master course on nonlinear differential equations and dynamical systems, can be extended and be used to solve research problems in the engineering sciences.

## Introduction and overview

The study of a one-dimensional wave equation such as

$$u_{tt} - u_{xx} = 0, \quad t > 0, -\infty < x < \infty \quad (1)$$

goes back to the middle of the 18th century when d'Alembert in [1] solved an initial value problem for Eq. (1) on an infinite interval (that is, on  $-\infty < x < \infty$ ) by using characteristic coordinates. In Eq. (1)  $u = u(x, t)$  is a displacement (usually a lateral displacement of a string),  $x$  is a space coordinate, and  $t$  is time. When the initial displacement and the initial velocity are given by  $u(x, 0) = f(x)$  and  $u_t(x, 0) = g(x)$ , respectively, one obtains as solution the well-known formula of d'Alembert

$$u(x, t) = \frac{1}{2}f(x+t) + \frac{1}{2}f(x-t) + \frac{1}{2} \int_{x-t}^{x+t} g(s)ds. \quad (2)$$

On a semi-infinite interval (that is, for instance on  $x > 0$ ) this formula (2) can also be used to solve an initial value problem for a wave equation. For a Dirichlet type of boundary condition at  $x = 0$ , or for a Neumann type of boundary condition at  $x = 0$ , it is also well-known that the functions in the classical formula of d'Alembert should be extended as odd, or as even functions in  $x$ , respectively. How the functions should be extended for a Robin type of boundary condition (with constant coefficients) at  $x = 0$ , is less well-known, but it was already discovered at the end of the 19th century by Bryan in [2]. Recently, in [3] and [4], the extension procedures on semi-infinite intervals for problems with a mass-spring-damper boundary condition at  $x = 0$ , were presented for a string equation and for an axially moving string equation, respectively.

On a bounded interval (that is for instance on  $0 < x < L < \infty$ ) the classical formula of d'Alembert can also be used to solve an initial value problem for a wave equation. In the literature only the cases where one has Dirichlet and/or Neumann boundary conditions, are solved by using the formula of d'Alembert, and leads to odd and/or even periodic extensions of the functions in the formula of d'Alembert. For other boundary conditions the formula of d'Alembert is not used, most likely, because it is not (well) known how to extend the functions in the formula of d'Alembert for other boundary conditions than those of Dirichlet type or of Neumann type. Usually

the method of separation of variables, or the (equivalent) Laplace transform method is used to solve initial value problem for a wave equation on a bounded interval for various types of boundary conditions with constant coefficients. However, when a Robin boundary condition with a time-dependent coefficient is involved in the problem, then the aforementioned methods are not applicable. In [5] it has been shown how characteristic coordinates or equivalently, how the classical formula of d'Alembert can be used to solve an initial value problem for a wave equation on a bounded, fixed interval with at one endpoint a Dirichlet type of boundary condition, and at the other end a Robin type of boundary condition with a time-dependent coefficient. The Robin boundary condition with a time-dependent coefficient is an interesting one to study from the applicational (and from the mathematical) point of view. When one considers the transversal vibrations of a string which at one end is attached to a spring for which the stiffness properties change in time (due to fatigue, temperature change, and so on), then a Robin type of boundary condition is obtained with a time-varying coefficient. But also in the study of longitudinal vibrations of axially moving strings with timevarying lengths (as simple models for vibrations of elevator or mining cables), one obtains, after some transformations as a first order approximation of the problem, a wave equation for which at one end a Robin type of boundary condition with a time-varying coefficient has to be satisfied.

In the next section an example will be treated to show the applicability of the formula of d'Alembert. For more examples the reader is referred to our recent publications [3, 4, 5].

## Example

As example the vibrations of a semi-infinite string (that is, equation (1) with  $x > 0$ ) will be studied with a spring attached at  $x = 0$ . It will be assumed that the spring stiffness is time-varying and given by  $k(t) > 0$  (see also Figure 1).

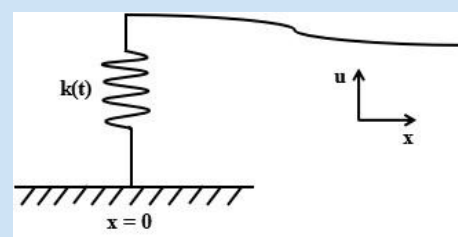


Figure 1: The transverse vibrating string with a time-varying spring-stiffness support at  $x = 0$ .

The initial-boundary value problem for this string is given by (in dimensionless form):

$$u_{tt} - u_{xx} = 0, \quad t > 0, x > 0, \quad (3)$$

$$u(x, 0) = f(x), \quad u_t(x, 0) = g(x), \quad x > 0, \quad (4)$$

$$u_x(0, t) = k(t)u(0, t), \quad t \geq 0. \quad (5)$$





Obviously, the formula of d'Alembert as given by (2) satisfies the partial differential equation (3), and the initial conditions (4). It should be observed that for negative arguments  $f(x)$  and  $g(x)$  are not (yet) defined. So, for these negative arguments the formula of d'Alembert (3) still has some "freedom" to satisfy the boundary condition (5). By substituting (2) into (5) we obtain

$$\begin{aligned} & \frac{1}{2}f'(-t) + \frac{1}{2}f'(t) + \frac{1}{2}g(t) - \frac{1}{2}g(-t) \\ &= k(t) \left( \frac{1}{2}f(-t) + \frac{1}{2}f(t) + \frac{1}{2} \int_{-t}^t g(s)ds \right), \end{aligned}$$

or equivalently,

$$\begin{aligned} & f'(-t) - g(-t) - k(t) \left( f(-t) + \int_{-t}^0 g(s)ds \right) \\ &= -f'(t) - g(t) + k(t) \left( f(t) + \int_0^t g(s)ds \right). \end{aligned} \quad (6)$$

Obviously, the left-hand side of (6) contains the undefined extensions of the functions  $f$  and  $g$  for negative arguments, and the right-hand side of (6) contains known functions. By putting

$$y(t) = f(-t) + \int_{-t}^0 g(s)ds \quad (7)$$

(implying  $\frac{dy}{dt} = -f'(-t) + g(t)$ ) it follows that (6) can be rewritten in

$$\frac{dy(t)}{dt} + k(t)y(t) = h(t),$$

where  $y(t)$  is an unknown function, and where  $k(t)$  and  $h(t)$  (given by minus the left-hand side of (6)) are known functions. This first order ordinary differential equation for  $y(t)$  can be readily be solved (with  $y(0) = f(0)$  from (7)), yielding

$$y(t) = f(0) \exp \left( - \int_0^t k(s)ds \right) + \int_0^t h(s) \exp \left( - \int_s^t k(\tau)d\tau \right) ds. \quad (8)$$

The solution  $u(x, t)$  of the initial-boundary value problem (3)-(5) is now given by (2) for  $x - t > 0$ , and for  $x - t < 0$  by

$$u(x, t) = \frac{1}{2}y(t - x) + \frac{1}{2}f(x + t) + \frac{1}{2} \int_0^{x+t} g(s)ds,$$

where  $y(t - x)$  is given by (8).

## Conclusion and future work

In this note it has been shown that the formula of d'Alembert can be applied to a much larger class of problems than is generally assumed. This also implies that a larger class of weakly nonlinear problems for wave equations can be studied by means of characteristic coordinates (see also recent work in [6, 7]). Currently a bachelor student, a master student, and a PhD student are working also on these weakly nonlinear problems for wave equations. For instance, the PhD student studies a moving boundary problem or Stefan problem for the motion of a string vibrating against an obstacle. This problem may serve as model for the transverse vibrations of strings in musical instruments like the sitar or the veena (see also [8], and Figure 2).

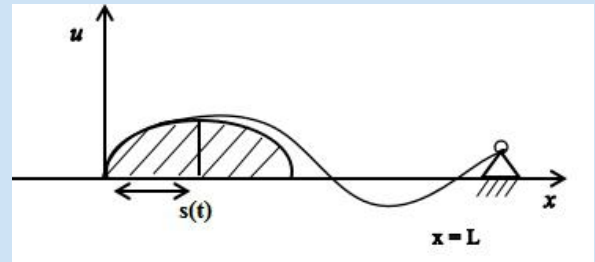



Figure 2: String vibrations against an obstacle and a moving contact point at  $x = s(t)$ .

Another example of a recently studied, moving boundary value problem for a wave equation is the problem describing the ice-induced vibration of upstanding, water-surrounded, and bottom founded offshore structures (see [9]). For all of the examples as mentioned in this note, the old formula of d'Alembert plays an important role in the analysis of the problems. 

## References

- [1] J. d'Alembert, Recherches sur la courbe que forme une corde tendue mise en vibrations (Researches on the curve that a tense cord forms when set into vibration), Hist. l'Académie R. Des Sci. Belles Lettres. 3 (1747) 214-249.
- [2] G.H. Bryan, Note on a problem in the linear conduction of heat, in: Proc. Camb. Phil. Soc. (1891) 246-248.
- [3] T. Akkaya, W.T. van Horssen, Reflection and damping properties for semi-infinite string equation with non-classical boundary conditions. Journal of Sound and Vibration, Vol. 336, pp. 179-190, 2015.
- [4] N.V. Gaiko, W.T. van Horssen, One wave reflections and energetics for a semi-infinite traveling string with a nonclassical boundary support. Journal of Sound and Vibration, Vol. 370, pp. 336-350, 2016.
- [5] W.T. van Horssen, Y. Wang, G. Cao, On solving wave equations on fixed bounded intervals involving Robin boundary conditions with time-dependent coefficients, Journal of Sound and Vibration, Vol. 424, pp. 263-271, 2018.
- [6] R.A. Malookani, W.T. van Horssen, On the asymptotic approximation of the solution of an equation for a non-constant axially moving string. Journal of Sound and Vibrations, Vol. 367, pp. 203-218, 2016.
- [7] R.A. Malookani, W.T. van Horssen, On parametric stability of a nonconstant axially moving string near resonances. Journal of Vibration and Acoustics, Vol. 139 (1), 011005 (12 pages), 2017.
- [8] A.K. Mandal, P. Wahi, Natural frequencies, modeshapes and modal interactions for strings vibrating against an obstacle: Relevance to Sitar and Veena. Journal of Sound and Vibration, Vol. 338, pp. 42-59, 2017.
- [9] A.K. Abramian, S.A. Vakulenko, W.T. van Horssen, On a simple oscillator problem describing ice induced vibrations of an offshore structure. Nonlinear Dynamics, 98, pp. 151-166, 2019.

# Freshmen elective courses

Isa van der Bent, Janne Heslenfeld, Annerieke Ohm, Second year AM Students

**In the third period of the first year of the Bachelor Applied Mathematics, every student has to choose an elective course: a physics course, an electrical engineering course or a computer science course. This article presents the experience of students who followed these courses, to help you make the decision.**

## Algorithms and Data structures – Annerieke

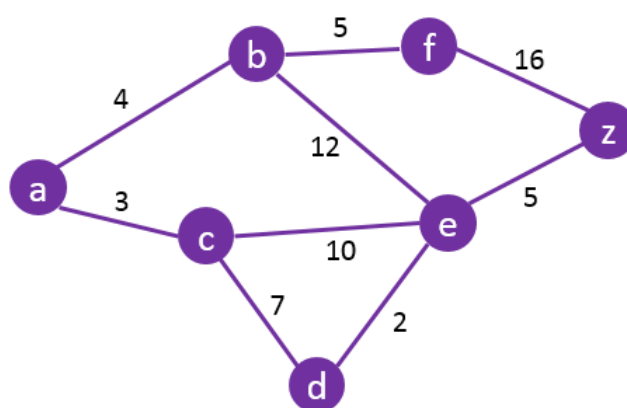
I found the choice of an elective last year quite easy. I really enjoyed the course “Introduction to Programming” and really wanted to further improve my programming skills. Besides, physics was never one of my favorite subjects and since two of the three electives were physics-related, I chose the Bachelor Computer Science course “Algorithms and Data Structures” or ADS for short.

I really liked the course. This was mainly due to the contents of the course, we learned a bit about how Python actually ‘works’, so how data is saved and how it is accessed again when it’s needed. We also learned how to judge which one of two implementations of the same problem is faster and with that how to implement certain built-in Python functions in a more efficient way.

We also learned about several useful algorithms, for example Dijkstra’s algorithm. This algorithm gives an efficient way of finding the shortest path from a point A to a point B. This is very useful and has a lot of real-life applications. When you want to go home to your parents in the weekend and you look at the planner to see which trains you should take, this planner probably uses Dijkstra’s algorithm, or a similar one, to quickly calculate the fastest way to get you home. Or when you want to visit your grandma who lives on the other side of the Netherlands and you type her address into your navigation system, this system uses Dijkstra to calculate the best route to drive to your grandma as quickly as possible. Besides learning how to implement this, we also learned how it really worked, because we also had to be able to do it by hand. We received a small problem and needed to find the shortest path from a point A to a point B by hand.

So, the contents of the course were great, but I also really liked the way it was given. Throughout the lectures, there would be some online questions we could answer, to see whether everyone was still following. Halfway the lecture there would usually be an “intermezzo” talking about the applications of the subject we were talking about. Besides lectures we also had two hours of tutorial and four hours of lab session. During the tutorials we would have several small problems, both on paper and on the computer. We would then get a certain amount of time to do the problem and after that we would discuss it to see how we did and to be able to see a good way of tackling these problems. During the lab sessions we had time to work on the feedback assignments. These were more complicated versions of the problems we did in the tutorials.

I do not regret my choice of elective. The course was a lot of fun and my programming skills have definitely improved a lot. I also liked how it was really something completely different from my other courses



## Mechanics and Relativity - Isa

Hi everyone! I’m Isa and I am currently a second year mathematics student. I chose to do the physics course, which is called Mechanics and Relativity and I have been asked to write about my experience!

Each week, there are two lectures and two exercise classes. As the name of the course already kind of spoils, the first part of the course, up to the midterms, is about classical mechanics. After the midterms, the course switches to relativity. The final exam is about both topics.

Let’s first talk about the lectures. The course is given by dr. T. Idema, a biophysicist and a researcher and teacher at the TU. He is an enthusiastic lecturer who interacts a lot with his students. During every lecture he used Feedbackfruits to ask us questions, of which he explained the answer after we had tried to figure out the answer.

During a lot of the lectures on mechanics, there was some sort of experiment performed to demonstrate the working of some concepts. This was really helpful (for me at least), because I immediately got a better understanding of the quite abstract concept that is behind it.

The instructions were given by Drs. E. Van Elderen, who was helped by two TA’s in my year. Every instruction, a set of around ten exercises was handed out, based on the topics discussed during the last lecture. The first few exercises were very doable and they became progressively more difficult



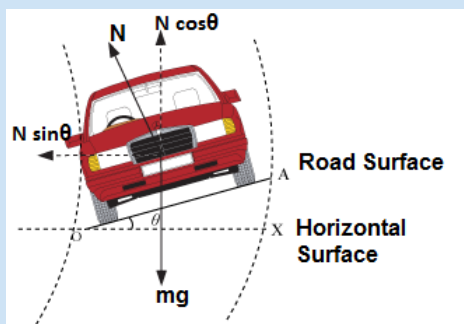


until you arrived at the last exercise of the set: the challenge. Because our group consisted of only 20-25 students and there were three teachers, there was lots of room to ask all our questions.

The first part of the course is on classical mechanics. You start with forces, Newton's laws of motion and equations of motion. Then the concepts of energy and momentum are introduced. This basis is used to talk about rotational motion and oscillations.

Then after the midterm, you start on special relativity, immediately using Einstein's famous postulates (axioms) to establish a basis. After that, you learn about Lorentz transformations and spacetime diagrams.

For me, the course was quite hard. Combining that with the fact that I'm normally not that into physics, I was surprised to find out that I enjoyed the course, especially the part on special relativity. I think that that's partly due to the fact that I thought the topic was interesting and partly due to the enthusiasm and patience of the teachers and assistants. It was nice to have a more practical course, with a very clear application in real life, between all those very abstract subjects of the first year.



## Electricity and Magnetism - Janne Heslenfeld

I am a second year Applied Mathematics student and last year I chose Electricity and Magnetism as my elective course. The main reason I chose this course is because of the interest in physics in high school. During my high school I really enjoyed physics as well as mathematics, especially the courses about electricity. So this elective course was the perfect way to learn more about the interesting topics of physics in high school.


The start of the course was pretty hard, since it was an Electrical Engineering course instead of a mathematical one. The way in which the lectures were given, was pretty different from what I was used to in my own study. Therefore I had a bad start and did not quite ace my first test (I got a 5...).

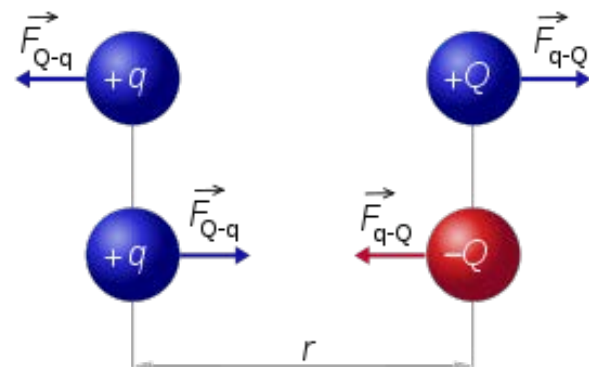
Luckily there was the rule that if you did not do good on your first exam, your second exam counts for 100%. This gave me the motivation to ace my second test! After a while I got used to the way of teaching and therefore the course became more clear for me. That is why I scored an 8.0 for my end-term and completed the course with an eight! So if you do not understand it in the beginning, do not panic. This course is easy to pass once you figure out the way of teaching.

About the course, we learned about the electricity and magnetism of different types of physical figures, like a sphere or a cone. We also discussed the influences of many external factors on these figures and how they relate to each other.

I was surprised to see that the course focused on the mathematical side of the subject instead of the physical approach. I had to solve a lot of integrals even though it was an Electrical Engineering course. Of course there still was a bit of physics involved, such as some famous laws.

The first one we got treated was the law of Coulomb, which is well known in the physical department. This law focused on the force between two point charges. These point charges represent two mass bodies with a charge in each of them. It is a very important law, because do you know that the world exists mainly because of the force of attraction and repulsion between charges? In the course we looked not only at the definition of the law, but also at the mathematical approach of the law, which I found very interesting.

To conclude, this course was interesting for everyone that does not only have interests in mathematics but as also in physics. We discussed the physical subjects in a mathematical way, which gives you a brighter view of how you can apply the mathematics we learn in the regular courses. However this course is not treated like any other regular courses you follow, so be aware! It may get tricky in the first half. 



$$|\vec{F}_{Q-q}| = |\vec{F}_{q-Q}| = k \frac{|q \times Q|}{r^2}$$



# Survey sampling at Statistics Netherlands

Ruth Koole, Master of Science

**In a society where the amount of information is growing explosively, free access to reliable and integral data is crucial. There is an ever-growing demand for statistical information about the economic, social, political and cultural shape of countries. As the national statistical office, Statistics Netherlands (CBS) provides statistical information and data to support the public debate and policy development [1]. Sometimes, this information can be retrieved from existing sources, from for example administrative records, but quite often there is a lack of such sources. A survey is then a powerful instrument to collect new statistical information.**

Many surveys are carried out by Statistics Netherlands to obtain information about the Dutch population. In order to do this, a sample of inhabitants is selected from all Dutch inhabitants. The inhabitants that are selected in this sample receive a letter with the request to fill in a questionnaire. The data that is collected from the inhabitants in the sample, is then used to estimate characteristics about the whole Dutch population.

Statistics Netherlands aims to spread their surveys equally among the Dutch inhabitants, such that each inhabitant is selected in a sample of Statistics Netherlands approximately as often as the others. To ensure this, inhabitants have an equal probability to be selected in a sample.

Furthermore, Statistics Netherlands tries to keep the response burden on the Dutch households low. It can sometimes occur that two or more inhabitants who live on the same address are approached in a short period of time (or even at the same time). If this occurs, it is assumed that those inhabitants experience this as response burden. This is not desirable and it is expected that this leads to non-response.

To prevent this from happening, Statistics Netherlands applies a so-called screening procedure to their samples, which makes some inhabitants in the sample not eligible for participating in the survey. Inhabitants that are not eligible after screening do not receive a letter with the request to participate in the survey. This screening procedure for example ensures that if an inhabitant is selected in the sample, any other inhabitant who lives on the same address cannot be selected in a sample of Statistics Netherlands in the next twelve months.

A consequence of applying the screening procedure is that not every inhabitant has the same probability to become non-eligible after screening. For example, an inhabitant who lives on his/her own on his/her address, will never become not eligible from the sample by that reason, whereas an inhabitant who lives with many others on his/her address has a higher probability to become non-eligible after screening. Consequently, not every inhabitant has the same probability to be selected in the sample after screening.

Thus far, it is assumed that the effects of the screening procedure are negligible. In other words, despite applying the screening procedure, it is assumed that if inhabitants have equal probabilities to be selected in the sample, inhabitants also have an equal probability to be selected in the sample after

screening. Now that sample sizes are increasing, the question arises whether it is still fair to assume that the effects of the screening procedure are negligible.

## Sampling design

An important part of survey sampling is the decision for the sampling design that is used. The sampling design is a procedure that is used to select a sample  $s$  from a finite population  $U = \{1, \dots, N\}$ . To ensure that the inhabitants in the sample are spread proportionally among the different municipalities, a two-stage sampling design is used. In practice this means that first municipalities are selected with probabilities proportional to their population size, and subsequently inhabitants are selected from the selected municipalities, such that each inhabitant has the same probability to be selected in the sample.

Another reason to use this sampling design is that costs can be reduced by the introduction of the cluster size  $m$ . The cluster size is the minimum number of inhabitants to select in a municipality. In the past, data collection was usually done by face-to-face interviewing. The introduction of the cluster size means that the interviewer could immediately visit several inhabitants in the same municipality and thereby travel costs could be reduced.

I will now explain this two-stage sampling design by using an example.

**Example 1.** Suppose a population of size  $N = 10$  contains 3 municipalities  $U_1, U_2, U_3$  with sizes  $N_1 = 6$ ,  $N_2 = 3$  and  $N_3 = 1$ . Let the cluster size be  $m = 2$  and the sample size  $n = 4$ . Define the step length  $F$  by  $F = N \frac{m}{n} = 10 \cdot \frac{2}{4} = 5$ . This means that the line segment representing the population is split into equal parts of size  $F$ . In Figure 1 this is illustrated graphically.

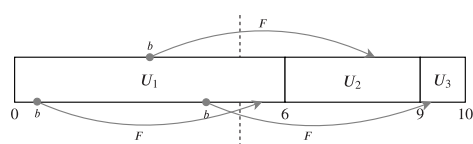


Figure 1: Graphical representation of the example, with a population of size 10 containing 3 municipalities.

Next, we draw a random value  $b \in (0, F]$ , which is known as the random start. The municipalities that correspond to the values  $b, b + F, b + 2F, \dots$  are then selected in the sample of municipalities. Note that municipality  $U_1$  has a population size that is larger than the step length. Consequently, municipality  $U_1$  is selected in the sample for all possible values of  $b$ . We then say that municipality  $U_1$  is a self-selecting municipality. Depending on the value of the random start,  $U_2$  or  $U_3$  can be selected in the sample of municipalities. In Figure 1 three different values for the random start are illustrated.

After the municipalities are selected, inhabitants from those municipalities are selected using simple random sampling without replacement [2].





## The screening procedure

The sample that is selected by the two-stage sampling design is not the sample that is used for data collection. The sample that was selected by the sampling design first undergoes a screening procedure, which eliminates some elements from the sample. This is mainly done to make sure the surveys of Statistics Netherlands are equally spread among the Dutch households and to ensure that inhabitants who cannot or presumably will not participate in the survey do not receive a request.

The inhabitants that are removed from the sample due to the screening, can be grouped into three categories:

- **Screening on the occurrence of an address:** If the address of an inhabitant already occurs in one of the samples in the past twelve months, the inhabitant is removed from the screening procedure.
- **Screening on confidential information:** In the Netherlands, inhabitants can request their municipality to not share their data in the Personal Records Database<sup>1</sup>. If an inhabitant has declared this, he/she is removed from the sample during the screening procedure and hence he/she can never receive a questionnaire from Statistics Netherlands.
- **Screening on other reasons:** This category is negligible and for example removes inhabitants that have passed away or emigrated recently.

If we assume that only screening on the occurrence of an address is applied<sup>2</sup>, we can derive an approximation of the conditional probability that an inhabitant is selected in the sample after screening  $S^*$ , given that it was selected in the sample before screening  $S$ . This probability is dependent on the number of inhabitants that lives on the address of inhabitant  $k$  (including inhabitant  $k$ ), which we denote by  $a_k$ . We then find that the conditional probability equals [2]:

$$\mathbb{P}(k \in S^* \mid k \in S) = \sum_{i=0}^{a_k-1} \frac{1}{i+1} \binom{a_k-1}{i} \binom{N-a_k}{n-i-1} \frac{1}{\binom{N-1}{n-1}}. \quad (1)$$

The conditional probability is computed for different values of the sampling fraction  $f$  - which is defined as the sample size  $n$  divided by the population size  $N$  - and for different values of the number of people that live on the address of inhabitant  $k$ . This is plotted in Figure 2.

From Figure 2 we can conclude that the conditional probability is not equal for all inhabitants and that the effects of the screening procedure become larger as the sampling fraction increases. Hence we can conclude that one should be cautious with assuming that inhabitants have an equal probability to be eligible after screening.

## Statistical testing

To identify the effects of the screening procedures on samples that have recently been selected and screened, the distribution of auxiliary variables in the population and in the sample after screening are compared. We say that a sample is *representative* with respect to a variable if its relative distribution in the sample is equal to its relative distribution in the population [3].

Suppose we observe a categorical variable with  $K$  categories, and let the number of inhabitants per category in the population  $U$  be denoted by  $c_1, \dots, c_K$ , such that  $c_1 + \dots + c_K = N$ . Suppose we select a sample of size  $n$  from the population  $U$  with equal probabilities. Let  $(P_1, \dots, P_K)$  denote the vector of the random number of inhabitants in each category in the sample. Then we say that the vector is distributed as the *Multivariate hyper-geometric distribution*.

$$(P_1, \dots, P_K) \sim \text{Mult. Hypgeom.}(n, c_1, \dots, c_K) \quad (2)$$

<sup>1</sup>In Dutch better known as Basisregistratie Personen (BRP).

<sup>2</sup>We also make more simplifying assumptions, see [2].

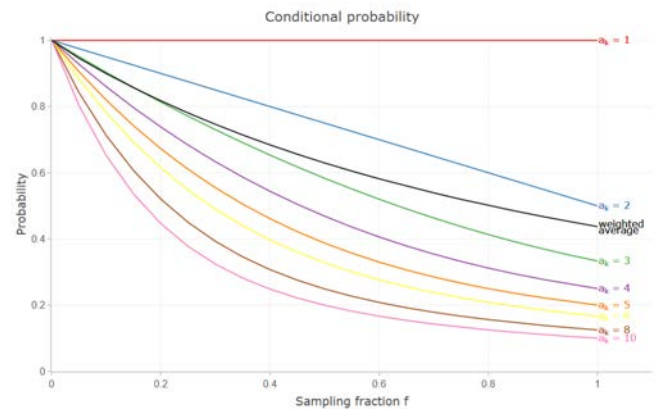


Figure 2: Plot of the conditional probability of equation... as a function of the sampling fraction  $f$  and the number of people on an address  $a_k$ .

If the screening procedure is negligible, the sample after screening is representative for the population with respect to relevant auxiliary variables. Let  $n^*$  denote the sample size of the sample after screening and  $(M_1^*, \dots, M_K^*)$  the vector of the random number of inhabitants in each category in the sample after screening. Then we can define the null-hypothesis as

$$H_0 : (M_1^*, \dots, M_K^*) \sim \text{Mult. Hypgeom.}(n^*, c_1, \dots, c_K). \quad (3)$$

By choosing an appropriate test-statistic, we can use a parametric bootstrap approach to find an approximate  $p$ -value for testing the hypothesis, see [2]. By applying this test to many samples and for different auxiliary variables, I could conclude that in general inhabitants that are removed by the screening procedure cannot be considered representative for the population. For some samples, this also causes that the sample after screening is not representative for the population.

## Estimation of population characteristics

The data that is collected from the inhabitants in the sample after screening is used to find an estimate of a population characteristic. In my thesis I investigated important properties of two different estimators: the *Horvitz-Thompson estimator* and the *generalized regression estimator*. I have shown that under specific conditions, the generalized regression estimator is *consistent* and *asymptotically unbiased* [2]. However, if the screening procedure is applied, the conditions are not met and hence we cannot conclude that the generalized regression estimator is consistent and asymptotically unbiased [2].

## Conclusion

To sum up, for the reasons that are mentioned above, we can conclude that it is not fair to assume that the effects of the screening procedure are negligible. I believe that my work made useful contributions to the evaluation of the screening procedure, but many interesting directions remain to be explored. The evaluation will be continued by Statistics Netherlands.

## References

- [1] Statistics Netherlands (CBS), Organisation, <https://www.cbs.nl/en-gb/about-us/organisation>, August 2019
- [2] R.L. Koole, Survey sampling at Statistics Netherlands; the consequences of screening the sample, Master thesis, Delft University of Technology, Centraal Bureau voor de Statistiek, 2019, <http://resolver.tudelft.nl/uuid:ca9c06d8-086b-4d98-baac-00e4001719f5>
- [3] Jelte Bethlehem, Applied Survey Methods - A Statistical Perspective, John Wiley and Sons Inc., Series in survey methodology, 2009



# The Plank Problem

Frank van der Made, Applied Mathematics Student

Open mathematics problems can be hard to grasp, in particular for bachelor students. In my bachelor thesis I try to rewrite the mathematics of an article about an open problem to mathematics that has been covered in the bachelor. The chosen problem is: The Plank Problem.

## History

The Polish-American mathematician Alfred Tarski did in the early 30's of the 20th century research in what later became the plank problem. The idea is as follows. You can make planks in  $\mathbb{R}^2$  by looking at the (infrequently long) space between two parallel lines.

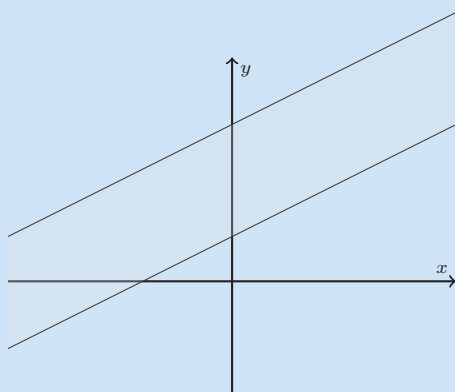


Figure 1: Plank in  $\mathbb{R}^2$

With one or more of these planks you can cover areas. Tarski limited himself to the convex areas and proposed that:

**Theorem 1 (Tarski's Plank Problem [1]).** *If a sequence of planks covers a convex area  $C \in \mathbb{R}^2$  then the total width of these planks is at least the minimal width of  $C$ .*

This makes sense intuitively. You could even try this yourself by cutting out a convex shape out of this MaCHazine and trying to cover it with a sequence of planks, for which you can use strips of paper. However Tarski couldn't prove his statement, he only knew how to prove it for the unit disk. He also suspected that it not only holds for  $\mathbb{R}^2$ , but also for higher dimensions.

It took a while before someone knew how to prove Tarski's problem. In 1951 Thøger Bang proved Tarski's problem, also the higher dimensional case [2]. However maybe the most important part of this article of Bang was when he introduced a new, stronger version of the plank problem. This version became known as "The Relative Plank Problem". In this problem the widths of the planks are measured relative to the width of the convex area in the orientation of the plank. This conjecture is still open to date.

## The Relative Plank Problem

**Conjecture 2 (The Relative Plank Problem).** *Let  $C$  be a convex area in  $\mathbb{R}^d$ . Let  $p_1, p_2, \dots$  be planks in  $\mathbb{R}^d$  with normals  $\mathbf{v}_1, \mathbf{v}_2, \dots$  such that  $C \subset \bigcup_{i=1}^{\infty} p_i$  then*

$$\sum_{i=1}^{\infty} \frac{w(p_i)}{w(C, \mathbf{v}_i)} \geq 1$$

Here  $w(p_i)$  is the width of the plank  $p_i$  and  $w(C, \mathbf{v}_i)$  is the width of  $C$  in the orientation  $\mathbf{v}$ .

As said, the idea is that the widths of the planks get scaled to the width of the area in the orientation of the plank. We will look at an example in  $\mathbb{R}^2$ :

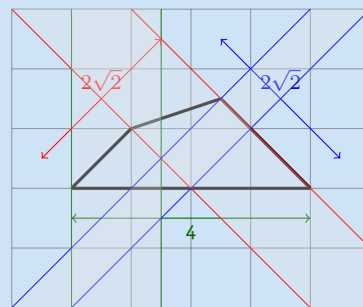


Figure 2: Convex shape covered by three planks

The numbers visible in the figure show the  $w(C, \mathbf{v}_i)$ . We see:

$$\text{Blue plank } p_1: w(p_1) = \frac{1}{2}\sqrt{2}$$

$$\text{Green plank } p_2: w(p_2) = \frac{1}{2}$$


$$\text{Red plank } p_3: w(p_3) = \sqrt{2}$$

and thus

$$\sum_{i=1}^{\infty} \frac{w(p_i)}{w(C, \mathbf{v}_i)} = \frac{\frac{1}{2}\sqrt{2}}{2\sqrt{2}} + \frac{\frac{1}{2}}{4} + \frac{\sqrt{2}}{2\sqrt{2}} = \frac{1}{4} + \frac{3}{8} + \frac{1}{2} = \frac{9}{8} \geq 1.$$

We conclude that in this particular case the conjecture holds.

## Ball's discovery

Despite that the problem remains open, there have been breakthroughs. Keith Ball proved a certain part of the problem in 1991 [3]. He proved the relative plank problem for symmetric bodies. So if the chosen convex area is convex as well, then Ball's paper provides a prove. In my bachelor project I looked at this article in detail and had the goal to make the presented proof more accessible for others by rebuilding everything from definitions and theorems we learned during the bachelor mathematics. 

## References

- [1] A. Tarski. Uwagi o stopniu równoważności wielokątów (in Polish). *Parametr* 2 1932.
- [2] T. Bang. A solution of the "Plank problem". *Proc. Am. Math. Soc.* 2 1951.
- [3] K. Ball. The plank problem for symmetric bodies. *Invent. math.* 104 1991.



# Miscellaneous





# Hyperloop

Timo van Asten, Software Engineer of Hyperloop Team

**Last fall I joined the fourth Delft Hyperloop team as a full-time software engineer. Delft Hyperloop is a D:Dreamteam that works on improving the development of a new exciting form of transportation which has the ease of a train and the speed of a plane: the Hyperloop.**

## What is Hyperloop?

Transportation has not seen a revolution in over a hundred years. After planes, trains, cars and boats, Hyperloop aims to be a fifth mode of transport. The Hyperloop is a high-speed transportation system using near-vacuum tubes in which pressurized vehicles, called pods, travel. Due to low air resistance in the tubes, the pods can travel with speeds of over 1000 km/h, while being more energy efficient, environmentally friendly, and convenient than airplanes. It aims to be a competitor of short-haul flights, for example those between Europe's major cities. Hyperloop would make it possible to travel from Amsterdam to Paris in under 30 minutes.



The idea of a such a transportation system is not a recent one. As early as 1904, the American Robert Goddard, who is credited with the creation of the world's first liquid-fueled rocket, already came up with a concept which closely resembles a Hyperloop. He even patented the concept, but this was so long ago that this patent has already expired again. However, only recently this idea seem to gain some traction within society. This October, Hardt Hyperloop, which was started by members of the first Delft Hyperloop team and now is a commercial company, received a multi-million-euro investment which it will use to "realize the European Hyperloop Center: a three kilometers Hyperloop test facility to prove Hyperloop technologies at high speeds". On December 3rd, it was announced that this facility will be built in either Groningen or Zeeland.

This traction all started in August 2013, when Elon Musk published the 'Hyperloop Alpha' paper. In this paper written with the help of his "compadres" at SpaceX and Tesla, he proposes what the Hyperloop transportation system should look like. The paper discusses the tubes, pods, propulsion system,

routes, safety aspects and economics of the Hyperloop system, to show that it is a viable new mode of transport. If you are interested, I highly encourage you to check out the paper online.



## The Competition

To accelerate the development of a functional prototype and to encourage student innovation, SpaceX organizes the Hyperloop Pod Competition. Student teams around the globe are challenged to design and build a Hyperloop pod to travel through a 1.2 km low-pressure tube built by SpaceX in California. There is only one criterion to win: maximum speed. Winning this competition is my main focus within the Delft Hyperloop team.

To participate, teams have to hand in increasingly detailed design proposals during the year. Based on these proposals SpaceX will decide which teams can participate in the Competition Week in LA. During this week the pods are thoroughly tested to validate that they meet SpaceX's rules and regulations. Examples of tests that are performed are: a vacuum test, structural tests, tests on the correct behavior of the software and test runs in the tube at atmospheric pressure. Only the teams that pass all these tests are allowed to participate in the final to compete against the other teams. The final consists of one run over the full length of the near-vacuum tube. The number of teams that even make it to this point can be counted on one hand. Therefore, it is already quite an achievement to get at that point. Delft Hyperloop has managed to do so in every competition it has participated in.

For us as a team, making it to the finals is not enough. We want to win! The current speed record is 463 km/h from our colleagues of the Technical University of Munich. We intent to go a lot faster this year.

Right after the 2019 competition last summer, Elon Musk tweeted that the 2020 competition would feature a 10 km tube with a curve. This is nearly ten times the length of the tube used in the 2019 competition. As of the time of writing, this has not been officially confirmed and we are very excited to hear of SpaceX to see if Musk will indeed be able to deliver on this.





## The Team

Our team consists of 33 students from various disciplines of which 30 joined the team as full-timers. Besides Computer Science and Mathematics, we have people from Aerospace Engineering, Applied Physics, Mechanical Engineering, Electrical Engineering, Nanobiology and Industrial Design Engineering. Unlike almost all D:Dreamteams, we are not housed in the dreamhall. Instead we are located in the old pilot plant opposite StuD. It is one of the most historical buildings of the TU Delft campus. Some of the old machinery is still present in the building, which gives it a very pleasing industrial atmosphere that fits the work we are doing very well.



The team is divided into departments, which each have their own responsibility for the research and development of the Hyperloop Pod. For our team these department are: Management, Propulsion, Powertrain, Scalability, Partnerships, Structures, Suspension, Braking and Sense and Control. The last department is the one that I am part of as a software engineer.

## Sense and Control

The Sense and Control department is responsible for most onboard electronics. In essence, we build the senses and brain of the pod. The Sense and Control system has four main tasks: sense, control, navigate and communicate. Below I will elaborate on these tasks.

### Sense

The pod is equipped with a multitude of sensors for different purposes. First of all, these sensors need to monitor the state of all subsystems of the pod, like the temperature, voltage of the batteries and the pressure of the braking system. This is to ensure that all subsystems are within operating range before starting the run. Furthermore, there are sensors which we use to determine the position and velocity of the pod while in the tube. The main method we use for this is detecting reflective tape strips that has been placed on the inside of

the tube every 30 meters. To detect these strips we use diffuse sensors, which shoot a beam of light at the wall of the tube and detect the intensity of the light that reflects back. Once we detect a strip, we know the pod has moved 30 meters and we can determine our speed.

All these sensors are connected to a custom designed circuit board, which in turn feeds this data to the onboard computer. That is where I write the software for. This computer then uses this data to perform the other three tasks of the system.

### Communication

Besides collecting the sensor data, the pod needs to be able to communicate this data to an external monitoring system (EMS) that is located outside of the tube. This is done by connecting the onboard computer to a wireless network that is similar to the one used in the rail tunnel in Delft. The sensor information is then displayed at a custom build GUI, which enables us to monitor the health of the pod in one glance.

The connection to the pod is also used to remotely control it by sending commands over the network. Since this connection is used to trigger a manual emergency brake, it is important for it to be stable. If we lose connection the pod will engage the brakes automatically for safety reasons, even if it could have continued autonomously. Since we only have one chance on a successful run in the tube, the communication has to be one of the most robust parts of the system.


### Control

The system has to control the motors, brakes and battery systems of the pod. For this, we use the same communication protocols that are used in modern cars. It is important that the software is built in such a way, that it is impossible for conflicting actions like braking and accelerating to happen at the same time. To enforce this in the software, we use a Finite State Machine or FSM for short. Examples of states we use are the idle state, accelerating state and braking state. Since the FSM ensures that the pod can only be in one state at the time and only certain state transitions are allowed, conflicting actions will never happen concurrently.

### Navigation

Lastly, we have to use all sensor data to navigate the pod. Since the tube is straight, this mainly consists of calculating the braking-point in the tube. This is done by combining our speed and the deceleration curve of the brakes. These brakes brake with more than five times the deceleration of a Formula 1 car.

## Conclusion

All in all, being part of a D:Dreamteam has so far been an exciting and, more importantly, a fun experience. Working together with team members from other studies really broadens your insight into the engineering process. At the same time, I truly believe that this is the future of transportation and being a part of that is very motivating. Let's see if I'm right about that in a few decades. 



# Computer Science Puzzle

Louise Leibbrandt, Editorial Staff MaCHazine

## Problem 1

### *The Fifteen Puzzle*

This famous puzzle consists of fifteen square tiles numbered from 1 to 15 which are placed in a 4×4 box leaving one square out of the sixteen empty. The goal is to reposition the tiles from a given starting arrangement by sliding them one at a time into the configuration in which the tiles are ordered sequentially. Is it possible to solve the puzzle for the initial configuration shown in 1?

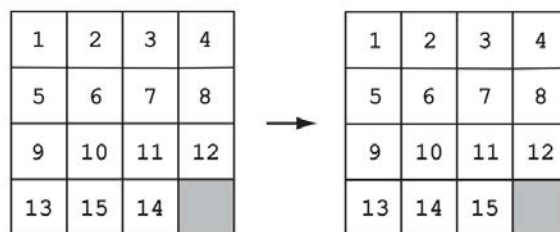



Figure 1: Initial and final positions of the Fifteen Puzzle

## Solution to last issues' computer science puzzle: Pancake Sorting

The problem can be solved in  $2n-3$  flips where  $n \geq 2$  is the number of pancakes given.

The decrease-and-conquer strategy leads to the following outline of an algorithm. Repeat the following step until the problem is solved: bring the largest pancake not yet in its final position to the top with one flip, and then take it down to its final position with one more flip. 

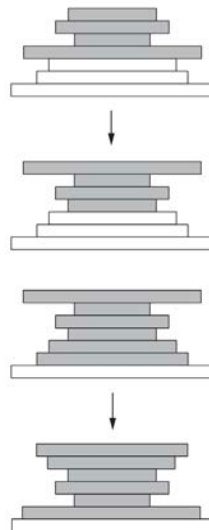


Figure 2: Two flips of the first iteration of the Pancake Sorting algorithm

## References

- [1] Anany Levitin and Maria Levitin, *ALGORITHMIC PUZZLES*, p. 68, p. 153-155, 2011





# Mathematics Puzzle

Kilian Buis, Editorial Staff MaCHazine

## Problem 1

The function  $f$  is defined on the integers and satisfies:

$$f(n) = \begin{cases} n - 3 & n \geq 1000 \\ f(f(n + 5)) & n < 1000 \end{cases}$$

Calculate  $f(84)$ .

## Problem 2

Suppose you need to guess a mystery number between 13 and 1300, created by Agent Huygens. A person before you, Christiaan, already has done some work to figure out the number.

- He asked if the number is less than 500. You do not know the agent's answer, but you have been told that the agent was lying. Christiaan, however, fell for it.
- He followed by asking if the number is a perfect square. Again, you do not know the agent's answer, but you have been told that the agent was lying once more, while Christiaan takes him at his word.
- Christiaan then asked if the number is a perfect cube. This time the agent answers truthfully, but of course you do not know the agent's answer.
- Christiaan then asked his final question: "Is the second digit of the number a one or not?". Once again, you do not know the agent's question, but Christiaan was certain that he knew the number.

This number seemed wrong, since Christiaan did not realise the agent was lying during the first two questions. Now it is your turn to guess the number, knowing all the information gained from Christiaan's questions.




Retrieved from: wikipedia

## Answer to last issues' mathematics puzzle

### Problem 1

0	1	1	0	0	1	1	0	1	0
0	1	1	0	1	0	0	1	0	1
1	0	0	1	0	1	0	1	0	1
1	0	0	1	1	0	1	0	1	0
0	1	1	0	0	1	0	1	0	1
1	0	1	1	0	0	1	0	1	0
0	1	0	1	1	0	0	1	1	0
0	0	1	0	1	1	0	1	0	1
1	0	0	1	0	1	1	0	1	0
1	1	0	0	1	0	1	0	0	1

### Problem 2

The number we were searching for was 6210001000. This number has six 0's, two 1's, one 2, zero 3's, zero 4's, zero 5's, one 6, zero 7's, zero 8's and zero 9's. 



# Science Trends: Algorithms and Genome

Akash Singh, Student Computer Science

**In this article you will find some 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.**

**This issue: Algorithms and Genome.**

**Why does studying genetics make sense?**

**Why should we turn to computer science for this?**

**Why should you care?**

Let's start off with some important terms.

Genome – the fundamental rulebook governing almost everything happening inside our bodies

Nucleotides – the alphabet in which genome is written

Mutations – errors, or typos, in the genome

Genes – meaningful paragraphs, or sections, in the genome

Imagine being born with an unknown condition which causes your intestines to be seriously inflamed. You make surgery trips to the hospital as if you're going grocery shopping on weekend and your life revolves around antibiotic pills and blood tests. No one can figure out what is wrong. Unfortunately, you've been dealt a particularly bad hand in the health department in terms of a particularly rare genetic condition which wishes to see you dead soon. I realize this is a pretty macabre start to an article which promised to be about science trends. But let us humor this hypothetical situation for a minute. Once you've sufficiently appreciated the tragedy of being in such a situation, imagine coming across a magic box which locates the mutation in your genome responsible for all this trouble. The doctors then go ahead and do a final surgery, thus fixing your genome back to a regular one, letting you lead a normal, surgery-free life.

Imagine being born with some weird genes which make your attention jump around like a ping pong on steroids. You're planning studying for exams one minute, the next minute you cannot resist the urge to go eat some donuts and the very next minute you are so enraged about your cold donut that you seriously question the point of attending university, studying for exams et cetera, when the universe is anyway going to end in a heat death and time is just an illusion. And all this while you're zoning out on an irrelevant YouTube video which has nothing to do with your exams, or donuts, or the universe. Attention Deficit Hyperactivity Disorder, or ADHD, which stems from certain funky mutations in your genes, can severely limit the ability of people to focus, control their impulses, or let go of frustration easily. Imagine being one of those people and you walk in a futuristic facility one day – they take some samples, do some analyses and in a few months, your ADHD is cured and you walk back home in peace intently listening to rustle of the wind and chirp of the birds.

These happy endings are not figments of my imagination. The first scenario I described actually happened, in 2010, when six year old Nicholas Volker's genome was sequenced to identify and treat the mutation wreaking havoc on his digestive system, a first of its kind procedure which saved the boy's life.[1] ADHD, on the other hand, is an active research field in bioinformatics today and there are signs of positive progress being made. But what is special about this? Diseases have been researched since hundreds of years now. So what are we doing differently this time? For one, the conditions described above emerge from mistakes in a person's genome. This is different from having an infection because your body is designed to fix infections. Hence, with a little help (antibiotics), it can deal with infections. The same body, however, is also designed to keep replicating your genome, faithfully. So if you have an error in your genes, your body will keep making erroneous copies of those genes as long as you live and your cells keep multiplying. Without realizing it, the body is preserving these errors. This is why situations emerging from mutations in the genome are so difficult to deal with. Imagine having an app which you really, really wish to use. So much that your life depends on it. Unfortunately, the app has bugs in its code which causes it to crash and not save files and show you cat videos randomly. What do you do? You install a better version of the app, maybe even purchase the premium one. What do you do if that app is your body and the bug ridden code is your genome? For a long time the answer was to accept it as the reality of life and try really hard to move on. Bioinformatics is trying to make the other solution feasible: study and fix the code of this super important app.

Bioinformatics, in simple terms, is studying the genome using algorithms. Obvious question: why? Simple answer: because the genome is huge. Remember nucleotides, the letters of the genetic alphabet? Nature is extremely verbose. It had billions of years to write the genetic codes of all living things so it wrote tons and tons of code. This code dictates the color of our eyes, response-time during video game nights, and how easily we get pissed off. In other words, the genetic code is fundamental to the situation of living things. So much that I am not kidding when I say all of life with its richness, diversity, beauty and whatnot is just genes trying single-mindedly to do copy-paste. Continuously. Till the end of time (or that species). So, it is not crazy to try and study it, make sense of it, and maybe, just maybe, fix errors in it. The only problem is, and I cannot stress this enough, the genome is huge. If someone would start typing your genetic sequence on A4 sheets and make a stack of them, like this:

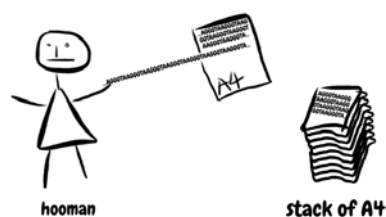


Figure 1: Typing the genome down on an A4 sheets





Then by the time they are done typing your entire genome, the stack will look pretty high, like this:

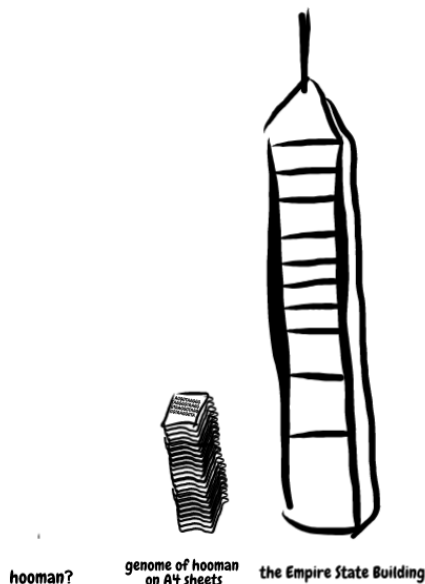


Figure 2: Stacking the entire genome printout

Maybe look at the stack again and count to ten to let this sink in.

DNA is huge. But, it has all the answers. From why are my eyes brown or why am I fat despite all the hard work to why am I skinny despite the exercise or why do I have cancer? DNA has all the answers. Problem is, it is insanely difficult to look for the answers in a sheet of A4 papers THAT high.


This is where the algorithms come in. I remember talking to a friend, who happens to care a lot about coding, and he says, "Commanding machines to do these insane calculations for you is very cool". I agree. We will see shortly why this is so cool, in this context. A lot of what goes on in our bodies is governed by genes and all of us have a huge pool of the same or very similar genes (our genome codes for approximately 20,000 distinct genes). They instruct manufacturing and functioning of thousands of different proteins as and when required and everything fits together better than a Swiss clockwork. Except when there is a problem. Genetic disorders can be as small as an error of 3 nucleotides and yet can cause a problems as severe as Cystic Fibrosis (a condition where the patient has to breathe through a pipe for the entirety of their lives with very short average life span, 40 years)[2]. We have a problem, a clue, and a stack of papers wherein lies the clue. The clue is 3 letters long and the stack is 100 meters high. A better idea than jumping right in the stack and spending the rest of eternity drinking coffee and reading cryptic A4 sheets is to take a deep breath and write some code. Commanding a computer to search for that clue in that stack will be simpler. Not only because there are A LOT of those A4 sheets to analyze but also because studying the genome is challenging - there is no rule-book of nature which might tell us what a certain sequence of nucleotides do. Unlike physical systems wherein phenomenon are governed by a finite set of laws (Newton's laws of motion, general theory of relativity et cetera), biological systems are infinitely more complex where very often a single fundamental law explaining all observations is not apparent. Sometimes,

cells produce the same gene from two sequences even though the sequences are not identical. In other cases, the nucleotide sequence representing a certain gene is not placed at a single but at multiple locations, operating like an international team of coders communicating and working over Skype calls. Therefore, we often have to rely on comparisons with experimentally observed gene behavior in other species to form hypotheses and then turn to observations, hoping to see patterns which might indicate towards the genetic regions which we need to narrow down upon. Algorithms do it much, much faster than us which is why we rely on them. Which is why coding is cool.



Figure 3: Studying the genome stack using algorithms

The horizon of bioinformatics is not restricted to just remedying the errors of genome. Once we truly map the genome and upload it on a hard drive, we can imagine about improving it, maybe even perfecting it. Remember, a great reason for why we are what we are as persons is because of our unique genetic code. Thus, a perfect genome might mean a perfect human in terms of intelligence, athleticism, even emotional intelligence. In his book Homo Deus, Yuval Noah Harari paints an expansive picture of what the future of humanity might look like. Having solved historical problems like war, famine, and poverty to a great extent, humanity might set its eyes on the ultimate fantasy of living beings – immortality. The genome is the building block of the human situation and has a huge say about our body, mind, health, mood, and life span. This means decoding the genome might decode the secret to unprecedented intelligence, perfect bodies, health and happiness, and indefinite life span. It might mean we will be manufacturing perfect human babies specifically designed to become an Einstein or Picasso. It might mean our manufactured babies might become perfect politicians (is that possible?), top-grade scientists, brilliant musicians or whatever we might imagine. These manufactured super-humans might solve the string theory, fix climate change, design benevolent AI, and revolutionize interstellar travel.

And it all begins with a laptop, and the genome – A, T, G, C. 



## References

1. <https://www.forbes.com/sites/matthewherper/2011/01/05/the-first-child-saved-by-dna-sequencing/3132822037c0>
2. <http://bioinformatics.algorithms.com/>
3. Doodles drawn on Sketchpad 5.1 - <https://sketch.io/sketchpad/>

# Historical Figure: George Boole

Daniël van Gelder, Editorial Staff MaCHazine

**While one would think that a mathematician that has a TU Delft lecture hall named after himself would have spent plenty of time sitting in one himself, this mathematician did not spend any time in a lecture hall at all! George Boole, who is famous for many important theories in logic and laid the theoretical foundations for Computer Science, was appointed professor without earning a university degree at all.**

George Boole did not come from a rich family and due to his father's serious illnesses he received little formal teaching. However, he did end up having several teaching jobs while growing up and spend a lot of time studying mathematics in his free time. While studying mathematics he wrote many papers and articles which led to him being noticed by the academic world and he was eventually appointed professor at Queen's College in Cork in 1849. In particular, his pamphlet "Mathematical Analysis of Logic" published in 1847 received admiration from, among others, Augustus De Morgan. In this pamphlet he argued that logic should be combined with mathematics instead of philosophy.

This pamphlet formed the basis of his work on what we now refer to as Boolean algebra. Boole proposed a system where an algebraic expression denotes truth values (e.g. true or false). Individual variables denote truth values and operators denote the logical relation between the variables. Boolean algebra defined basic operations: AND ( $\wedge$ ), OR ( $\vee$ ), NOT ( $\neg$ ) and secondary operations which are a composition of basic operations: implication ( $\rightarrow$ ), XOR ( $\oplus$ ), equivalence ( $\equiv$ ). Boolean algebra does not yet describe quantifiers like in First-Order Logic. However, this set of definitions already allows us to define neat logical expressions like:  $\neg(p \vee q) \rightarrow (r \wedge s)$ .

The most well-known and probably most important application of Boolean algebra is in electronic circuits and more specifically: computers. While it is technically possible for computers to work with more than two symbols for values, for pragmatic reasons they don't. Therefore computer circuits are a literal manifestation of Boolean algebra. However, Boolean algebra does not specify any rules for numeric operations like addition. Therefore, for digital circuits to also allow for arithmetic operations, the carry operation is introduced and with that the circuits can compute almost anything.

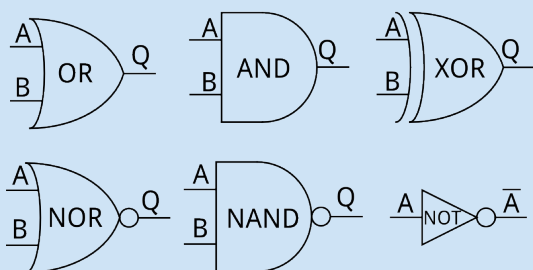


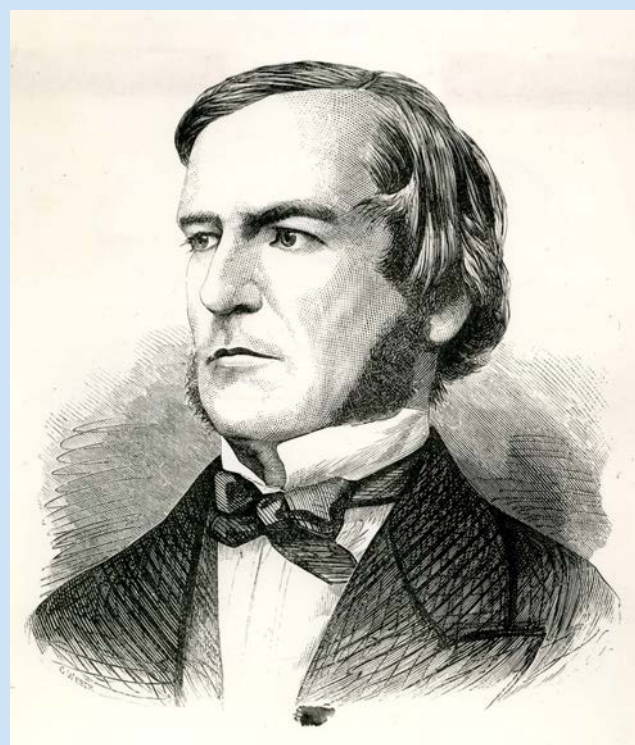
Figure: An example of digital logic gates showing some logic operations

Mathematics was not the only field in which Boole was an active intellectual. He held publicized addresses on Isaac Newton, philosophy and theology. Boole had many views on Christianity and attempted to combine his insights in mathematics with his Christian faith. For example: he compared the Christian trinity to the three dimensions of space. In addition, he frequently mentioned his firm believe in the theory of divine creation mentioning that "the course of this world is not abandoned to chance and inexorable fate".

While he was a man of science and rational thought, the way Boole spent his last days was remarkably irrational. In November 1864 Boole fell ill and developed pneumonia after walking home in heavy rain. While pneumonia at that time was a dangerous, but curable disease, his wife believed that the treatment for an illness should resemble its cause. So since Boole walked home in heavy rain, he should be covered in wet blankets since the wetness brought his disease upon him. This of course led to a worsening of the disease and George Boole died a small month later on December 8 1864 aged only 49.

## References:

- [1]: <https://www.britannica.com/biography/George-Boole>
- [2]: [https://en.wikipedia.org/wiki/George\\_Boole](https://en.wikipedia.org/wiki/George_Boole)
- [3]: [https://en.wikipedia.org/wiki/Boolean\\_algebra](https://en.wikipedia.org/wiki/Boolean_algebra)
- [4]: <https://georgeboole.com/>
- [5]: <https://learn.sparkfun.com/tutorials/digital-logic/combinational-logic>











# THE \_DISCOVERY\_ OF \_CHRISTIAAN\_ HUYGENS

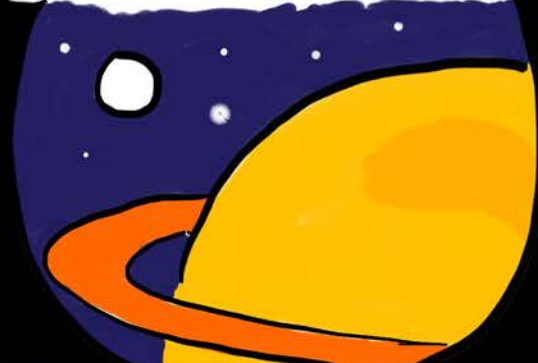
Christiaan Huygens has invented a better version of the telescope



Ah, Saturnus! It has rings!  
I told you so Galileo...



But wait, Saturnus has a moon?  
Let's see if I can zoom in there



What is that? There is life out there! What a  
Wonderful Intruiging Scientific Vagueness!



I will call this  
WISV Christiaan Huygens



That day, Christiaan  
made his best discovery





# Calendar



## Area FiftyLAN

Area FiftyLAN is the annual gaming event organized by CH. More than 200 gamers will spend the weekend having a blast playing games together, and there will be official tournaments where you can win amazing prizes.



## Company Dinner

Interested in finding out what companies are out there for Mathematics and Computer Science students? Enjoy a delicious three-course dinner for free at restaurant 'Het Vermeertje' together with employees from Magnus, ChipSoft and Ordina!



## Dies Week

On March 6th, our association will turn 63 years old. To celebrate this, the Dies committee will organise a week full of fun activities, ranging from a craft beer night to a delicious lunch!

## February

- 11 Lunch Lecture: Capgemini
- 13 Whisky Tasting
- 17 Career College: 4-Color Workshop by Brunel
- 18 Lunch Lecture: ASR
- 19 Double Degree Dinner
- 19 Algorithm
- 24 Company Dinner
- 25 Lunch Lecture: TBA
- 25 Teacher-Student Lounge
- 26 General Assembly 4
- 28+29 Area FiftyLAN

## March

- 1 Area FiftyLAN
- 3 Lunch Lecture: Witteveen+Bos
- 4 iCom Information Session
- 16-22 Business Tour
- 17 Lunch Lecture: Computer Science
- 19 MatCH Activity
- 23 Dies Opening & Reception
- 24 Dies Activity
- 25 Dies Lunch Lecture & Craft Beer Night
- 26 Dies Lunch & Activity
- 31 Lunch Lecture: Applied Mathematics



# > De kans om mezelf breed te ontwikkelen

## Dat wil ik!

Bij Technolution krijg ik veel ruimte om te groeien. Vakinhoudelijk én persoonlijk. Ik ben nu ontwikkelaar, maar ik leer veel andere vaardigheden, zoals projectleiding en trainingen geven. Wil jij jezelf ook breed ontwikkelen? Bij Technolution bepaal jij de richting van je carrière.

**Jolien**

Software designer

**[technolution.nl/jolien](https://technolution.nl/jolien)**