AMACHAZINE

Volume 23 - Issue 4 July 2019 Wiskunde Informatica Studievereniging 'Christiaan Huygens'

MEET THE

Ambassadors

FIVE YEARS OF

Network as CH Events

AN INTERVIEW WITH

Ionica Smeets

THE MATH BEHIND

The Human Power Team

CONTAINING:

CURRENT AFFAIRS | ASSOCIATION | COMPUTER SCIENCE | MATHEMATICS | MISCELLANEOUS





Board 62 of the association for Applied Mathematics and Computer Science 'Christiaan Huygens' would like to present the Potential Board 63 of 2019-2020:

Board 63

Chairman Secretary Treasurer Applied Mathematics Education Affairs Computer Science Education Affairs Public Relations Career Affairs





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Advertiser index

Witteveen+bos

Editorial

As a committee, we are always working on improving the MaCHazine. One of the ideas was to change the editorial for this issue, because we heard from some of the readers that they want to know more about the people behind this beautiful MaCHazine. Therefore, since it's the end of the year, we decided to all answer the question:

What was the most awesome thing that you did last year?

Daniël - "During the first semester of this year I went on exchange to Singapore, which was an unforgettable experience. Apart from studying at a very good university, I got to travel around Asia and meet a bunch of amazing people. Although I was very nervous about going there alone, it turned out to be very exciting to live abroad. I can definitely recommend going on exchange as part of your minor. If you want to find out more about my experiences on exchange, I wrote a small article about it in our last issue."

Eva - "I think, I mostly enjoyed my semester in Sweden. During that time, I got to see a lot of countries that I had never been to, including Russia! While I was in Sint Petersburg, I joined a limousine tour. Together with a big group of students, we got into 3 white limousines, while it was snowing like crazy, and popped a bottle of champagne at several locations. That was really a great evening."

Jeroen - "Last february, I went on a weekend trip to Sofia. Here, I had the opportunity to shoot with actual guns! I shot with a revolver, a Semi-automatic firearm and a shotgun. The shooting experts were very relaxed and easy, which made it even more scary for me. But when you eventually pull the trigger, it gives you an adrenaline rush. This is certainly something I would like to do again!"

Kilian - "What I enjoyed the most this year, were all my foreign trips. Recently I visited Barcelona and earlier this year I went on a weekend trip to Antwerp and Ghent. With the study association I had a great time in Manchester, and I went skiing in France. The last I enjoyed the most, because I had never skied before and I actually really liked it, plus I did not injure myself."

LOUISE – "It has always been a dream of mine to take my family diving in the nature preserve of Cabrera; a small island off the coast of Mallorca. However, due to its remote location, it was never possible as the dive school I dove with did not have the means of transportation to get us there. During the summer my parents made the adventurous decision of buying an old fisherman's boat making this dream finally possible. I was able to take my family and it was spectacular! We saw big barracudas, groepers and we were even able to spot a few dolphins."

Marjolein - "This year I studied in the USA for a semester. It was amazing to see so many different places and to meet so many people. Every week was fully planned with even more new things to do. Being there was an unforgettable experience."

Maxime – "I am really glad I auditioned for the X Dance Team, which is the official demonstration dance team of X (formally Sports and Culture), consisting of eight enthusiastic girls. Together with the team I performed on the "Lichtjesavond" in Delft, the Presentation Night of X and on "Festival Aangeschoten Wild" this year. These were great experiences and I love the sisterhood vibe of the team and creating choreographies together. Our next performance will be at the Info and Sports market of the OWEE, I hope to see you there!"

Tom - "This year was full of awesome things, but the thing that I enjoyed the most was making the CH Annuarium 62. The best Annuarium ever. Working on it took quite some time, but the moment it was finished and you received the book, was one of the best experiences this year. And then seeing other people reading and enjoying the book we've put so much effort in is an awesome experience."

Willemijn - "The most awesome thing I did this year was probably that I and a group of friends spent several weeks in the third quarter of this year designing and building a bar for a big party. It was fun to think of all the possibilities for themes and how we wanted things to look. Almost every day we would come together to paint or to hang up lights and the end result was amazing! After all the preparation we served drinks at this bar for 3 days and had an amazing 3 days of partying!"

Wouter - "Last summer, together with my parents and sister I went on holiday to South-Africa. In this 3 week trip we saw everything ranging from animals, museums, historical locations and everything else this beautiful country had to offer us. In a particular safari we even saw a lioness hunting at dawn from 4 meter distance! This was a thrilling holiday, especially since you don't visit South-Africa often."

















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From the Board

Yanna van der Vlugt, Treasurer

As this year is coming to an end, a slight feeling of panic is starting to

creep up on me. With every passing week I realize how little time I have

left at my good old (but right now, quite messy) desk at CH.

My desk is hidden away behind the corner of the board area of the CH room, with my screens facing away from everyone else. This is quite necessary for the position of Treasurer, since most of the time, I'm busy with the finances of CH, which are usually kept top secret. It's also a good place to focus on my bookkeeping without being constantly distracted by whatever's going on by the couches. However, it can get quite lonely- sometimes people don't even realize I'm here!

At the moment, I'm working on my financial update for the fifth (and last) General Assembly of the year. The update is based on the third-quarter report I made a few weeks ago. These reports mainly serve as a way to get a full overview of the financial situation of the association. They also include a prediction for what the result will be at the end of the year. This prediction gets more precise throughout the year, as committees finish off their work and activities come to an end. When making my first-quarter report, I still had no idea what to expect of the year, while by now almost everything is fixed.

Just like the MaCHazine, I see the finances as a sort of "diary" of CH. If we need to know which restaurant was booked for a dinner 3 years ago, or how many people were at the SjaarCie BBQ in 2012 (144, by the way), I can look it up in Exact (my bookkeeping software) within a few seconds. This diary also shows me how much we've already done this year. We've welcomed a record number of freshmen to EEMCS and had international students in our freshmen committees for the first time in the 62-year existence of CH. We've had a Symposium, LANparty, Mathematical Career Orientation Day, Hackathon, inspiring lectures, and

so many other great activities organized by our many committees, to which we owe a big thank-you. A lot to be proud of, and a lot to miss when I go back to studying next year.

But enough looking back, when there's still a lot to look forward to! Today, 40 second- and third year students embarked on an in-house day to KPMG in preparation of the iCom trip to Manchester which will be taking place next month. We're also very busy with the promotion of the On-Stage Interview, a concept inspired by College Tour which we'll be organizing for the very first time. And I'm lucky enough to be one of the 30 participants of the Study Visit, with who I'll be going to Japan and South Korea 54 days from now (yes, I have a countdown). Having gotten to know the group through the in-house days, workshops and lectures in the preliminary program, I can be sure in saying it's going to be an amazing trip.

One of the most exciting changes of this year is still in the making. Next week, together with the ETV we'll be signing the papers to officially set up a foundation for the /Pub, which will be run by students starting next September. We've spent a lot of time deciding on beer and payment system providers, drafting documents and contracts, meeting with the faculty, forming the foundation board and so much more. All this to make a more attractive, well-organized and student-friendly /Pub (with, hopefully, even cheaper beer!).

And then there's a lot of things that are only just beginning. I've just had my first meetings as QQ'er of the Business Tour committee, who will (as the name suggests) organize a trip to various companies in the Netherlands and abroad. I'm looking forward to an awesome trip in March 2020! The Gala committee has also just started off and the evening (and the day after) have already been reserved in my calendar.

Even though summer is drawing closer, the time to give up my desk is not quite here yet. I hope you've enjoyed this year as much as I have and that I'll see you at the upcoming events or maybe in a newly renovated /Pub. Happy reading!

Current Affairs





TU Delft News

Wouter Versteegh, Editorial Staff MaCHazine

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.

Vidi grants for seven leading TU Delft researchers

The Netherlands Organization for Scientific Research (NWO) has awarded a Vidi grant worth 800.000 euros to seven leading TU Delft researchers. A Vidi-grant is a favor granted to researchers who have done years of research after their promotion. They can use this money for their next five years of research. Each year researchers can apply for a Vidi-grant, this year 443 scientists gave it a go. However, only 85 researchers were picked. The University of Utrecht did the best with 10 Vidi grants.

Research financer NWO selects researchers based on the scientist's quality of research, originality of the research proposal, expected scientific impact and possible applications. The grant is a part of the so called "Veni, Vidi, and Vici grants", used for starting, experienced and very experienced researchers respectively. A few of the research proposals selected include Deep Learning for Artifical Intelligence by Jan van Gemert (EEMCS), harmony of Operator Algebras for Quantum Mechanics (Martijn Caspers, EEMCS) and Climate Adaptation Policy by Neelke Doorn (TBM).

TU Delft scientists create world's smallest autonomous racing drone Unmanned Aerial Vehicles (UAVs), better known as drones, are really popular right now. Where they were initially used in military applications, their use is expanding rapidly to commercial, scientific, recreational and other domains. One of these new applications is drone racing. Drone racing is a brand new major e-sports type where participants use their drones to race against each other. Drone racing is interesting for science since it poses new challenges for Aerospace Engineering, Artificial Intelligence and Systems and Control. You can compare this to the Formula 1, where teams try to optimize their car to achieve the best results, only this time you don't need a driver.



One of the labs in Delft that tests this is the Micro Air Vehicle Laboratory, or the MAVLab. Their aim is to make light-weight and cheap autonomous racing drones to compete against other enthusiasts. MAVLab has now created a racing drone that is the smallest autonomous racing drone in the world. It is 10 cm in diameter and weighs only 72 grams.

The main innovations are extremely efficient and robust algorithms. The new drone uses these algorithms to race a 4-gate track. It can fly laps at an average velocity of 2 meters per second, which is competitive with other larger state-of-the-art racing drones.

Besides the fun you can have with drone racing, developing these drones may be useful in other areas too. Since these drones can fly much faster, they can cover more area. This can be used for landscape imaging, rescue missions or even package delivery.

44th edition of the Ringvaart Regatta

This year the 44th edition of the Ringvaart Regatta was held. This is an annual student rowing event organized by volunteers of the Delftsche Studenten Roeivereeniging Laga. When Laga turned 100 years old in 1976, they celebrated this by organizing a 100 kilometer rowing race against the student rowing club Njord from Leiden. Soon other rowing clubs heard of this race and the Ringvaart Regatta became an annual event. Each year around 800 people compete.



The Ringvaart starts at Asopos, another rowing club from Leiden and ends at Lijm&Cultuur in Delft. The Ringvaart is one of the most well-known and intense rowing races in the world. With 100 kilometers, it is one of the largest continuous rowing races. This year 176 boats applied. These boats can be single people rowing, but also rowing teams that consist of multiple people. After they finish at Lijm&Cultuur, a well-deserved party is held with free beer for everyone!

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Amsterdam is going crazy!

Fred Vermolen, Department Numerical Analysis

In May 2019, I read about the Amsterdam plans to ban all gasoline and diesel cars in 2030. Next to this ban, the Amsterdam politicians Sharon Dijksma and Femke Halsema want to ban private fireplaces. The reason is to clean the air and to reduce the emission of CO₂.

One of the recent news items dealt with the plans of the Amsterdam politicians to ban all diesel and gasoline cars from 2030. Furthermore, the Amsterdam municipality wants to prohibit private fireplaces in the houses of people. The reason for this ban is to reach clean air in Amsterdam and its surroundings, in the framework of the 'Action Plan Clear Air'. Of course, at first glance, these measures are absolutely marvellous. It is fantastic that the government wants to attain clean air. However, one could also have some reservations against these plans since a completely non-fossil fuel based public and private transportation system would require charging points for hundreds of thousands of vehicles, only in the city of Amsterdam. I would expect that the technology of electric cars will have improved by this time. Currently the maximum distance that an electric car is able to drive (the action radius) is about 540 kilometres for the most economical cars. This distance is not too bad, although it takes hours to recharge the battery. But as I have said, I expect these charging times to decrease in the future. Nevertheless, to build the infrastructure for charging cars efficiently will take an enormous economical investment. Furthermore, the technology might be changing very rapidly, hence the current charging points might not be satisfactory. Another thing concerns the Amsterdam citizens, who will have to buy electric cars and dispose their diesel/gasoline cars. They will hardly get any money from their fossil-fuel based cars, since nobody in their nearby region will be interested in these vehicles, which will increase the difficulty to buy an electric car. The Amsterdam or even Dutch economy may suffer from these measures a lot, whereas many other countries will take a much more gradual transition to electric vehicles.

This type of measures are in the wake of preventing climate change, which is based on the hypothesis that mankind is influencing global climate. Actors like Greta Thunberg, from Sweden, are (ab)used to encourage people to reduce their ecological footprint. Of course, climate is changing. The Netherlands have lost their winters. However, climate is a dynamic physical (meteorological) quantity. This follows from its definition: Climate is the average weather over a time-span of thirty (or some people use fifty) years. The definition entails a certain, limited period. If climate would be stationary, then, one would never have incorporated a limited period in this definition. On the other hand, it looks like that the climate in The Netherlands is changing very rapidly during the most recent period. However, it is still unclear to me whether this change has been caused by mankind. I really do not know. Some people argue that 97% of all scientists support the claim that mankind is the main cause for the current climate change, whereas another group of people argues that the former group has moved aside all studies that were inconclusive in the claim whether mankind is the main

cause of global climate change (anthropogenic global warming). The natural gas CO_2 is believed to be one of the main culprits in climate change. I have seen several graphs of the (reconstructed) temperature of the planet against the (reconstructed) global CO_2 content in the air. The correlation looks amazingly close to one. However, we must bear in mind that correlation does not say anything about causation (what causes what), and furthermore, I wonder how people reconstructed these figures. Policy makers tend to believe the first group. In my own opinion, it is crucially important that mankind reduces its footprint on the planet, and that we really should strive for clean air, more forests and that we should really strive for sustainable agriculture, transportation and that we should really give nature a chance, and uphold diversity of life (animals and plants). So in this sense, I warmly welcome all policies that clean the air and return land to nature in The Netherlands. However, I do not understand why the government will allow the plans to build a big new highway system around Amsterdam and Zandvoort to facilitate the Formula-One races in Zandvoort. What about the extension of Schiphol Airport? How can I understand this in the context of reducing the CO₂ emissions? Is it the economy? Or is our government going to require that Formula-One races will be stripped of petrol-based cars? Sometimes I think that I am losing my mind.

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Well, I have bored you enough. It is time for a couple of pints. Skål! 📢

Current Affairs

















Association



Meet the Ambassadors

Jeroen Nelen, Career Affairs W.I.S.V 'Christiaan Huygens'

Since 2018, we (the study association) have a team of six Ambassadors

at the study association. In this article, we would like to explain the

concept of an Ambassador and introduce them to you.

The Concept

A few years ago, we noticed that we were in contact with some very prominent persons within the industry. These are very valuable connections that we wanted to keep for a longer period of time. Therefore, our desire was to connect these people to our association to keep and expand our network. Because of this, we started this new concept of an Ambassador. So what do they do exactly? For example: they give inspirational talks on Alumni activities, Hackathons and other events. Furthermore, they advise us on some of our problems and they use their connections to get in contact with people we could not personally reach before. We would like to introduce them now!

Bas van Staalduinen

Bas van Staalduinen is an alumnus and former Board member of the association. He finished his study Applied Mathematics in 1996 and started his career at CGI Nederland. He started as a business consultant, but was quickly promoted to project leader. For many years, he managed different projects within the domain of Justice and Safety. Now, he is a Director Consulting Services at CGI, where he



has a leading role in business development activities and is responsible for the quality of the services provided.

Peter van Laarhoven

Peter van Laarhoven is also a former Board member of the association. He finished his study Applied Mathematics at TU Delft in 1982. After his study, he started as researcher at Philips. Later, he became consultant at McKinsey. After working there for 5 years, he started as a Logistics Counsellor for KLM Cargo, while also being a full professor at the Eindhoven University of Technology. Next, he



worked as Director Strategy of TNT and as Director Corporate Development at Schiphol. New, he is active on the supervisory board of TNO, CB, CQM and Port of Moerdijk.

Rob Fastenau

Rob Fastenau studied Applied Physics at the TU Delft and started working at Philips Research afterwards. At Philips, he worked as head of a department and as Director R&D. He became a Board member of FEI company and the Executive Vice President Marketing and Technology of FEI Company. In 2011, he became dean of the EEMCS



Faculty of the TU Delft for six years, where he was responsible for six research departments. Now, he is still active at the university as e-dean, where he is responsible for the online education programs.

Ronald Prins

Ronald Prins graduated from TU Delft in 1994, in Applied Mathematics. After completing his studies he worked at the Dutch Forensic Institute on breaking security used by criminals. In 1999, Prins founded Fox-IT with fellow TU Delft alumnus Menno van der Marel. The company would eventually be in the very first rank of internet security providers. Now, he is



an Associate Member at the Dutch Safety Board and member of the TIB, an independent organization that supervises whether the AIVD uses their power legitimately.

Wouter Stoutjesdijk

Wouter Stoutjesdijk is an alumnus and also former Board member of the association. After receiving his master degree in Computer Science in 2001, he started as a consultant at Accenture. After a few years, he decided to expand his skills and completed an MBA at INSEAD. Next, he worked in telecommunications in Belgium where he had several roles and ended up in the board, responsible for customer, IT and network operations in the role of Chief Customer



Experience Officer. Now, Wouter works at Liberty Global as Director Connectivity Marketing where he leads the development of Strategic Customer Value Propositions across Europe. His mission is to transform the company into a customer-focused one.

Jaya Baloo

While studying at the Tufts University in Boston, Jaya wanted to become a diplomat. After a while, she switched careers to work for KPN as a Network Services Engineer and later on Senior Network Administrator. Then Jaya took a break from KPN to work in different roles at a few different companies as Security Specialist at France Telecom and Verizon Business. When confidential information was hacked



at KPN, Jaya was appointed as Chief Information Security Officer (CISO) at KPN. As CISO, she manages a team of over 100 passionate network specialist and ensures that KPN is ready for the super computer, when the time comes. Now, Jaya is the only CISO of the Netherlands that is in the top 100 CISOs globally.

MatCH

Sebastien van Tiggele, Promotion Affairs MatCH

Let me begin by introducing to you the MatCH committee of 2018-2019: Kawin Zheng (Chairman), Jeroen van Steijn (Secretary), David Vos (Treasurer), Jeroen Janssen (Sports Affairs), Floor Laseur (Game Affairs), me (Promotion Affairs) and of course our Qualitate Qua Tom Heijnders. We have the honour of running the sports and games committee of Christiaan Huygens and it is our goal to reach out to as many students as

possible and present them the fun in sports and games!

We started the year with a good old classic among MatCH activities: the Casino Royale. The /pub was transformed into a casino hall, where visitors had a whole plethora of different games to play: from Kawin who was dealing at the blackjack table, to Floor and me spinning the roulette table and the rest hosting the various poker games. After entering the /pub, the gamblers got a cup with tokens filled to the brim to use during the night. You'd better try not to go all in before gathering a good amount of tokens, because once you've lost them all, it would be over for the night. Every guest not only received a free glass of champagne with his or her ticket, but they were also given bitter garnish during the breaks. This helped the participants stay focussed during the intense poker games.



The winner of the night would have been the last person with still tokens left, but instead two winners have been chosen. One who would be named King of Poker, as he clearly won most of the poker games (having hoarded quite a hefty amount of tokens) and one who would be named King of the Roulette, who went all-in at the last minute and won spectacularly at the roulette table. Both champions received a sincere congratulations and both walked home with a bottle of champagne. Not every event has to attract an enormously large amount of people to be successful. Even though having such a great participation of students is a great accomplishment and results in lots of cosiness, sometimes bigger doesn't necessarily mean better. A perfect example would be our second activity: Ice Skating. We did not get any idea served on a plate like our first activity, as the casino gets organised every year – with great success. After thinking through what felt like a hundred different ideas, we noticed the planned event was exactly on the last day the ice skating rink in Rotterdam was opened. We all agreed it would be quite a novel idea to go ice skating as the winter came to an end and this would be the perfect opportunity to have a fun good-bye with the cold.



Unfortunately, the people managing the rink were not so fond of giving out any way of discount other than the standard 50 cent group sale (by bringing 15 people or more). Even though this would result in quite an expensive undertaking, the MatCH always puts the wallets and pleasure of our students first by making the tickets very cheap! Furthermore, after facing the difficulty of promoting an event happening right when "The Classic" took place (Ajax vs. Feyenoord), we still managed to gather an impressive 30 people that took the time out of their day to travel with us all the way to Rotterdam.

A lot of skills were shown during the various laps around the rink that night, and some even watched parts of the football match whilst taking a pause from all the ice-dancing that took place. We even observed an international student who had never skated before, yet could skate more swiftly than some of us who have stood on the ice since they were kids.

The third and possibly last planned activity is an outdoor Laser Tag on the campus of the university. This event still has to take place at the moment this is written, but it will certainly be an amazing day! We'll receive the participants at around 4 o'clock, after which the 7v7 Laser Tag can begin!

Organising this activity hasn't been a piece of cake either, as our original plan was on quite an illustrious location: inside one of the faculties on campus. Evidently, this was not achieved since it required various approvals among the different levels of management in the faculties. After a lot of work of our chairman Kawin, we unfortunately got denied of our amazing plan.

Nonetheless, do not get upset! Our activity will spark the feeling of summer vibes after the cold winds of winter. Going outside for a quick game of laser tag will undoubtedly get CSE students interested and help them get outside sometime. We hope to see you there!

Kind and sporty regards 🚺













Translating the

association into a book

Jasper Rou, Content Affairs of AnnuCie

Tuesday May 14th all of you probably bought the most beautiful book ever made. During the annudrinks we could present the result of half a year of hard work: the first-time English, green and gold Annuarium 62 of W.I.S.V. 'Christiaan Huygens' with the fitting theme 'Translation'.

We tried our hardest to translate everything that happens at and around CH and the people involved with that to words and photos and bundled them. We think that it was a success, but we invite you to judge for yourself. If you didn't give it a thorough look yet, we welcome you to, after finishing this MaCHazine, solve the translation puzzle on our committee page, try to find the answers to the photo quiz or only look at the corner and flip very fast to see one of the bigger achievements of Lay and Out Affairs.

Fitting to a majestic book was the epic presentation during the annudrinks, which was more extensive than ever due to the fanatic scoping of money of our Treasurer (and perhaps a "slight" overestimation of the expenses). Here everyone who bought a book also received a translatable toy with which everyone could entertain themselves while waiting for their book to get signed. During the drinks we also were very happy to receive all of your congratulations, only Content Affairs "returned" some of them.

Those congratulations were also a bit for you as the participation was again very massive this year. We really enjoyed the contributions, memes, quotes and responses to the AnnuQuete. The last sadly did not have a fun puzzle this year after our Secretary realized, having spent ten hours of perfecting it, that our idea was not very practical.

Having finished the bigger part of our committee, it is time to look back very happily. We already miss each other, the 'joke round' our Chairman established and of course our mascot Clarence, named after the legendary Clarence Seedorf (look up in the Annu why he is such a legend). We wish our potential successors good luck with the attempt to complete the impossible task of making a more beautiful Annuarium.



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Hackathon It's Hackening

Raoul Bruens, Chairman HackDelft 2019

Hackathon events are becoming more and more popular, both among participants and companies. As a participant, you get hands-on experience with data sets and cases that are prevalent within a specific corporation. This can give you tremendous insight into potential job prospects or companies that you may want to work with in the future. As a company, you get excited and creative programmers assigned to your specific case, after which they will try to come up with a solution to your case. You can learn a lot from these solutions and a lot of hackathon winners are invited to pitch their solution to the management department of the company.

While generally hacking is seen as 'breaking into a system', the more general definition entails 'a piece of computer code providing a quick and elegant solution to a particular problem'. This means, in the context of a hackathon, to come up with a proof of concept within the given time constraint.

W.I.S.V 'Christiaan Huygens" HackDelft committee organized their third edition of the hackathon last May. The annual HackDelft event took place at the Sport & Culture Center - X. With more than 100 participants, the 2019 edition was a great success. Four companies presented their data set during the opening ceremony: CGI, Optiver, Sogeti, and PwC. CGI presented their real-time data stream on train track data provided by ProRail. Optiver had set up their own stock exchange, in which participants could build trading algorithms to compete within that exchange. Sogeti presented their data set on the reimbursement system within their company. PwC presented their 'capture the flag' contest, in which participants had to find a flag (i.e. a piece of code) in different levels within a custom-made environment. Before hacking, there was a short window in which teams had to decide at which company they wanted to do their project.

After the opening ceremony, the 24 hours of hacking commenced! During these 24 hours, participants worked on their solution, based on the information that they had gathered by either the opening presentation or by talking to the company employees themselves. On Saturday, HackDelft's partner MLH gave a 'Code in the Dark' workshop, which entailed remaking a given HTML website as complete as possible within 15 minutes without compiling your code. Of course, the best rendition of the website was given a price.

On the early Sunday morning, the 7 am morning gymnastics was given by our lovely secretary to energize the participants that pulled an all-nighter. Later that morning, a pitch workshop was given by Viki Pavliç, to prepare the participant for their own pitch.

After hacking ended and all products were submitted, our group of expert judges (Agathe Balayn, Asterios Katsifodimos, Mauricio Aniche, Matteo Mosca) listened to all the pitch from the participants, after which the award ceremony could begin. There was a winner for every company, and the best, most innovative product was given the main prize as winners of the 2019 HackDelft Hackathon. If you're interested in joining HackDelft, next edition will be held in 2021. We hope to see you at our next HackDelft Hackathon, were IT'S HACKENING!



DIES: EnCHanted

Ivo Chen, Secretary of Dies Committee

became 62 years old.

Every year the birthday of the study association CHristiaan Huygens is celebrated with one week of activities organized by us, the DIES (Dies natalis, birthday in Latin) committee. This year, CHristiaan Huygens

The theme of this year's DIES weak was 'EnCHanted'. All the activities we organized were "EnCHanted". To promote the DIES week, cotton candy was given to everybody on the day Christiaan Huygens turned 62 years old. The cotton candy could be smelled through the whole EEMCS building, which was good for our promotion. Within the DIES week, a magical lunCH lecture was given, whiCH included a magician performing an act. The lecture was interactive and the magician explained some of his tricks. The whole lecture room CHIP was packed full with people. The magician's inspiring motivational video half way his show was celebrated with applause and even after his show people talked about it for more than an hour in CHristiaan Huygens.

There are also a few traditional activities whiCH are given every year. These are the member lunCH on Monday, the 'uitbrak' lunCH on Fridays and the (magical) special beer tasting. The (magical) special beer tasting in the /pub was visited by a lot of people. You were able to buy a ticket for 10 different half-special beers. The beers were handpicked by us, the DIES committee. So we hope that everyone who was there really liked the beers. We also created the order in whiCH the beers were to be drunk. We picked three very heavy beers, and although we put those three beers at the end of the list, we heard people saying those were too heavy. I myself think it was nice to have some really special beers whiCH you won't drink so often.

I also want to introduce our committee. Our CHairman is Jonas Duifs. Despite being very busy as the steering wheel of his team at Proteus, for whiCH he has training 5 or 6 times eaCH week, he was always prepared for the meetings and was getting stuff done. The Treasurer is Finn Dijkstra and he creates nice excel sheets for the budget of the DIES. He even created one on his phone, but accidentally dropped his phone, broke it, and could not upload the budget anymore on the drive. We felt sorry for his phone, but he still got a turf during the meeting for missing an action point. Then we have Sophie Walboomers, she did the Promotion. She has enCHanted hair and looks like the hero of Brave. She brought up many fascinating and good enCHanted ideas for the committee, like abseiling from the EEMCS building and jumping (with drinks). For the Planning we had Rona Roovers. During the enCHanted beer tasting with just our committee she knew a lot about all kinds of beers (we tasted 10+ different ones). She felt a bit ill so she went away earlier, and then we noticed how muCH we missed her. Her knowledge about all the different beers was enCHanting to see. Then Rik Westdrop. Everybody knows Rik that is the CHairman of W.I.S.V. 'CHristiaan Huygens'. We know Rik as our Qualitate Qua and his always very informative 'wist-je-datjes' at the end of a meeting. We know that he must have a lot of meetings, whiCH makes the 'wist-je-datjes' of Rik the best moment of the meeting.

I am Ivo CHen and I'm the secretary of the DIES. For me this was my first committee at CHristiaan Huygens. I enjoyed the DIES week very muCH and hope you did so too!



Computer Science





The Honours Programme, a student's experience

Henk-Jan Wermelink, Student Computer Science

In 2017, I started the Honours Programme at Delft University of Techno-

logy. Together with Philippe Lammerts, I started a project about "Bias in

intelligent personnel selection systems", supervised by Ms. Liem.

For a period of two years, I worked together with Philippe on several topics within this domain. First, we started working in collaboration with the Erasmus University on analyzing CV's, after this, we worked on a tool that could detect potential bias and lastly, we did data analysis together with the European Personnel Selection Office.In addition to the project, I took a course in "Leadership in a complex world" and went to a summer school called "Experiencing China" in Beijing China. To finish up the programme, I will attend a summer program at CERN in Geneva next summer.

The summer school in China had the purpose of giving international students an experience of the Chinese culture. It was organized by the most prestigious University in China; Tsinghua University. I was placed at Tsinghua in the "Online Education & Entrepreneurship" track. This track mainly consisted of lectures and field trips. The lectures were given by guest speakers from MIT, Tsinghua, Oxford, and other well-known Universities. The field trips were organized at start-ups and colleges that heavily used technology in their business and education. At the end of the summer school, we got the task to come up with a product within the field of online education. My group came up with the idea of an application for children, that uses augmented reality, to help them learn English in a playful manner. This was then judged by a Chinese expert panel, and surprisingly our idea won. Therefore we got the opportunity to pitch the idea in front of the 360 participants and professors from the University. This summer there is a summer program at CERN in Geneva planned. Together with 20 other students from Delft, we will participate in a 3-week program at CERN, with the goal to find new opportunities in business for their findings. Prior to the program, there are eight preparation lectures.



After the summer I will finish up the Honours Program and this also marks the end for my time in Delft. I look back with pleasure on a great period in Delft and will follow up on my studies next door in Rotterdam.





Building a SQL testing automation tool

Daniël van Gelder, Editorial Staff MaCHazine and Student Computer Science

One of the seemingly most boring tasks of software engineering is testing. A task that most programmers would rather postpone until absolutely necessary. However, computer scientists wouldn't be computer scientists, if they wouldn't try to automate everything they do. This has led to several attempts to automate software testing. As part of the Honours Programme Bachelor, me and my partner Paul van der Stel started to work on a project in order to make the life of a software tester a little bit easier.

EvoSQL: Evolutionary Test Data Generation

The solution that was found is called EvoSQL. It is a Search-Based test generation algorithm that finds test data based on evolutionary principles. In other words: it is a Genetic Algorithm. The idea of a Genetic Algorithm (GA) seems complicated but once understood it is rather straight forward in implementation. A GA tries to create so-called 'Individuals' and evaluate them based on a 'fitness' function. This function evaluates how well such an Individual performs and this can be based on any heuristic. The GA tries to optimize this score such that it ends up with an ideal Individual. By mutating (changing values), combining (merging data) and discarding Individuals, the fitness function will slowly converge to an optimum. EvoSQL applies this idea to SQL data. It decomposes the query into 'coverage targets', which are the different conditions that affect whether a row is returned from the database. If a database row can be generated for each coverage path, a kind of MC/DC coverage is achieved for the query. A set of these rows with their coverage path is referred to as a 'Fixture'. More precise details of the implementation can be found in the paper of EvoSQL [1].

The Brew Module

Most of our work revolved around processing the Fixtures that were generated by EvoSQL. While these Fixtures contained the data necessary for creating tests, they were never exported or generating actual tests. This is where our extension on the project comes in, a module that we refer to as: Brew. The Brew module forms a pipeline (Figure 1) which can run EvoSQL on a query, process its output and generate a fully standalone Java project with unit tests covering all paths in the query. However, its functionality is not restricted to generating unit tests. Anyone can pass his/her own output generator, such that the results of EvoSQL can be used for any purpose. Currently the Brew module is able to produce both JUnit 4 and JUnit 5 tests and print them either to the console or to a file and supports both Postgres and MySQL syntax (but this can be extended too!). Overall, Brew is a very flexible and robust module and does not restrict a developer to any kind of format. Our goal in the design of this module was to satisfy the requirements of EvoSQL: generating tests from the generated data, but also giving possible future contributors the chance to do something else with it. In order to finish our Honours project, we will try to demonstrate the effectiveness of EvoSQL by mutating the original query and running the generated tests on its mutation. While our results are not in yet, we expect that running the tests on a mutated query will make at least one test fail in most cases, thus proving that EvoSQL generates adequate testing data.

If this article has gotten you interested in the project, you can check it out on Github [2] and try it out yourself!

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 EvoSQL Repository: https://github.com/SERG-Delft/evosql



Figure 1: Pipeline of Brew



Five Years of Network at CH Events

Paul van der Knaap, IT Responsible for CH events

In recent years, CH has been organizing both the Area FiftyLAN gaming event as well as the Hackathon. In organizing these events, many elements are involved in running the event from beginning to end, and one of them is the network infrastructure. But how does this work? What kind of problems do you run into while providing the network for these

events?

I want to take you along with some experiences we've had over the years and the great stories that originated from them. But first, let me introduce myself. Written on my shirt, five years ago: Paul "Pauluzz" van der Knaap. Commissioner of Systems at the first Area FiftyLAN events. Together with the rest of the LANcie, we started the first edition of Area FiftyLAN. I already had prior LAN experience, with working over 30 events as crew in the past - which definitely came in handy when putting together a list of necessities for organizing a LAN party. Ever since that first year, I have been providing the network for both AFL and HackDelft, together with a friend of mine: Edwin Verheul. He's been a network guru for a long time within the LAN scene.

Area FiftyLAN - Network stories Year 001

The TU Delft has a fast gigabit network. We wanted to create our own internal network - no problem, that could be arranged. However, you cannot simply plug in an internet cable at the TU Delft and have a working network connection. The process started by sending a request to the IT department to figure out what the possibilities were. After some time, we were able to set up a meeting with a senior system engineer at the TU Delft to look into possibilities of getting an internet connection in the LAN area. There were two spare network outlets available in a room close to the big hall. After manually patching these in the basement of the S&C building, this was all dealt with quicker than expected.

On the first day of the event, everything ran pretty smoothly. But, as one would expect, this only lasted until the end of the day when we tried to connect the old PIN device. This didn't work anymore. We tried to configure the device with different settings, but to no avail.

Time to ask the TU Delft IT hero, Eelco Slagbook, who promptly came to the event in his free time to figure out what the issue was. Thankfully, it was fixed! How? Apparently the old PIN device used a fixed separate network on which they could connect. Using a different IP address or VLAN was absolutely



impossible. The final fix was to change the routing on a specific IP block from EEMCS to S&C – as well as creating another connection on the TU network routers, which was directly in the VLAN of the PIN Device.

Year 010

S&C was supposed to be under constructions this year, so it was not possible to host Area FiftyLAN there that year. This meant the LAN was hosted at 'DW' – Drebbelweg for this year. This also meant a new exploration into network availability. Eventually, close to the deadline, we managed to get to full speed working outlets from a secure room somewhere in the hallways. We couldn't access these ourselves, so this meant preparing the cables in the week before the event, and cleaning them up the week after the event.

The PIN device was also in for another party this year, but due to the incredible experience from the year before, this was solved in a similar way.

Year 011

S&C's reconstruction was supposed to be finished this year - but construction had only just started. And the first thing they did? Cut almost every existing cable in the venue and replace them with some temporary network outlets. Great...

After overcoming some bureaucracy (I was not allowed to inspect the venue as I had to get permission from both the event manager at S&C, as well as the IT department to take pictures of the venue) - we found some potential network outlets under the entrance of the sports area. They worked. Sort of. Sometimes. Actually, they didn't. The speed varied between 100Mbit/s and 500Mbit/s, depending on the mood of the cabling and routers.

Houston, we have a problem? Fortunately for us, the door to the basement was unlocked due to the construction work - and was not allowed to be closed due to fire regulations. We put 100 meter long cables all the way from the network switches in the basement, right through the construction area all the way to their final destination. Sounds easy right?

Well, it technically was, but there were still some issues left. We weren't allowed to enter the construction area without qualified equipment. So this meant liaising with the construction site manager, who was not too happy about our grand plan. After some calls, though, we were allowed to go in. And all this haggling was for what? Only because we needed to walk about 5 meters over the construction site! 5 meters! \

Oh yes, and of course the cable length was too much for the PIN device, so that meant putting a switch somewhere in between, right on the construction site. Fortunately, our constructions friends never noticed.

This year we also upgraded the network equipment which we have been using ever since. The main switches are Quanta LB4M switches with 48x copper ports and 2 SFP+ uplink ports. SFP+ allows us to use 10 gigabit connections over fiber. To prevent the fiber from being stepped upon, we also decided to use ropes across the hall to attach the fiber cables to. Side bonus: it looks fancy!

But there's more exciting stuff in this third edition. Saturday evening, poof, whilst the event is in full swing, the internet connection is gone. There is no link anymore. Swapping the cable didn't work. We had no other option than to ask our IT hero at the TU Delft again. At 11 pm in the evening, we call him - and he made some calls. Problem solved. Someone at the event figured it would be a good place to start downloading torrents - and as such we were flagged and banned from the network. Of course we cannot disclose the future solution to the problem, but since this one-off occasion we did not run into the same issue again ;).



Year 100

"Hé Edwin, shall we build one of those statistics walls?" - "Do we need it?" -"No, but it looks fancy!" - "Okay, let's do it, I'm in." Totally unnecessary, but it looks cool and that totally justifies building it. Get the screens on Monday, get some construction material and time to build. Right on time before we start building the event again on Friday. To fill the screens with satisfying content, we spent the whole weekend generating traffic data and statistics.



And what about the PIN device? Well, that old device has finally been upgraded, so that now works without all the additional work of getting it up and running :).

Year 101

What is there to tell for this year? It has finally become a smooth routine. This year, the construction work at S&C was finished. We also got lucky as the renovation left some additional available network outlets available. With some additional work by the IT department these are now permanently available and only need to be remotely configured for use.

This year, we also cached Steam games for the first time. In hindsight we also definitely needed it, since we often were quite close to the bandwidth cap of 1 Gbit/s. Without the cache, we would have needed to throttle some traffic.

Hackathon

For the LAN, almost everyone is connected to the local network with a cable, and only a few participants are connected through the WiFi on their phones and tablets. For the Hackathon, everything is a bit different, since everyone is wirelessly connected. This means a lot of access points are required to equally distribute the load.

A lot of access points at random places also meant we needed cables at weird places. And what better way to do this than with some overkill? Just use a lot of rope to hang the core infrastructure in the air, as we do not want anyone standing on fiberglass cables laying on the ground.

Network Infrastructure - an outline Curious as to how it's all done?

The TU Delft internet is connected to a router which runs pfSense. On here, we use different VLAN's for management, WiFi and the participant's wired network. The internal network interfaces are connected with 10 Gbit/s fiber to the core switches. From here, we distribute fiber cables to the switches on the tables of the participants. Aside from this, we also use port mirroring to capture all traffic with ntop on a different machine to categorize the network usage. With this, we can for example see, that in 2018, 30% of the traffic was from Steam, 13% from Twitch and 5% from YouTube.

Aside from all the cables, we also provide a WiFi connection for all participants. Since the regular available WiFi is hardly enough to handle so many clients simultaneously, we create our own local WiFi network.

Traffic trends

When we started in 2015, we had a peak of around 300-400 Mbit/s of traffic during the event. Over the years more and more games are played through Steam and the size of the games increased a lot. This, combined with the steady increase of streaming services such as YouTube, Twitch and Netflix, made that during the last event in 2019, the traffic was close to the maximum cap of a gigabit throughout a large portion of the event. During the last edition, a total of 4.3 TB of traffic passed the network.

Final Words

Thank you for taking interest in our "behind the scenes" tour! We look very much forward to the challenges that next editions will bring - and of course, we also hope to see you at the next editions of these CH events!

Finally, we want to include a special thanks to Eelco Slagboom. Without his dedicated work at the TU Delft IT department this event would not have such a proper network, and our work would be a lot more complicated if not impossible.



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Computer Science in other studies

Willemijn Tutuarima, Editorial Staff MaCHazine

For computer science students, programming is an everyday task and even mathematics students encounter it pretty often in their study. For other studies this might not necessarily be the case, but in the last few years it has become clear that computers cannot be easily excluded in any field of study or work. Programming is probably the easiest way to learn to understand how computers and embedded systems work and thus it would be logical for other studies to also include it in their curriculum. Here we have a look at the programming and computer side of some of

the other studies offered in Delft.

Mechanical Engineering at Haagse Hogeschool

One of the obvious studies for using embedded systems would be mechanical engineering, because a lot of the mechanical machines are starting to become automated with computers. The people who make the machines should also be able to work with the components and understand how to move parts by using software. One of the ways this study incorporates programming is their programming courses where they learn to program in Arduino and to use HTML for their layouts. The other way they use computers is during their projects which they have twice a year. In these projects they make their own machines and write their own programs.



Applied Earth Sciences at TU Delft

Another field of study that uses a lot of machinery for getting data and controlling machines is Applied Earth Sciences. From getting to know how the surface of parts of the earth move to calculating volumes of chemicals of rocks within the earth. Applied Earth Sciences is one of the many studies at the university that uses the Matlab program to make calculations on the data they receive from their surroundings. Next to Matlab's own language, the students also learn Python in their projects to calculate properties like water saturation or the shale content of the ground.



Technical Medicine at TU Delft

Technical Medicine will probably not be the most obvious study to encounter computer science in their curriculum, but they actually do in their course Medical Computer Science. In this course it is not the main goal to learn how to write programs or to learn about how computer works but to learn how to analyze, interpret and use data they get. One of the goals is to learn how to improve computer processes and to learn methods and techniques from computer science to do so. Next to this, another goal is to learn the properties of medical data and to describe in what way the information and communication has value and meaning.

Mathematics





Nothing in Evolution Makes Sense Except in the Light of Mathematics

Remie Janssen, PhD Candidate Optimization

To understand a biological species, we have to understand its

evolutionary history. Such histories are represented as graphs called

phylogenetic networks. The study of these networks is new and exciting,

with surprising connections to other fields.

Evolutionary history

In 1973, Theodosius Dobzhansky wrote an essay called "Nothing in Biology Makes Sense Except in the Light of Evolution" [6]. He argued that we can only understand biology if we understand how biological systems evolve. This evolution can be understood at different levels. We might ask how DNA changes, how this influences organisms and species, or how the change in organisms and species eventually results in the origin of new species. The answer to this last question is often given in the form of a *phylogenetic tree*. This is a branching diagram that shows a sequence of *speciations*, the splitting of one species into two (or more) species.



Figure 1: Three bird species. The Golden-crowned manakin (middle) is a hybrid of the other two. [1, 11]

However, in biology, things are never as simple as we first think they are and there may be strange events that do not fit inside a tree. Some complications that we may encounter arise from *hybrids*, organisms whose parents are of different species, and *horizontal gene transfer*, the exchange of genetic material between two individuals of different species. Both do not fit into a phylogenetic tree, as branches leading to different species would have to recombine. A representation of evolutionary history that does allow for these recombinations is a *phylogenetic network*. Using these, we can more accurately represent evolutionary histories, and thus better understand evolution and biology as a whole.

Phylogenetic networks

Phylogenetic trees and networks are special types of graphs. Graphs consist of a collection of nodes, and lines between these nodes. Phylogenetic networks represent evolutionary history, so in addition they incorporate time as an orientation: a direction for each line. As time is acyclic, the networks must be acyclic, too. Lastly, the species of interest appear in the network at the

leaves, the endpoints of the network, and they all have one common ancestor, the unique source of the network which is also called the root.

To simplify the picture a little, we often consider *binary networks*. These networks have four types of nodes: one *root*, which has indegree-0 and outdegree-1; the *leaves*, which have indegree-1 and outdegree-0; *splits*, with one incoming and two outgoing arcs, which represent speciation events; and *reticulations*, with two incoming arcs and one outgoing arc, which represent hybridizations/gene transfers. This means we can easily count the number of strange events: the number of reticulation nodes is the *reticulation number* of the network. The reticulation number is a measure of complexity of the network.



Figure 2: Abstraction to phylogenetic networks. The disks and squares are female and male individuals, and there are lines from parent to offspring. By grouping and abstracting, we get a phylogenetic network as on the right.

Building the network of life

The aim in phylogenetics is to reconstruct the evolutionary history of a set of species. Of course, we need some information about the species of interest. This is where DNA sequences come in. The genome (one entire set of DNA) of an organism contains that organism's 'building plans'. Such plans should not change too much between one individual and its descendants: the child of an elephant should be an elephant. In fact, genomes change slowly over time, and are therefore convenient as a source of evolutionary information.

One way to reconstruct phylogenetic networks, is to use this information directly. The amount of change can be seen as a measure of evolutionary time. Hence by comparing genomes of two species, we can get a distance between them. We can then try to find a network in which all measured distances fit logically: the distance between two species is equal to the length of a



path from one species, up to a common ancestor, and then down to the other species. This leads to interesting combinatorial questions, like whether a set of distances corresponds to a network at all [3].

Another reconstruction method assumes we can find small networks that agree with our data, and that we want to find one network that *displays* them all [2]. This means we want a network in which all the small networks can be drawn. A trivial solution can always be found by drawing all the small networks and connecting them at the root and the leaves. Although mathematically elegant, it is biologically meaningless. To exclude such solutions, we note that the construction introduces a lot of reticulations, which represent rare evolutionary events. Therefore, the reconstruction methods that combine networks often take the form of an optimization problem: find a network that displays all input networks with a minimum number of reticulations.



Figure 3: Three small networks, and two networks containing all three. The left one is much simpler than the right one, which is constructed as in the text. The second small network is coloured red in both bigger networks.

Not all methods rely solely on the simple assumption that reticulations are rare. Some work with a more complicated model of evolution, where the change of the genomes is explicit. Evolution of sequences is inherently random (evolution is based on *random* mutation and selection). This means that these models must be stochastic. In fact, they are Markov models that randomly produce DNA sequences given a network. The structure of the network determines the dependencies between the (random) DNA sequences for the species. If two species are closely related, their sequences are largely the same with high probability. Using these models, we can calculate the *likelihood* of the network: the probability that a certain network produces the sequences we have found in the real biological samples. Again, the reconstruction method is essentially an optimization problem: given a set of sequences, find the network with highest likelihood.

An exciting new field

So, we see that reconstruction methods in phylogenetics often consist of solving optimization problems. Many of these problems are analogous to ones already answered for phylogenetic trees. The phylogenetic network paradigm has only become popular in the last fifteen years or so, which means there is still a lot left to do. There are problems whose generalization can easily be solved for networks, and problems that turn out to be very hard when networks are involved. Trying out these problems is exciting, because you never know if you are going to strike gold, and find an elegant mathematical proof for a biologically relevant problem.

Another reason the field is so interesting, is that the problems can involve very different types of mathematics. Obviously, graph theory is often involved, but to what extent may surprise you. There are connections with other optimization problems such as Hamiltonian path [7], but also with graph isomorphism problems [5, 10], and treewidth [9].

Of course, it's also important to know whether a problem is computationally easy or hard: for practical purposes, we want to get biologically relevant networks quickly. Hence, papers about phylogenetic networks often include an algorithm, and a proof that the algorithm is roughly as fast as it can be. This is most likely in the form of an NP-hardness proof, as working with networks instead of trees makes many problems hard.

An issue with most data, is that it is partly random in nature. This means that deterministic methods do not always work, and we have to turn to stochastics and statistics. This may involve Markov processes, for the modelling of populations and genomes (integrating population genetics with phylogenetics); statistical consistency, to prove that methods do what they are supposed to do given enough data [12]; and topological data analysis, where some characteristics of the networks are related to the shape of the data [4]. It may even need a combination of statistics and algebraic geometry: an intriguing way to study spaces of distributions [8].

Lastly, even for the most pure mathematicians, there may be interesting phylogenetic problems. A recent unpublished paper finds a connection with category theory [13]. Although the claims seem somewhat wild, they show that category theory may be useful to classify phylogenetic networks.

We've seen that mathematics is vital in the understanding of evolution, and the light that evolution shines upon biology might just be the reflection of the light that mathematics shines upon evolution. So nothing in biology makes sense, except in the light of mathematics.

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Application of data science in waste water treatment plants

Witteveen+Bos

As a major infrastructure consultant company, Witteveen+Bos works in

the area of waste water and drinking water systems as well.

Recently we received data from a water treatment plant. The data was measured/recorded over a period of 5 years. The main questions to be looked into were:

1. What is the relationship/dependency between different variables at various plant stages? A plant stage can be defined as a place where a subprocess occurs. For e.g. at the buffer tank, effluent is collected over the whole week

- 2. How do these variables effect the "Nitrite Separation Efficiency"?
- 3. How have the trends changed over the period of time?
- 4. How can we visualize a high dimensionality dataset?

5. Can we make a predictive model using the data to forecast the separation efficiency?

Understanding the plant layout

Figure 1 shows the layout of the plant. At different locations (numbered 1 through 9), a number of parameters were recorded. The plant gets input from different sources (such as waste water from butcher houses, sanitary lines etc.) and outputs bio-gas, treated water and solid waste which can be further processed. Before proceeding further, it is very important to understand the underlying process dynamics. The flow chart shown below gets a new batch of waste water every Monday, which then goes through treatment throughout the whole week.



Figure 1: Waste Water treatment plant layout

Challenges involved

The following difficulties / challenges can be expected while analyzing data from such plants:

1. On average there are 4-5 parameters at each location. Therefore it becomes a bit of a challenge to correctly identify the parameters responsible for effecting the plant separation efficiency.

2. Apart from the dimensionality of the data, the relationship between the variables is also difficult to estimate because it may not be linear.

3. The dataset might not be complete and there can be missing values in the dataset.

4. Outliers can also come into the dataset due to a typing error or malfunctioning sensor. Therefore the dataset must also be checked for outliers because they prove to be a hinderance while training the model on the dataset.

Approach

Before starting to analyze the dataset, it is very important to visualize the data. As human beings, our brains have evolved to find patterns in pictures. Therefore, visualizing the dataset can give a valuable insight about the distribution, trends and extreme values in the dataset. Figure 2 shows the distribution of nitrite separation efficiencies during two separate periods. A number of observations can be made from this visualization. For example, since the data is bimodal, the plant operates at a lower efficiency in the "red" period than in "green" period most of the times.



Figure 2: Nitrite Separation Efficiencies during different periods

Outlier Detection

Outliers can come into a dataset due to various reasons such as typing errors or sensor failures. However, outliers might also indicate an important phenomenon or novelty. Therefore the outliers have to be checked in order to be certain as to why they were labelled as outliers. Different algorithms can be used / compared to identify outliers in the dataset. Figure 3 shows the comparison between the decision boundary of different algorithms.



Figure 3: Decision boundaries compared

The following text is inspired from Python's scikit-learn module online help forum.

The Elliptic Envelope algorithm (first in Figure 4) is robust to outliers. However, it assumes the data is Gaussian and learns an ellipse. It thus degrades when the data is not unimodal.

The One Class SVM (Support Vector Machines) is known to be sensitive to outliers and thus does not perform very well for outlier detection. This estimator is best suited for novelty detection when the training set is not contaminated by outliers.

To perform outlier detection in high-dimensional datasets is beneficial to use random forests. The Isolation Forest 'isolates' observations by randomly selecting a feature and then randomly selecting a split value between the maximum and minimum values of the selected feature.

Another efficient way to perform outlier detection on moderately high dimensional datasets is to use the Local Outlier Factor (LOF) algorithm. The LOF algorithm computes a score (called local outlier factor) reflecting the degree of abnormality of the observations. It measures the local density deviation of a given data point with respect to its neighbors. The idea is to detect the samples that have a substantially lower density than their neighbors.

Once the appropriate algorithm and corresponding outliers are selected, the domain expertise comes into picture. The outliers must be checked along with a domain expert as to if they were correctly identified. A detected outlier in the "pH" time series is shown in Figure 4.



Visualizing the dataset

The dataset consists of more than 50 dimensions and therefore it is not possible to plot it unless some form of compression to the dataset is applied while still retaining much of the information of the dataset. Here, we can use the technique called "Principal Component Analysis" (PCA). Using this technique helps visualize the dataset and we can see if any patters/clusters exist in the dataset. Figure 5 shows how PCA can be used for such high dimensionality dataset.



Feature Selection and prediction model

For making a prediction model, feature selection plays an important role. Here, we cannot rely solely upon correlation coefficients between the nitrite separation efficiency and different variables because correlation coefficients are only capable of explaining linear relationships between the variables. In order to account for the non-linear relationships, advanced statistical techniques along with domain expertise play an important role.

For modelling, it is very important to understand the underlying process dynamics. The entire dataset cannot be considered as a continuous time series because each Monday a new batch of effluents enters the plant and thus only the days in each week are dependent upon each other, but the different weeks are independent of each other. Therefore, to train the predictive model, the data is to be structured in such a way so as to account for this fact. Once the dataset is ready, different algorithms can be tested on the dataset and hyperparameter tuning can be carried out to get optimum prediction models.

Figure 6 shows the results of the prediction model





Further work

The purpose of this article was to demonstrate how data science can be used in water treatment technology to our advantage. Using data science we can get a better insight into the process and process variables and their dependencies. A methodology to model a water treatment plant using machine learning techniques is also shown in case no models are available to describe the plant. To gain full advantage of the Deep Learning Techniques, the dataset has to be large and in case of large datasets, predictions can be made much further ahead into the future. The current model is at least able to capture the general trend in the data and takes into account the relationship between the different variables.



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Ionica Smeets: not just an alumnus

Eva Slingerland, Editorial Staff MaCHazine

She is a science journalist, has a PhD in mathematics, wrote 3 bestsel-

lers, and was seen in several Dutch TV programs like Zomergasten, De

Wereld Draait Door en De Slimste Mens. She was born in Delft, lived on

the Choorstraat for years, and finished her Master here. It's clear that her

roots lie in Delft and, even more precisely, at EEMCS!

Enough reasons for the MaCHazine to approach her for an interview. Luckily for us, she was already in Delft for Inspiring Dialogues, an event organized by TU Delft for Life on the 7th of May. Later that week, our chief editor Eva called with her to ask some final questions.

From Computer Science to Applied Mathematics

In 1998, Ionica started studying in Delft. After finishing her first year in Computer Science, she switched to Applied Mathematics. In the interview with her, she told me more about this choice. 'I think it was mostly because I was a member of CH, where as a Computer Science student you also get to know a lot of Applied Mathematics students. I did not really like my courses in Computer Science and also felt lost in the huge group of students. Applied Mathematics was a way smaller study and the students seemed to be a lot closer to each other. The teachers also seemed much more approachable and enthusiastic in that time. So, I borrowed some mathematics books from a friend I knew from CH to see if I liked it, and I did. Also, I talked to a lot of people and in the end it just felt better to switch to Applied Mathematics.'

Activities and committees

Ionica didn't just study Applied Mathematics, she was also actively involved in the student life of CH, where she was part of several committees. 'I started at the FaCie and was asked for the Wocky. Recently, I heard that there were the old Wocky and the new Wocky, and that the old Wocky was kind of lame. Then I remembered that I was probably part of the old Wocky, which I still think was really cool.



Photographer: Ype Driessen 🚽 🕥



I remember once coming up with the great idea to make pink and green pudding that had to be whisked. It was a disaster, since we didn't have any mixer and had to do everything by hand.

De Wocky! bedankt de WIEWIE voor het op tijd regelen van het busje.



Next I was part of the Faculty Student Council and I joined the MaCHazine, where I have also been the chief editor for a while. And, lastly, I was part of the FlitCie, where we were the last photo committee that still used analogue camera's, which I honestly loved. Of course, my friends and I also went to all the parties. I especially liked the themed parties. For one party, everyone was supposed to dress up as their hero and my two friends and I ended up dressing like each other. We had found out that we all had the same size, even for shoes. So we used each other's clothes and did our hair and make-up like each other. It was really funny, since the people that knew us got it, but other people were constantly wondering why we didn't dress up. Later, when I was looking at the pictures from that night, I suddenly wondered why I was on a picture talking to a guy, turns out it wasn't me: it was my friend in my clothes.'

Ionica wasn't part of any of the student associations, though she had a busy life next to studying and being part of several committees. 'I followed several courses at the culture center (which is nowadays part of X). I've also been writing for Delta, the university newspaper. In the first part of my study I worked in the library of my home town one day every week. Next to that, I sold tickets to the shows and was responsible for the PR at a theater. On top of that, I went dancing in Speakers almost every Thursday night, which I think is comparable to the Steck nowadays.'

Being a student now vs being a student then

An interesting question that was asked during Inspiring Dialogues, was if she'd rather be a student in 2005 or 2019. She said that she still preferred her own time of studying in 2005, since she thinks that the students back then had a better time. During my interview with her later that week, I asked her about her reasons behind this. She explained it by telling about her experiences of studying Applied Mathematics in Delft. 'Firstly, I followed two elective courses in my master with only two students. For example, the course Topology was given every other year, and I wanted to follow it in a year that it wasn't organized. There was another student that wanted to follow it too, so we just approached the teacher, K.P. Hart, and he agreed to give the course for just the two of us. It was a very chilled environment, where he just asked us what topics we wanted to learn more about, and then he'd create the course content around it. The same thing happened with another course. I don't know what the situation in Delft is right now, but as a teacher now I really can't imagine that I would give a course to just two students. Honestly, I don't know how I'd find the time to do that. Secondly, it was very normal for me to just go by a teachers' office and talk about a mathematics book, that wasn't even part of a course, but that we both simply thought was interesting. For example, I visited the office of professor Aarts, who passed away almost a year ago, quite frequently. Nowadays, I don't think that happens anymore, simply because the teachers don't have enough time for the students. Plus, the student now get less student grants, so there is a lot more pressure. Every time my colleagues say that students nowadays are lazy, I'm surprised. I honestly think that students now work way harder than the students 10 or 20 years ago, so there isn't much to complain about.'

From Applied Mathematics to Science Communication

In 2005, Ionica finished her master, but she wasn't quite done with the university. So, she pursued a PhD at the University of Leiden with 'On Continued Fraction Algorithms'. And now, she is a professor in Science Communication there and a science journalist. During Inspiring Dialogues she tells about her road from mathematics to science communication.

'I think in general, when you look at people who are at a rather nice position, as I am now currently lucky enough to be in, then it might look like it was all a plan or strategy to get there, and it definitely was not. I think it's good to remember, also when you read biographies of people, that the person telling the story is telling it after everything happened. So it seems to make sense that it all worked out, even though they have probably been struggling during the process. For me personally, I've always been writing, so when I was seven I made my own little booklets about a fish who could do amazing things and I started writing for the school paper when I was in high school. When I was in Delft, I first wrote for the MaCHazine, then I went to Delta and I took a course in science journalism.

So as a student I was already in journalism and communication. But, I felt like this was something you only did when you weren't really good at what you were studying. Since I was rather good at mathematics, I thought that it would be a waste of talent to do many courses on communication. In hindsight, I really regret that. One of my missions in my Leiden master specialization is to tell this to students. If you're really good at what you're studying and you're also interested in communication, it's not a waste of talent, it's something that adds to it. However, because I thought that science communication was not for those who are good at mathematics, I did a PhD in pure mathematics, because I thought that would be something really interesting to do. During my PhD, I started writing more and more. One thing I would really like to advice you is to look at the things that you actually like. Especially when you're a good student, it's easy to confuse being good at something with liking it. So, I was good at mathematics and I thought that I liked doing mathematics, but in hindsight maybe I liked getting high grades at something that was considered difficult, more than actually doing mathematics. During my PhD I noticed that I would spend a Saturday night until midnight writing an article for the newspaper about mathematics, but I would never spend a Saturday night working on my thesis. This is something that I think all students need to figure out. What are the things that you are actually looking forward to, that are worth working on, even if it isn't for grades? After my PhD, I became an independent science journalist, it was a rather gradual process. So first I worked two days at the university and as an independent journalist, until it became a full time journalist. And then I came back to university, which was pretty cool too, but that's a different trajectory.'



Her main motivation for going back to university was that she missed students. So right now, Ionica works at the University of Leiden as a professor in Science Communication, where she does research on how to improve communication with the general public and teaches courses on the theory behind this. However, she is still busy with a lot of other things: every now and then she sneaks in a popular lecture, she writes columns in the newspaper and whenever she is in Delft, she tries to step by CH. With all this information, we think that it's fair to conclude that Ionica Smeets is definitely not just an alumnus, since she is so much more than that.



Math applied in Aerospace Engineering

Rolijne Pietersma, student Aerospace Engineering

Ever wondered how other studies deal with mathematics? Of course every bachelor at the TU Delft deals with mathematics, but it differs per

faculty. Aerospace mainly focuses on the practical use of mathematics

and this article will discuss that.

I am Rolijne, I study Aerospace Engineering at the TU Delft and I am currently in my third year. The courses at Aerospace Engineering can be divided into three categories: Aerospace Design, Aerospace Engineering and Technology, and Basic Engineering Sciences. All of these courses rely on mathematics, but only courses within Basic Engineering Sciences discuss new mathematical theories. These courses are Calculus, Linear Algebra, Probability and Statistics, and Differential Equations. They only deal with mathematics and can be applied everywhere, so not only in Aerospace Engineering.

The main focus of these courses is that you can apply the theory. The derivation of these theories is also discussed, but this is rarely an exam topic. Calculus and Linear Algebra are given in the first year. Calculus is split up into Calculus I and Calculus II. The former is again split up into Calculus I-A and Calculus I-B, each worth 3 ECTS. Calculus II and Linear Algebra are both worth 5 ECTS. In the second year Probability and Statistics and Differential Equations are given, which are both worth 4 ECTS. So in total there are 6 courses that deal purely with mathematics and have nothing to do with aerospace. These are worth a total of 24 ECTS. There are also other courses that fall within Basic Engineering Sciences, such as Statics and Thermodynamics. These courses are also not specific for Aerospace Engineering, but do not solely deal with mathematical theorems.

The knowledge that is obtained in these purely mathematical courses is applied to all other courses. The courses that fall within the category of Aerospace Design focus on the design of structures. It discusses the process of how to get from an idea to the actual product. Weight is a very important aspect and it influences many different parts of an aircraft. In the first stages of the design, when very little is known about the aircraft, the weight is based on statistical data, so the knowledge from Probability and Statistics is applied. During one of the projects the goal was to design a wing of a hypothetical aircraft. The first step is to gather data about an aircraft with similar requirements and gather useful relationships between characteristics of the planes. Aerospace Design courses are more focused on the thought process behind the design and why you made certain decisions, rather than the actual calculations of the design.



Figure 1: An airfoil, which is the shape of a wing, represented in Computational Fluid Dynamics software. The software makes use of many partial derivatives in order to recreate how the flow reacts to the airfoil. https://quickersim.com/cfdtoolbox/aerodynamics/

Whereas Aerospace Design does not focus on the actual calculations of the design, the courses within Aerospace Engineering and Technology focus on the theory to do these calculations. Several courses that fall within this category are Aerodynamics, Structural Analysis, and Flight Mechanics. These courses rely on the mathematics taught in the previous mentioned courses. A lot of the derivations in these courses involve operations that were explained in Calculus and many other courses deal with matrix manipulation, which was explained during Linear Algebra. However, the theory explained during Calculus often involves integration or other complicated operations. Engineers would rather be a little lazy than do complicated or tedious work, so the problem is often simplified in such a way that the integration can be avoided. During many courses certain assumptions are made that simplify the equations significantly and we do not have to perform difficult calculations. The simplified version is not far from reality, so it is acceptable. So all these mathematical theories are discussed, but in the end the problem is often simplified to avoid them. Moreover, many theories about matrix operations were discussed during Linear Algebra. Unfortunately, these can be quite labor intensive when the matrices become large, so often matrix operations are performed on computers.

Overall, Aerospace Engineers have several courses that deal with only mathematics and we apply this knowledge to other courses. However, often we simplify the equations in such a way that complex calculations are no longer necessary.

Miscellaneous





Science Trends

Willemijn Tutuarima, Editorial Staff MaCHazine

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

Processing using light pulses^[1]

A data processor using light pulses has been created which uses magnets to record computer data. This uses almost no energy, which could solve the problem of creating fast data processors without the high energy cost that the processors would usually have. The enormous amount of energy used for keeping servers running and not overheating could finally be a problem of the past because of the invention of creating short light pulses on top of the magnets in the machine. This way, the temperature does not increase and having to cool servers will be no problem anymore. They plan to continue research for using these techniques for processing.



A battle against stress^[2]

After another year of studying or working, all of us probably know how it feels to have a little bit (or a lot) of stress. Well, there might be a solution that does not work in a magical way but in a scientific way! In a clinical trial of 264 adults who took a supplement of magnesium and vitamin, the amount of stress for the group that took only magnesium decreased with 42% and the group that took both decreased with 45%. The explanation for this is that magnesium plays an essential role in stress responses and low levels of it trigger the release of stress hormones. Vitamin B may also help against stress because it can alter the levels of the brain neurotransmitter serotonin and GABA which are both involved in depression and anxiety. Vitamine B has also been shown to lower blood pressure and reduce the impact of certain stress hormones. This shows that taking vitamin B and magnesium into your diet might really help with the stress.

Augmented reality in the real world^[3]

A study done by researchers from the School of Humanities and Sciences, found that people who had experience with augmented reality have changed interactions in the real world. In AR people would avoid sitting on chairs that they saw another character sitting on and they took this same behavior into the real world and did the same in the physical world. They discovered that using augmented technology can change the way people walk, turn their head, how well they do on certain tasks and how they connect socially with other people. The findings mirror a lot of the research done on virtual reality, where a real-life environment is simulated while in AR a layer of information is placed on top of the physical surroundings. AR is special through the way that it can put people into the same room while they are actually on the opposite sides of the world. This can be very useful in online communication or in video conferencing because of nonverbal communication. A lot of research is still done where communication skills are tested with augmented reality and this will continue as the market of AR grows.



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Historical Person: Alonzo Church

Daniël van Gelder, Editorial Staff MaCHazine

Alonzo Church was born in Washington D.C. in 1903. At this time, the mathematics field was in rapid movement: Hilbert had introduced his 23 unsolved problems, Einstein formulated his mass-energy equivalence theorem and the field of computer science was in its infancy. Church received his first degree at Princeton as early as 1924 and his doctorate only three years later. Throughout his life, he held positions at a wide variety of universities and contributed to science up until 1990. He retired twice, after continuing working following his initial retirement in 1967. His work mainly focused on mathematical logic, recursion theory and theoretical computer science. In this article we will explore some of his work which (still) are at the basis of computer science and show its relevance today on the fields we, as mathematics and computer science students, study today.

Lambda Calculus

While studying the foundations of mathematics, Church formulated lambda calculus (also written as $\lambda - calculus$). The definition of lambda calculus is as follows: lambda is a formal system in mathematical logic for expressing computations based on function abstraction and application using variable binding and substitution. This is a very formal way of saying it describes a system we can use to describe computation. In fact, this model can be used to simulate any Turing machine. Lambda calculus can describe functions, variables and function-applications, allowing it to function as a formal basis of describing computer programs. This has made it one of the foundations of early computer science and a source of nightmares for second-year Computer Science students. At its basis, lambda calculus has a very simple rule set for syntax describing notation as can be seen in Table 1.

From these simple rules one could already write some programs. By defining natural numbers as lambda terms, it is possible to perform arithmetic computation:

The number zero is defined as: $\lambda s.(\lambda z.z)$, abbreviated as a function of two arguments as: $\lambda sz.z \equiv 0$ When this function is applied to itself, the successor of zero is found which is the number one: $\lambda sz.s(z) \equiv 1$. By keeping on reapplying this, one can find any natural number n. This might seem a strange concept at first, but in a way, natural number n. This might seem a strange concept at first, but in a way, natural number sare defined as: the number n is repeating a function n times. Using this concept, one can find the successor function describing the successive number to natural number n. This function is formulated as: $S \equiv \lambda wyx.y(wyx)$. As an example we can find the successor to zero as follows: $\lambda yx.y((\lambda sz.z)yx) = \lambda yx.y((\lambda z.z)x) = \lambda yx.y(x) \equiv 1$. We derived this solution using the two reduction operations also described by Church: α -conversion and β -reduction. It is now not hard to imagine how we can describe functions like addition and multiplication using our successor function. However, these types of functions can easily look very intimidating and complex.

Church-Turing Thesis

Both Alonzo Church and Alan Turing studied the foundations of mathematical computation and both sought to answer the following questions: Is everything computable? What are the limits to computational mathematics? Can we write a problem for every problem? This led both scientists to formulate a formal definition of computable problems independently of each other. Fortunately, neither of them was proven wrong as the statements turned out to be identical. While many variations of the thesis exist, I chose to formulate it as follows: *"Every effectively calculable function is a computable function."* This thesis has many implications which will be studied in the Complexity Theory course. However, the thesis itself has actually never been proven to be true and for a long time academics have suspected that quantum computers would prove the thesis wrong, but this hasn't been the case so far.

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Syntax	Name	Description
x	Variable	Represents a parameter or a mathematical/logical value.
$(\lambda x.M)$	Abstraction	Expresses a function for which M is a lambda term and variable x is bound in the expression.
(M N)	Application	Applies a function to an argument. Both M and N are lambda terms and commonly M is a function applied to N .

Table 1



The math behind the Human Power Team

Sebastian Hartgring, Member of Human Power Team

The Human Power Team is a dreamteam trying to extend the boundaries of human potential! Our goal is to break the woman human powered world speed record of 121.8 km/h. This is achieved by designing and producing a special aerodynamic recumbent bike (a 'VeloX') and by selecting and training two top athletes. In this article, we will explain more about the race, about the team and about how we use mathematics for all this.

The race and world record

The record-breaking attempt will be held at the World Human Powered Speed Challenge: a race for human powered vehicles from different categories in Nevada, United States. For one week, every athlete can make two attempts on each day, one in the morning and one in the evening, to get the highest top speed. First, the athlete has 8 kilometres to gain speed and after this, a sprint of 200 meters is commenced. The time difference for the 200 meters is measured and determines the top speed (v = s/t).

Several factors must be considered during the race, including the official rules and the safety of the athletes and teams. The rules ensure a fair race where only human power is used. Energy may only be stored for 'one input power cycle', which means that your energy cannot be stored as potential energy using tools like flywheels and springs, and electrical and chemical energy can only be used to charge the sensors, communication devices and other assisting tools. Also, the vehicle must start at zero velocity with only the help of other team members.

The team

Our team, the ninth Human Power Team, has started working full-time in the dreamhall since the end of August. During the year, the team follows different steps and completes different phases, with as final goal a world record breaking VeloX 9. The first phase is the design phase, where the design of the VeloX 9 is realised. A conceptual design is made where each department presents its innovation, and this design is turned into the final design. The result of the design phase is a detailed digital design, which our team made using CATIA software.

Subsequently, the production phase starts where all parts of the VeloX 9 are manufactured. This does not mean that the designing has stopped, as parts are continuously adjusted and optimised to ensure the perfect fit and function. In addition, fitting moments are organised as control point to see how the whole design comes together and if it meets the needs of the athletes, for example in terms of the ability to move and cycle comfortably inside the VeloX. These are very exciting moments: you can see the design become reality and misfits can cause a delay for the whole production process.

When the VeloX 9 is operational and ready to be driven, the testing phase is commenced. The parts are tuned using test results and athlete feedback, and gradually the top speed during practice is increased. We start testing at a



remote road near the campus, but we also train at F16 landing strips (thanks to our partner Defensity College) and the RDW testing facility in Flevoland. At the same time, we continue to produce spare parts which we bring to the race. Our dreamteam year ends in September 2019 with the biggest moment: the World Human Powered Speed Challenge in Nevada!



Figure 1: There exists an ideal moment in time for the athlete to commence the sprint. After the maximum power level has been reached, the power will decrease. If the sprint is engaged too soon, the athlete will enter the sprint with a decreasing velocity. Alternatively, when the sprint is started too late, it cannot be exploited fully.

Study of variables

We used a sensitivity analysis during the design phase to get an insight in the range of influence of relevant design parameters. This analysis gave us, among others, an indication of the influence when using new tires with a different rolling resistance (this year, we will use custom made tires in collaboration with Vredestein), it determined the importance of aerobic and anaerobic power and attempted to quantify the influence of air resistance.

The main equation used during this study is the differential equation obtained using the balance of forces of the VeloX 9 and the second law of Newton:

- - -

$$m \cdot v = F_P - F_d - F_r + F_g,$$
where $F_P = P/v,$ $F_d = \frac{1}{2}\rho(v - v_{air})^2 C dA,$
 $F_r = c \cdot m \cdot q,$ $F_a = i \cdot m \cdot q.$

Using the initial conditions ($v_0 = 0.1 \text{ m/s}$ and $v_0' = 0 \text{ m/s}^2$) and the forward Euler method ($v_{n+1} = v_n + v'_n \Delta t$), the velocity profile of the race can be determined numerically.

The wind speed, the profile of the slope of the race track and the air density are determined using measurement results of previous races; and the mass of the VeloX 9, the power input profile, the CdA-value and the roll resistance coefficient are design parameters that determine the top speed of the VeloX 9.



Figure 2: Results of the sensitivity analysis from Human Power Team

The CdA-value and the roll resistance can be estimated using data from older VeloXes, but the relation between the mass and the sprint moment (important for the power input profile) is complex and nonlinear. With a lighter VeloX, the optimal moment for the athlete to commence the sprint shifts, which causes the power input profile to shift in time. This is why a genetic algorithm, part of the Matlab package, is used to determine an optimum for the mass and the timing of the sprint. A random set of values for the weight and sprint moment is created: the initial population. From this population, new populations are created using the old populations (the parents), classifying these values and turning them into values for the new population (the children). When the optimum is found, we can use these values as the parameters for the study of variables. This study is optimised for a design top speed of 125 km/h, a value set as the target by our team in the beginning of our dreamteam year.

Now that the design parameters have been estimated, their influences on the design and top speed of the VeloX 9 can be investigated. The studied variables are:

- The air resistance (CdA-value)
- The aerobic power of the athlete
- The maximum power of the athlete
- The roll resistance of the tyres
- The weight of the VeloX 9

After determining the optimal sprint moment and optimal weight, the sensitivity analysis is performed. This is done by slightly increasing each variable and determining the new top speed using the adjusted variable. This allows us to find the slope between the specific variable and the top speed, calculated around the design speed of 125 km/h. Investigating the degree in which the top speed changes, gives us the sensitivity.

We were able to conclude the following after the sensitivity analysis:

- The CdA-value is still crucial, as it has the biggest impact on the top speed;
- In the previous years there was not a special emphasis regarding the weight of the VeloX, yet weight saving has a relatively big impact on the top speed and the CdA-value has already been optimized during the last years;
- For our specific athlete, aerobic power plays a more important role than anaerobic power regarding the top speed;
- The exact rolling resistance of the new tyres are still unknown, but now we have an idea of the margins in which the new rolling resistance could affect the top speed.

Afterwards, we looked critically at the used models, possibles mistakes and the reliability of the applied methods.

- The genetic algorithm is able to find the local optimum, but it is possible that it does not find the global optimum that is not close to the starting conditions.
- During the sensitivity analysis of a parameter, the remaining variables are assumed constant whilst in reality, they can be affected by the change of the parameter. For example: a lower weight could result in a different optimal sprint moment, which also changes the top speed.
- The model used a constant wind speed in one fixed direction, which may not represent the conditions during the race accurately. Wind speed and direction may vary due to meteorological changes or changes in the environment, for example the presence of hills and bridges. This year we hope to also obtain measurements of the wind speed and direction along the race track allowing the next team to construct a wind profile.

Photographer: Bas de Meijer



Computer Science Puzzle

Louise Leibbrandt, Editorial Staff MaCHazine

Bakuro / Revelations

Fill the empty cells of the grid with the numbers 1,2,4 and 8 (i.e., only powers of 2). The numbers in each block in a column or row must add up to the number given in the clue above or to the left, respectively. No number can be used twice within any sum. The clues are given in both binary and decimal. The answers must also be written in both binary and decimal.



Solution to last Issue's Computer Science Puzzle

1) You must turn over card A and card D

Did you get this one wrong? This is called the Wason selection task and was devised by Peter Cathcart Wason in 1966. It may well have fooled you! Psychology researchers have shown only about 5% of the population gets it right. So well done if you did get it right. Although we think we act logically, often we don't. Most people think the answer is to turn over card A and card C, which wouldn't prove.

Why? The statement "every card with a vowel on one side has an even number on its opposite side" can only be shown to be false if there was an odd number on the opposite site of one known to be a vowel card (ie card A) and/or a vowel on the opposite side of one known to be an odd numbered (i.e. card D).

2) You must turn over card B and card C

Later in 1992 researchers Cosmides and Tooby found that people could do this task and select the correct cards, if they were given a version of the test that was relevant to a social situation, like the one here about whether someone is old enough to buy fireworks. Most people get this right, but found the first one hard, even though logically they are exactly the same problem.

We are better at logical thinking when it is socially relevant - we are social creatures more than logical ones, which is why we need to train our skills in logic. 🔕

Mathematical Puzzle

Kilian Buis, Editorial Staff MaCHazine

Problem 1 N4

A gigantic pie is split amongst 100 guests. The first guest gets 1% of the pie. The second guest gets 2% of the remaining pie. Then the third guest gets 3% of the remaining pie, and so on, until the last guest gets 100% of the remaining pie. Which guest gets the largest piece of pie?



Problem 2 N4

Evaluate

 $\frac{(10^4+324)(22^4+324)(34^4+324)(46^4+324)(58^4+324)}{(4^4+324)(16^4+324)(28^4+324)(40^4+324)(52^4+324)}.$

Hint: Use the identity: $a^4 + 4b^4 = (a^2 + 2b^2 - 2ab)(a^2 + 2b^2 + 2ab).$

Answer to Problem 1 N3

Important things that we know are:

- There are at most 13 tanks and we already have found 6 tanks in sectors Alfa en Beta. So the total number of tanks must be between 6 and 13.
- We also know that each sector has a different amount of sharks, with no more than 7 in each one. Since there are 2 in sector Alfa and 4 in sector Beta, sector Gamma can have 1,3,5,6 or 7 sharks.
- Out of all the 50 organisms in all 3 sectors, we know at least 7 of them are sharks, leaving a maximum of 43 fish in all the tanks. And the more sharks we find in sector Gamma, the fewer fish there are in sector Gamma.

Making a table of this gives us:

S	Ν	6 T	7 T	8 T	9 T	10 T	11 T	12 T	13 T
1	43								
3	41								
5	39								Х
6	38								
7	37								

Here S is the number of sharks in sector Gamma, N is the total number of fish in all tanks and T is the number of tanks. Now remember that the fish were equally distributed across all the tanks. That means that the possible value for the total amount of fish must be divisble by one of the possible values for the total amount of tanks. Looking at the table, there is only one possibility; 13 tanks and 39 fish in total (with 3 fish in each tank). So in conclusion, you must find 7 tanks in sector Gamma.

Answer to Problem 2 N3

To find the answer to the first sum, set

$$s = 10\sqrt{10\sqrt{10\sqrt{10}\sqrt{\dots}}}.$$

Then $s = 10\sqrt{s}$. Solving this gives s = 10.

Similarly, the answer to the second can be found, by setting

$$t = 10 \sqrt[n]{10 \sqrt[n]{10 \sqrt[n]{10 \sqrt[n]{\dots}}}}$$

Then $t = 10 \sqrt[n]{t}$. Solving this gives $t = \sqrt[n-1]{10^n}$.

Source Image: https://www.storyblocks.com/stock-image/knife-cuting-pieces-of-cake-hand-drawn-illustration-sxb0f5w1mnjr26apbe





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Made by: Maxime Hoekstra, Editorial Staff MaCHazine

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