De Vonk

Periodical of E.T.S.V. Scintilla
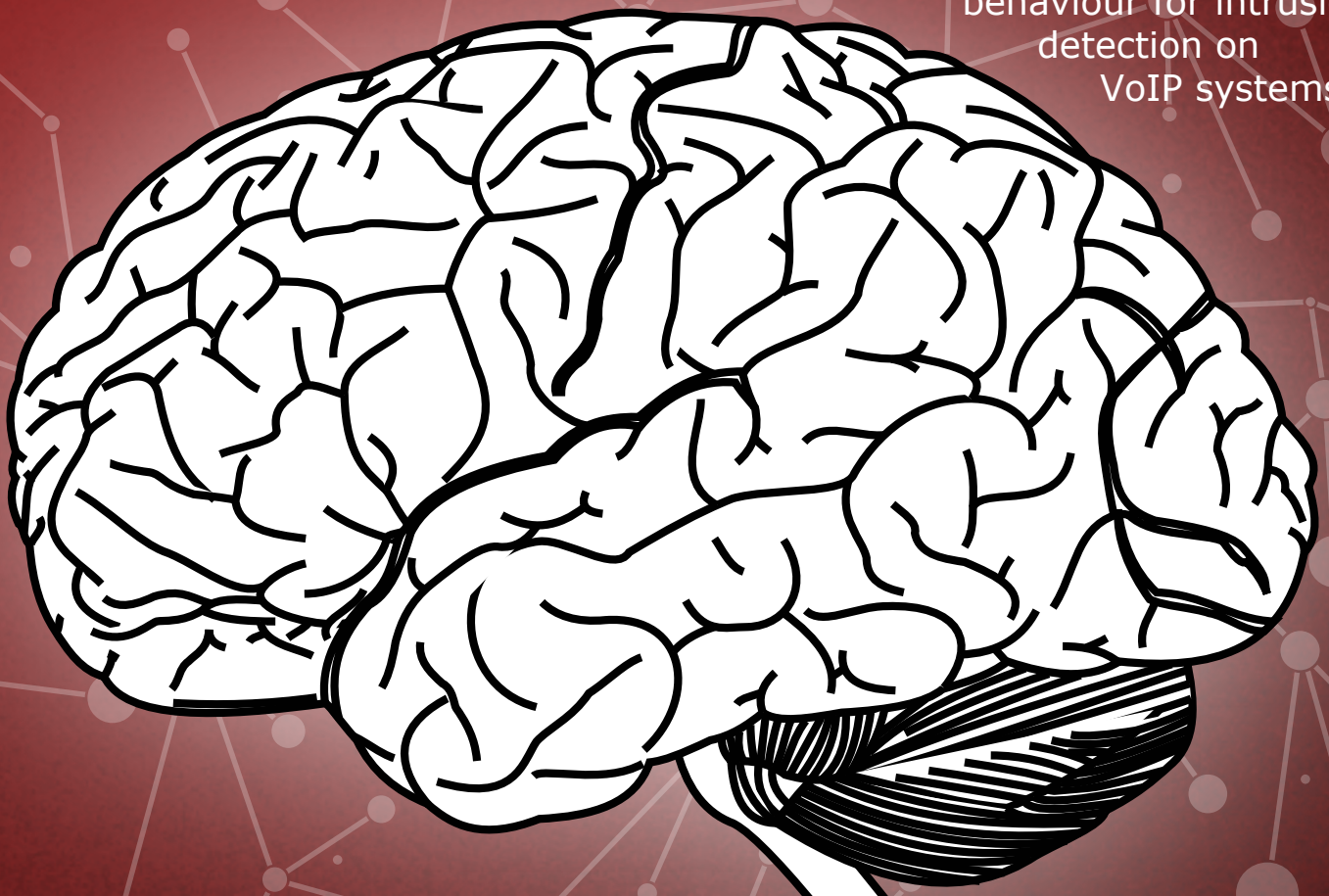
Master Thesis
Neuronal networks on petri plates

Study tour
Sakura Zensen

Internship
Modelling call behaviour for intrusion detection on VoIP systems

Can you fill this page? Come and join the Vonk. Mail to Vonk@scintilla.utwente.nl

Best wishes

Author: Robert Fennis

Dear readers. At the time of writing, most of worlds great leaders are spending their time in Den Haag (never call it The Hague if you are a proud Nederlander) talking about Nuclear safety. How do we keep our bombs safe from terrorists and prevent our reactors from melting down? To my surprise, Alaadin Al Dahir was not invited. I mean, if there is anyone passionate about ensuring the safety of our nuclear reactors its him right?

Enough of getting us engineers to the summit, what about getting them to us? A 'nuclear summit cantus'! Can you imagine? China's president Xi Jinping doing a Amicaal Ad Fundum with King Abdoellah II? No? I can! And it's awesome. This would probably be by far the best Cantus to be the Preases! Enough about doing a cantus with all the worlds great leaders, lets talk about this year.

We are now probably somewhere in May (Hi future me!) and in the final quarter of our study program. The first year students are struggling with their first confrontation with our big friend Maxwell. This year, EM-Field theory and Electrodynamics is combined into one big module so they will be facing a lot of vector calculus! I wish all of you a lot of luck since this will be probably one of the more difficult quarters in your bachelor program.
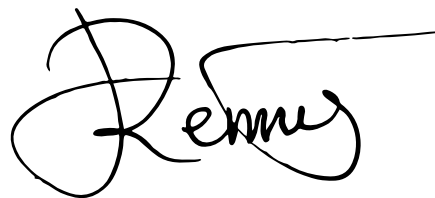
Second year students will be starting with their Bachelor 2 project shortly. For me, this was by far one of the most awesome periods in my bachelor so far. This is really the chance to be the engineer and solve a problem. Also, because you have a lot of time, you are really able to dive into a subject and specialize yourself in a specific skill that you need to have to engineer your product.

The third year students will be working on their bachelor assignment. I have no experience with doing a bachelor assignment but from what I have seen, its pretty though work. So I also wish all of those working on their bachelor assignment the best of luck.

It's time to wrap up. I hope you will have fun reading this Vonk. On a side note, if you want to contribute to such an amazing magazine, feel free to contact the committee! So again! The best of luck to all of you working your hunky butts of! I hope you all do well!

Op de koningin, op Scintilla!

Robert Fennis
President

Thales End-P Event
Wednesday 11 June
17:30h, Zilverling

VriMiBo
Friday 13 June
16:00h Abscint

General Meeting
Thursday 19 June
12:30h, Carré 3A

EWI-BBQ
Thursday 19 June
16:00h, Abscint

SCALA's SummerBBQ
Thursday 26 June
18:00h, O&O Plaza

Masthead

De Vonk

All members of Scintilla receive De Vonk free of charge by post.

8. Internship

A big part of a technical academic master, is the internship. For this period of four months, Erwin worked at the telecommunications company SpeakUp in Enschede for the development of a fraud detection system. In this article, you will learn which techniques can be used to prevent malicious VoIP calls. Of course, in this article there will also be some words about how the life of a student is in Enschede.

10. Afterlife

In every edition of De Vonk there is an article about the life of someone who is graduated. In this edition, Derk tells about the time immediately after his graduation and how life looks like in the present. You can read how did he find his job at AWL-Techniek in Harderwijk, what kind of tasks he has to do and what his plans for the future are.

15. Master's Thesis

Recently, Jelle got his master Electrical Engineering at the University of Twente. In his master assignment, he worked on neuronal networks. One of the many properties of neuronal networks is memory. How does our brain remember things and can the technology learn from nature to build artificial neuronal networks with the same performance? Read this article to find the answers.
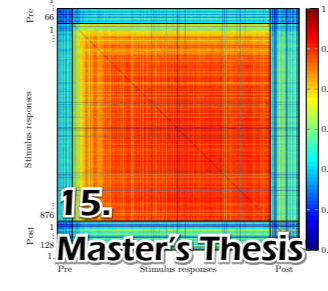
31. Study Trip

Scintilla aims to organise a big international study trip every two years. Since a few years, all participants in the trip take care of the organisation of the trip. In February of this year, a group of Scintilla members went to Japan for this trip. In this article, you can read how the participants experienced this trip and what they did on the other side of the world.

Editorial

Reflections

While the current Vonk is being put together, I have a few moments to reflect on De Vonk itself.

How does Scintilla think about De Vonk?

Well part of this has been discussed during the LTB brainstorm evening. One of the points of the evening was the question if De Vonk should stay or not.

This is in my point of view, a easy question. Of course it should stay! De Vonk is not only an important part of the image of Scintilla, but is also an enjoyable challenge to create and fun to read.

But this statement can be doubted. How many people do actually read De Vonk? And how many people would miss it? These are not questions that can be answered right now of course, but they are important to ask.

I for one enjoy both the reading and the creating of De Vonk, so I must regret the fact that I have the free time for these reflections when I should be working on De Vonk.

Tim Broenink

News for the Electrical Engineer

Author: Maikel Huiskamp

Quantum information send to multiple receivers

At the Canadian university of Waterloo scientists have demonstrated the first distribution of entangled photons at three different locations several hundred meters apart. This three photon entanglement leads to the possibility of multi-party quantum communication.

This non locality of particles describes their ability to "know" about each other's states instantaneously. This means that it might be possible to transfer information instantaneously. This transfer of non-local information of the states of the photon does not mean that communication can be done faster than the speed of light.

For this experiment photon triplets were generated in Resch's Lab. After their creation the first photons is delayed in an 580m optical fiber in the lab, while the other two photons are send through a 85m optical cable to the roof of the lab were they are send through two telescopes. The two photons were then send to two different trailers. Both trailers contained measurement equipment and a quantum random number generator to measure the photons independently. The measurements were also done in a small time window of 3ns to ensure that no other information transfer was possible.

This research could lead to multiparty quantum communication protocols, including Quantum Key Distribution (QKD), third man cryptography and quantum secret sharing.

Source: http://www.sciencedaily.com/releases/2014/03/140323184408.htm

Electric thinking cap helps learning new things

A psychologist and a professor of psychology have shown in a new study that it is possible to manipulate our ability to learn by applying a small electrical current to the brain. This effect can be enhanced or depressed depending on the direction of the current.
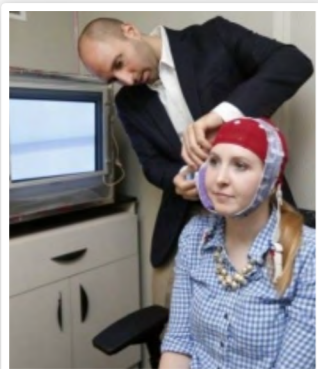
It is believed that the medial-frontal cortex in our brain is responsible for the response we experience when we make an error or do something wrong. Previous studies have shown that when we make a mistake a small negative voltages spike occurs milliseconds after the mistake was made. The researchers wanted to test if this activity influences the way how we learn things.

Using an elastic headband that secured two electrodes conducted by saline-soaked sponges to the cheek and the crown of the head, the researchers applied 20 minutes of trans cranial direct current stimulation (tDCS) to each subject. In this method a very small current flows from the anode through the skin, muscle, bones and brain to the cathode on the other side. Three sessions were run on each subject, one with a current from the anode to the cathode, on in the reverse direction and a noise condition.

The subjects were given a task that involved figuring out which color was mapped to which button on a game controller. During the test the electrical brain activity of each participant was measured. This allowed the researchers to watch the brain activity when an error was made. When an anodal current was applied the learning spike was twice as high in a majority of the participants and the participants made fewer errors, while when a cathodal current was applied the spike was smaller and the subjects made more errors. The effect of the 20 minute test did transfer to other tasks, and lasted for about five hours.

Source: http://news.vanderbilt.edu/2014/03/thinking-cap/

Solar cell can double as laser

The latest research in solar cell materials have shown that the new and promising material perovskite can also double a laser. The relatively new type of solar cell made out of perovskite material already have a 17% efficiency after two years of development while conventional silicon based solar cells have a efficiency of 20% after twenty years of development and now it is also possible to use the material for efficient lasers. Perovskite is also a very inexpensive material and can achieve a low level of impurities with inexpensive thin film solutions.

The researchers from Cambridge's Cavendish Laboratory have shown that perovskite upon light absorption releases very quickly two charges (an electron and a hole) which than take several microseconds to recombine. This lifetime of charges is long enough for chemical defects to have ceased the light emission in most semiconductors. By sandwiching a thin layer of perovskite between two mirrors a laser is produced where 70% of the absorbed light is reemitted.

http://www.cam.ac.uk/research/news/revolutionary-solar-cells-double-as-lasers
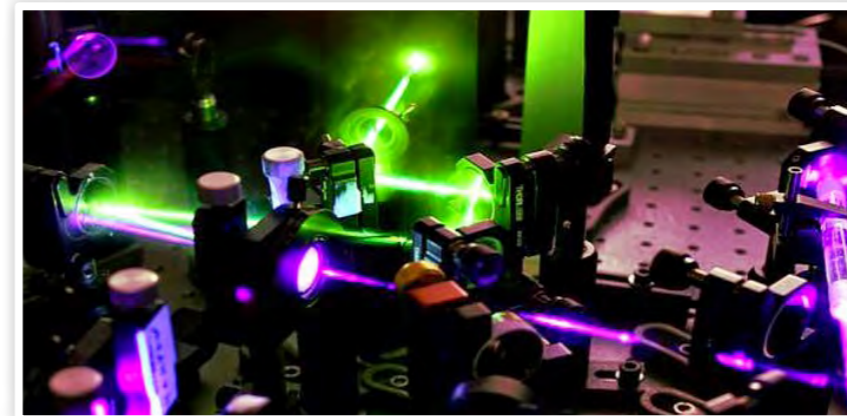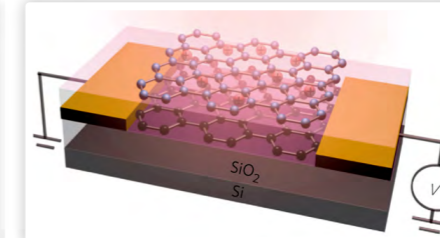

Infrared vision contact lens

The Michigan research institute created a contact lens which gives the user infrared vision. Graphene is capable of detecting the entire infrared spectrum, with visible and ultraviolet light filtered out. There is only one big problem with graphene and that is its thickness. Because graphene is only one atom thick it can only absorb 2.3 percent of the light that hits it.

To achieve the detection of infrared light an improved detection method is introduced. The researchers applied a technique in which they do not try to amplify the freed electron holes generated by the incoming light, but instead they amplify the electrical current near the electrical signals generated by the incoming light.

The researchers sandwiched an insulator between two sheets of graphene. The bottom sheet has an electrical current flowing through it. When light hits the top sheet free electrons and charged hole pairs are generated. The electrons are able to quantum tunnel through the insulating layer. The electron holes then generate an electric field that impacts the way the electrical current flows in the bottom sheet. By measuring this change of the electrical current in the bottom sheet the researchers could derive how much light hit the top layer.

Source: http://spectrum.ieee.org/nanoclast/semiconductors/optoelectronics/graphene-gives-you-infrared- vision-in-a-contact-lens

Computers teach each other by playing pacman

Some say that you cannot learn anything from playing computer games, but researchers from the University of Washington have developed an algorithm that enables computers to learn and teach each other by playing Pac-Man. This could lead to robots teaching humans.

The experiment contained a student agent and a teacher agent. The student agent is supposed to navigate the maze while being chased by the four ghosts. When the student would get into trouble the teacher agent stepped in to give advice.

Knowing when to give advice at the precise moment is a hard skill to get for teachers. The algorithms developed recognize the fine line between helping to much and too little or too late. In the experiment several students were able to outperform their teachers because they learned to think independently from them.

Source: http://spectrum.ieee.org/tech-talk/computing/software/computers-learn-and-teach-each-other-by-playing-pacman

Internship

Modelling call behaviour for intrusion detection on VoIP-systems

Author: Erwin Bronkhorst

One of the mandatory courses in the program of the master Embedded Systems is the external training, or internship. During a period of 14 weeks, you work on an assignment outside the University of Twente. For my internship, I got a nice job at SpeakUp, a telecommunications provider that is settled on the 'Kennispark' in Enschede. In this article, I will write my experiences on interning and I will give some details about the assignment I worked on.

Finding an internship

One of the first questions I asked myself before I went looking for an internship position, was whether I wanted to go abroad, or stay in The Netherlands. I have doubted a long time, because I am not a big fan of travelling and staying in the Netherlands kept me in my 'comfort zone'. However, I saw an internship abroad as a great experience and very instructional for my personal development. As a student in the ninth year of his study, it became more and more important to get an internship really fast (I had to finish my internship, graduation and last course in one year). In the summer of 2013, there was no time left to organise an internship abroad, so my doubts forced me to find an internship 'in the neighbourhood'.

On the internship Blackboard site I noticed an experience report of a student that did his internship at the company 'SpeakUp'. I know that company since I was a board member in the student association 'Studenten Net Twente' (SNT). Some former members of that association work there and the founder of the company is an old board member of SNT. I contacted the company and during a nice talk at the company we formulated an assignment and I finished the formalities at the University. On 2 September, my first day in the office started (Figure 1).

The company SpeakUp

SpeakUp is a telecommunications company, founded in 2003. It is located on the Business and Science Park in Enschede, so very close to the University. The company offers telecommunication services to the business market. The services are based on internet telephony (VoIP). The company provides a PBX (Private Branch Exchange), offers trunks to connect the current PBX of a company to the telephone network, offers SIM cards for mobile communications and provides all kinds of phone services like IVR (Interactive voice response), voice mail and dialling rules.

The total number of employees is between 40 and 50 people. Within the company are several departments, like Sales, Support, Development, Network Operations Centre (NOC) and Front Office. My assignment was done within the NOC department. This department takes care of all servers of the company, which are mainly colocated in different datacentres.

My assignment

A big problem with VoIP nowadays, is that the accounts get hacked. If a VoIP account is hacked, somebody else with access to the

Figure 1: My desk during my internship. Yes, I actually watched black screens most of the time.

account can make calls to other destinations. The fraudsters try to make as much profit as possible, so these are often calls to expensive countries. Furthermore, it are often long calls and not seldom the fraudsters make many calls at the same time. This results in a high bill for the customer at the end of the month. The customer should pay the bill, because it is his account that is being abused. However, SpeakUp cares a lot about its customers, so the company tries to prevent such high bills. My assignment was to make a system that was able to detect malicious behaviour, based on the normal behaviour of a customer. If a customer never calls to a foreign country and all of a sudden, a lot of calls are made to Sao Tome and Principe (yeah, my internship was good for my topography too), it is likely that the account is hacked. In that case, an alarm is raised and an employee of the company looks into the behaviour of the account in more detail.

Implementation

When I started my assignment, I looked into artificial neural networks: self-learning algorithms that are capable of finding outliers in big data sets. Unfortunately, I soon discovered that people behave abnormal all the time and a lot of legit phone calls were marked as outlier. The rate of these false positives was way too high and I did not feel confident that improving the system would significantly lower this false positive rate.

Therefore I decided to focus on the detection of malicious calls, based on the typical properties of malicious behaviour. After the analysis of several different malicious call sequences, I defined four properties that might indicate malicious behaviour: the number of concurrent calls of one account,

the geographic destination of the call, the rate of the call (Euro per minute) and the SIP response code. The SIP response code is a property that is generated on the VoIP-server and standardised in RFC 3261. For example, there is a SIP code for a call that is successful, a call that is cancelled before the other side picked up the phone and a phone call to a number that is busy.

Each phone call now gets a score for each of these properties and together with all phone calls of that account within the last 5 minutes I checked if the sum of each property exceeded a certain threshold. If one of the four properties exceeded the threshold for one account, a so called 'notification' was generated. If two notifications were generated by the analysed calls, an alarm was generated and the account was marked as 'hacked'. I choose to wait for two notifications and not for just one, to lower the amount of false positives. The process of notifications and alarms is shown in Figure 2.

When the final detector was ready, it was able to detect 96% of all hacked accounts with a false positive rate of 6% (i.e.: 6% of the detections were not malicious). Based on the total number of calls and fraud cases, this result is quite good and it might be used in a production environment in the future.

During the internship

One of the things I liked about my internship, was the way SpeakUp treated their interns. They were really integrated in the company. This was especially clear during the outings of the company. The first one was an event in the first week of October. As a sponsor of the 'Military Boekelo', a big horse event, SpeakUp has a stand where the company can organise meetings. This year, SpeakUp had decided to talk with other telecommunication companies about fraud, which was also the topic of my internship assignment. Therefore, I was invited to be at the event. After some interesting talks of the systems that other companies use, there was a drink and I could watch some horses doing nice sports. It was a very interesting and nice afternoon!
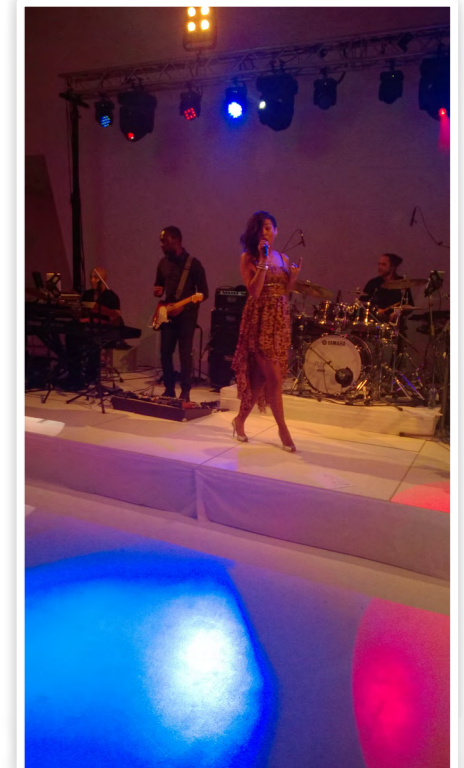
Figure 3: Rafaëlla (some Dutch singer) performing at the private party of SpeakUp

Another memorable moment of my internship was the celebration of the 10 year anniversary of the company. At 21 November, a big celebration was organised in the Jaarbeurs in Utrecht. The travel to the venue was by train and the trip back was with a touring bus. During the event, there was an excellent diner served and a big party with free drinks, live music of Rafaëlla (Figure 3) and all cool colleagues from the company. It was a great experience and it was a nice gesture to the interns that they were welcome too.

Conclusion

Despite the fact that my internship was not in an exotic country, far away from the Netherlands, I enjoyed my time at the Kennispark. One of the biggest advantages was that I could keep my usual social life, for example to visit activities of Scintilla and keep doing committees work. The assignment was very interesting and I'm quite happy with the results. And last but not least: the people at the company SpeakUp were nice to me, which is a must for a nice time.
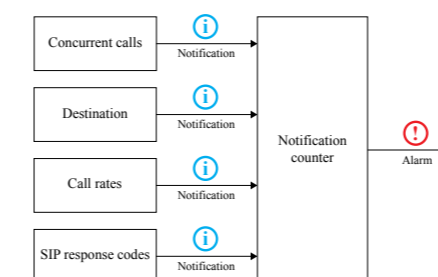
Figure 2: Schematic view of the misuse detector

Scrapheap Challenge

Author: Joep Zanen
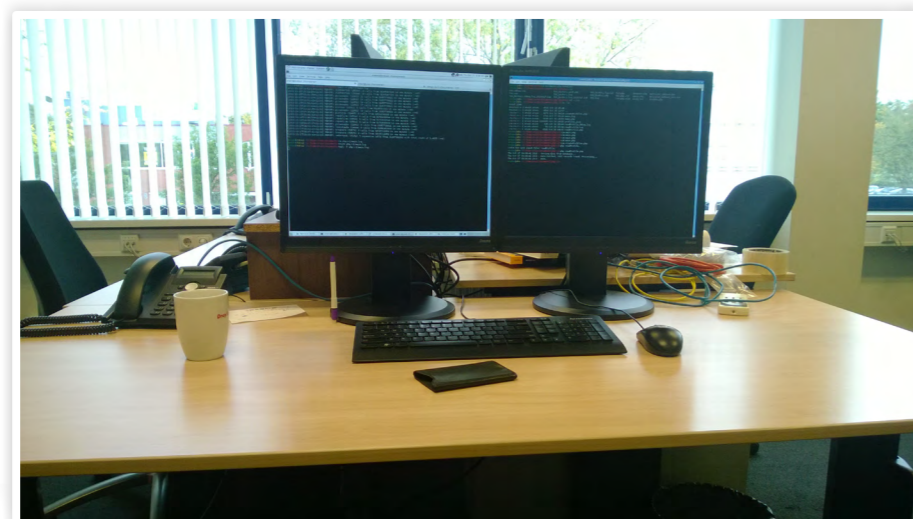
The weekend of 7-9 March, Scintilla organized the annual Scrapheap Challenge Electrical Engineering. In this competition seven teams of students competed to show their resourcefulness in both design and construction using only very limited time and resources.

For those who are not familiar with the Scrapheap Challenge: Scrapheap Challenge used to be a show on Discovery Channel in which two teams were given a, mainly mechanical, design challenge. With only one weekend of time and a scrap yard at their disposal, these teams would have to build a device which would beat the other team in a spectacular challenge. At Scintilla, we have our annual version as well. With only one weekend of time and a scrap yard at their disposal, our Scintilla members will have to construct a device which can compete in an electrical engineering challenge.

This year's challenge starts with a little history lesson. Let's start at the beginning. About 14 billion years ago the universe was born in the Big Bang. Somewhat later in time, we find the collision of our proto-Earth and a Mars-sized (the planet, not the candy bar) celestial body called "Theia". This created the moon, as well as an Earth with a composition which made our current life forms possible. A little later in time we find dinosaurs and other early life, which finally evolve into the most advanced species there is: the homo sapiens sapiens. If we take a look at the electrical engineering

student, we recognize a similar pattern. To start off: there was the birth of you. Somewhat further in time we find the collision of the young you and a person, called "Thea". A little later in time we find audio amplifiers and other early projects, which finally evolve into the most advanced technology there is: high-tech electrical engineering. The question which now remains is what made us humans this most advanced species. The answer: ranged weapons. Using simple spears, even the largest animals such as mammoths became our targets. Later on in history, we find more advanced ranged weapons: bow and arrow, cannons, muskets, automatic rifles. Since the introduction of drones the range of our weapons has become so large, that we do not even need to be on the same hemisphere as our weapons, let alone our targets. The conclusion one can draw from this history lesson, is the following: if the electrical engineer continues its parallels to the main events in the history of the Earth, our success will depend on increasing the range of our weapons. The logical assignment for the Scrapheap Challenge Electrical Engineering 2014 thus became destroying each other from a distance: robot wars.

On a Friday evening, the 7th of March, a group of 31 students were presented with

the challenge to make a robot which could destroy the balloon of a rival's robot, whilst defending the balloon attached to their robot. For the simple reason that every brilliant idea starts with a sketch on the backside of a beer mat, we continued with a brainstorm drink. As this session passed ideas got wilder and wilder, ranging from flails and robot swarms to harpoons and cutting the power cables of the opponents. After an evening of discussing, sketching and making a bond graph for shits and giggles, we called it a night.

The first two minutes of the next morning would be essential for the rest of the challenge: getting the most useful scrap. Whereas the mother lode of last year would have been a microcontroller for wireless communication, this year all eyes were on the powerful electro motors. Within a few seconds of the opening of the scrapheap most devices with motors, such as printers, were already gone. We, as the organization, had gathered over two busloads of scrap, but still the scrapheap was almost empty after the first five minutes of scavenging.
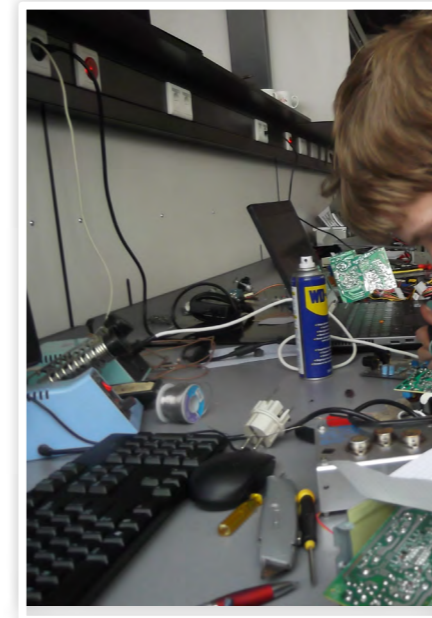
With their components, the seven competing teams started working on their contraptions. Some teams expanded their ideas with the use of microcontrollers and additional weaponry and some designs were even stripped off the idea of displacement. The coming day and a half, construction would
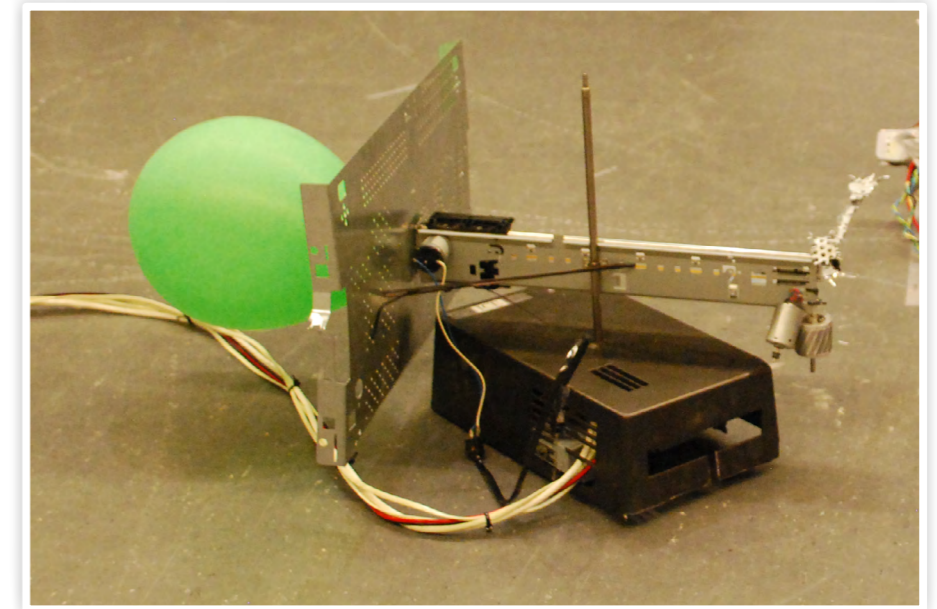
continue in a race against the clock to finish the contraptions.

Apart from the general participants, we as the committee were working on our so called "Devastating Object of Onmeunige Mayhem Breaking the Odds of Tie" (DOOMBOT).

The idea of DOOMBOT was to have our own robot which would enter the battle if there was no winner after three minutes. Having the team "the CHEATERS", we did not start from scrap, but used an old RC buggy and just attached a few spikes. This did not even turn out to be the best approach, but at least it was the most time efficient.

> "After two days of scavenging and construction it was time for the final challenge."

After two days of scavenging and construction it was time for the final challenge. In one epic tournament, it would be decided who will become the victor and who would be its victims. In the preliminary rounds of the competition, the computer case booby trap by team TSZT, the leech fan of mayhem by team incapabEL, the semi-stationa-

ry bulldozer by team Per Aspera Ad Astra and the epibration device by the Bazenteam were eliminated. Most for obvious reasons, others because of interference of the DOOMBOT. For some miraculous reason, the stabbing device of team SPARES managed to make it to the semi-finals, even though it was unable to move or even position its weapons. Less miraculously, it proved no match for the remaining teams and did not make it to the finale.

After eleven epic battles of robot violence, only two teams were still standing: the ravaging flail by our freshmen team "the Electrocuteers", and the accurate sting by Maikel en de BHV'ers. In a 47 seconds lasting fight, the Electrocuteers were beaten. Their flail could not match up to the agility and precision of their rival. Finally, after years of being second, some recognition for the Scrapheap efforts of Maikel en de BHV'ers. Congratulations!

Thales

THALES
Together • Safer • Everywhere

Ik was vijf jaar geleden met mijn studievereniging T.F.V. 'Professor Francken' uit Groningen op excursie in Hengelo. We kwamen bij het bedrijf Thales terecht en ik was onder de indruk van de technologische snufjes op het gebied van safety en security. Thales bleek een veel groter bedrijf dan gedacht met wereldwijd meer dan 68.000 medewerkers. Ook in Nederland bleek Thales meerdere vestigingen te hebben.

De opdracht die ik voor mijn stage zocht, lag voor mij klaar in Delft. Daar onderzocht ik met een wiskundige theorie de hoeveelheid informatie die in een radarecho zit en hoe dit verandert als het doel verder weg is, met als doel dat radars op schepen nog preciezer doelen op zee aan kunnen geven waar dat mogelijk is. Dat klinkt heel theoretisch, maar ik leerde om de theorie direct met praktijk te combineren met een techniek ontwikkeld door een Thales-afstudeerder in 2011. Omdat ik aangegeven had na mijn stage te gaan promoveren werd mij de kans geboden om tijdens de stage al papers te schrijven, samen met mijn begeleider. Deze papers zijn opgestuurd naar radarconferenties in Lille en A Coruña in Spanje. Als het daar goed ontvangen wordt dan zou ik daar via Thales zelf heen kunnen en een presentatie mogen geven. De ontwikkelde theorie zal de komende jaren verder ontwikkeld worden door mijn begeleider en nieuwe afstudeerders en stagiairs, met als doel dat het uiteindelijk geïmplementeerd wordt in radarsystemen.

Dat ik als student zo serieus genomen zou worden had ik niet verwacht.
Afgelopen februari ben ik afgestudeerd. De komende vier jaar ga ik promoveren in Groningen, maar als ik dat heb afgerond, zal ik zeker Thales in gedachten houden.

Edwin de Jong
Masterstudent Applied Physics, 24 jaar

Remco IJpelaar
Student Technische Informatica, 22 jaar

Tijdens de waterpolo vertelde ik mijn teamgenoten dat ik opzoek was naar een afstudeerplek voor mijn studie Technische Informatica aan de Hogeschool Avans in Breda. Mijn teamgenoten adviseerden mij eens bij Thales te gaan kijken. Ik heb op de site gekeken en vond de combinatie van groot, hightech en internationaal erg gaaf en besloot daarom te solliciteren voor een afstudeerplek. Ik kwam terecht aan de andere kant van Nederland, in Hengelo, waar veelal producten voor Marines worden gemaakt. Meer dan 85% van deze producten wordt geëxporteerd naar het buitenland, dat had ik niet verwacht in Hengelo te vinden. De gemiddelde leeftijd ligt hier wel vrij hoog, maar ik merk dat het gewaardeerd wordt als er jonge mensen binnen komen met frisse ideeën. Het wordt gestimuleerd om je mond open te trekken en kritisch te zijn, dat vind ik mooi!

In het onderzoek houd ik mij bezig met het opzetten van een sterke WiFi verbinding op zee. Als schepen onderling contact willen leggen via radio of satelliet is dat erg kostbaar, daarom is het van belang om alternatieven te onderzoeken. Het eindproduct dat wij voor ogen hebben zal bestaan uit een demonstratie van twee apparaten die over een afstand van minstens tien kilometer een WiFi verbinding kunnen opzetten en met een hoge bandbreedte data over en weer kunnen sturen. Ik onderzoek, bouw en test het project. Het project is in eerste instantie voor op zee bedacht, maar ook de kustwacht heeft inmiddels interesse getoond.

> *"Een WiFi verbinding opzetten die mijlen over zee reikt. Het lijkt me gaaf om later te kunnen zeggen dat ik aan de wieg van dit project stond."*

In juni hoop ik te kunnen afstuderen. Er is mij inmiddels een baan aangeboden als netwerk engineer bij Thales. Ook in mijn eerste baan als netwerk engineer zal ik betrokken blijven bij het project van de WiFi verbinding op zee. Ik hoop dat het over een paar jaar in werking is. Het lijkt me dan erg gaaf om later te kunnen zeggen dat ik aan de wieg van dit project stond.

Op zoek naar een stage, afstudeerplek of eerste baan?
Start jouw carrière bij Thales. **Kijk op www.thalesgroup.com/nl**

Neuronal Networks on petri plates

Author: Jelle Dijkstra

It is estimated that the human brain consists of approximately 10^11 individual neurons, cells with remarkable features that form electrical and chemical connections among each other known as synapses. These connections turn a cluster of nerve cells into a neuronal network that is complex enough to think about its own complexity. But why should it do that? Comprehending the mechanisms of the neuronal structures in living beings is a rewarding task in neuroscience. It may aid in understanding and therefore treating neurological disorders, such as Parkinson's disease, epilepsy and dementia. In addition, artificial neuronal networks may be fruitful for problems such as image processing, pattern recognition and artificial intelligence in general. For my master's assignment, I looked at one of the many properties of neuronal networks, namely memory. Memory can be described as the concept of storing and recalling information. In the broadest sense however, memory means that the current behaviour of a network depends on prior input. In my research I used two of the tools that are common in neuroscience: computer models and living networks cultured on petri dishes and tried to find changes in the spontaneous activity of these networks induced by stimulation.

The human nervous system

The human nervous system is composed of the peripheral nervous system and central nervous system (CNS). The latter can be subdivided further into the brain and the spinal cord. Together, the human nervous system fulfils three tasks: integration, coordination and regulation of the body.

It integrates all the information we receive from our environment and internal sensory systems to give us an idea of our current state. Based on this information, it coordinates our muscles to perform desired movements and regulates our body, e.g. our breathing, heart rate, etc. Everybody who has experience with control systems cannot but see the ingenuity of our control mechanism, for instance when balancing on one foot.

If we want to analyse our nervous system, we can do that in a top down or bottom up approach. In a top down approach, we can regard it as a black box with in- and outputs. The inputs are all our senses, e.g. hearing, sight, pain etc. Nearly all the output can eventually be reduced to muscular activity, but another important output is the non-muscular regulation of the body, for instance by sweating. The relation between the in- and outputs of the system are studied in different science fields, e.g. (neuro-) psychology. In my opinion, any kind of behavioural study can be seen as finding in- and output relations in our brain. With modern imaging techniques such as functional magnetic resonance imaging (fMRi), local activity in the brain can be measured by means of blood flow. This way, scientists related certain areas within the brain to different activities and emotions.

In a bottom up approach on the other hand, we start with the smallest relevant subsystems and try to rebuild the whole system from there. Ideally, both approaches meet somewhere in the middle. At the moment however, the gap between the two is still very large. Reasons for this are the shear complexity of the system, its small size and the fact that neuroscience is a relatively new area of research. Since the brain is a biological system, it is hard to tell which processes are relevant for its proper functioning. Not the complexity itself but only the evolutionary development towards this complexity must be logical.

In addition, the brain is – luckily – not static but shows plasticity, a collective for any changes that occur in a neuronal network. Without long-lasting changes in the brain, we would not be capable of adapting to new environments, gaining experiences or learning in general!

Building blocks of the nervous system

Neurons

Core components of neuronal networks are obviously neurons, schematically shown in figure 1. The large "sphere" in the center is called the cell body or soma. In the mammalian brain, the somas are approximately 10-20 um in size. A membrane that is partially permeable to ions, most importantly potassium and sodium, surrounds the soma. Thereby, electrochemical gradients form across the cell membrane. This membrane potential is important to describe the state of a neuron. At rest, the potential across a neuron membrane is approximately -65mV. A neuron has a so-called dendritic tree through
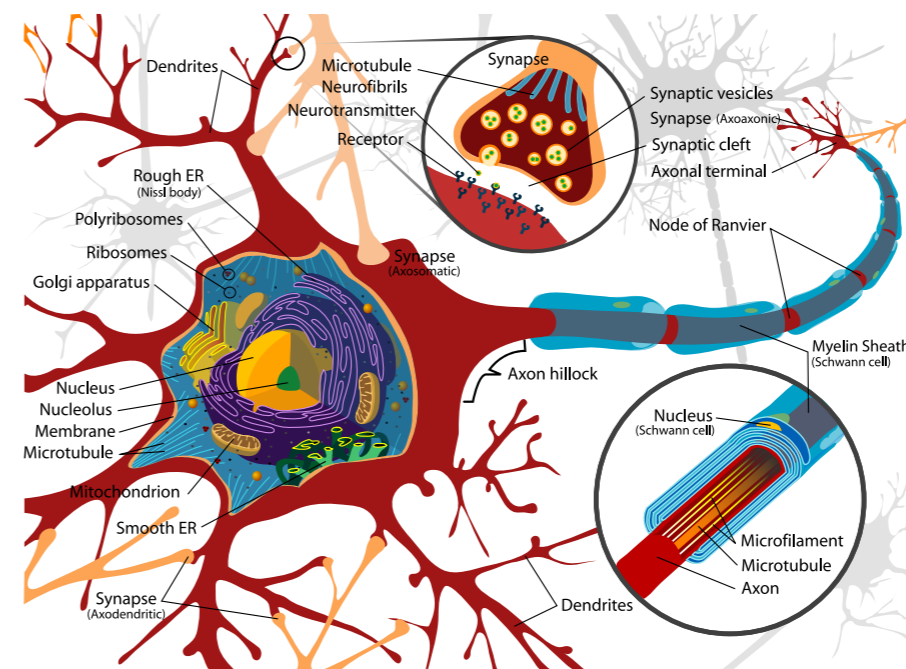

Figure 2: Membrane potential of a modeled neuron [1]. Noise is added between t = 20 ms and t = 75 ms. In the interval indicated by the red area, the neuron receives external input, which is enough to make it fire an action potential a couple of milliseconds later at t = 78 ms.

which it can receive input, affecting the membrane potential. If the cell is depolarized[1] beyond a certain threshold, it can fire an action potential as illustrated in figure 2. Action potentials are "all-or-nothing" and the shapes of action potentials are relatively independent of prior input. Summarized, a neuron can be seen as a combination of an analog and digital information-processing unit. It has an analog membrane potential that integrates external input. Only if this

> "A neuron can be seen as a combination of an analog and digital information-processing unit."

potential reaches a certain threshold, the neuron fires a digital all-or-nothing action potential. After firing, this action potential is conducted away from the cell body along the axons .

Synapses

When an axon of one neuron reaches the dendritic tree of another neuron, a synapse is formed. Synapses can be electrical or chemical in nature but the latter are by far more common. A single chemical synapse is unidirectional but two neurons can be connected bilaterally with two synapses and

Figure 1: Schematic drawing of a neuron. The large "sphere" in the center is the cell body or soma of the neuron. Important for the remainder of the text are the axons, synapses and dendrites through which the neuron connects with other neurons.
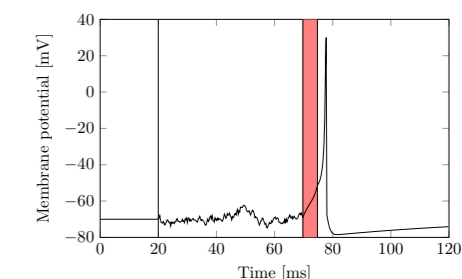
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[1] That is, the potential changes towards 0, meaning an increase of the membrane potential since it is negative in its resting state.
[2] Fun fact for the electrical engineer: the transmission through the axons is described by the telegrapher's equations, which is also used for technical transmission lines.

a neuron can even be connected to itself, called an autapse. When an action potential arrives at the presynaptic terminal, it causes the release of neurotransmitters that diffuse across the synaptic cleft. The neurotransmitters lead to a change in the ion permeability of the postsynaptic membrane, thereby causing an in- or outflow of ion currents and affecting the membrane potential of the target neuron. The magnitude of this current depends on the size of the synapse. One action potential fired by the presynaptic neuron is usually not enough to induce an action potential at the postsynaptic neuron. If however multiple action potentials arrive at the postsynaptic neuron in quick succession, possibly through multiple synapses, the target neuron may fire an action potential as well, closing the circle.

Synaptic plasticity
In order for a network to show memory, external input must lead to long-lasting changes. Input could cause structural changes in a network, e.g. new axons and synapses could grow or synapses could disappear. Another possibility is a change in the synaptic strengths of existing connections, also known as synaptic plasticity. The fact that the timescale of learning identified in biological networks is much smaller than the timescale of possible structural changes, implies that a mere change in synaptic strengths within an otherwise static network is sufficient for memory function. This is in agreement with a wide variety of theoretical work. If you want more information about this topic, search terms are Hebb's rule, Hopfield networks, attractor neural networks.

A mechanism that causes long-lasting

strength changes in biological synapses is called Spike-timing-dependent plasticity (STDP). It states that the strength of synapses change according to the precise timing between the arrival of presynaptic action potentials and the action potentials fired by the postsynaptic neuron. If a neuron B spikes very shortly after receiving synaptic input from neuron A, the connection from A to B strengthens. If the timing is reversed, the connection weakens. Spike-timing-dependent plasticity is intuitive in that synapses at which the postsynaptic neuron fires before the arrival of a presynaptic spike seem to be obsolete while synapses at which the presynaptic spike often induces a postsynaptic spike seem to be vital. Still, the challenge remains to show whether and, if so, how this low-level mechanism can explain the memory effects seen in neuronal networks.

Computational and cultured networks
By connecting the models described above, we can create a computational neuronal network and simulate its behaviour. Contrary to experiments with biological networks, simulations are perfectly observable and controllable but they are always a strong abstraction of reality. Even if we could make realistic models of all the processes in a living network, the model would become too complex to be useful in this study.
Neuronal networks can also be grown artificially. For this, a platform called multi-electrode array (MEA) is used. A MEA is a petri dish with a grid of electrodes at the bottom as shown in figure 3a. The outer contacts are used to interface with the rest of the measurement setup. They are routed to the center of the device where the electrodes are
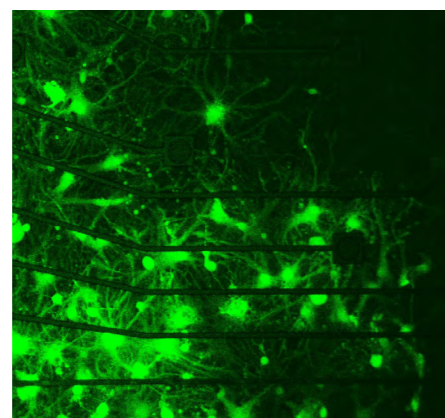
approximately 10-30um in size and have a spacing of 100-200 um. MEAs are plated with approximately 100.000 isolated, living nerve cells, usually taken from the brains of new born rats. Interestingly, these cells start to grow axons again and reconnect with each other, which is illustrated in figure 3b. Even more remarkably, a cultured network becomes intrinsically active about one week after it has been plated and shows spontaneous, synchronized activity called network

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> "We can create a computational neuronal network and simulate its behaviour."

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bursts. This activity can be recorded with the underlying electrodes that measure changes in the extracellular potential of neurons. Due to the very small signals (microvolts) and the noisy environment, the activity of the measured neurons is usually reduced to its action potentials. An exemplary network burst is depicted in figure figure 4a. The electrodes can also be used to electrically stimulate a network. Neurons near the electrodes can be activated and cause network wide responses known as stimulus responses. With respect to the duration and number of action potentials, stimulus responses are comparable to spontaneous network bursts. An exemplary stimulus response is shown in figure 4b.

MEA networks are relatively easy to culture, maintain and experiment with and have therefore become very popular in neuroscience. The advantage is that unlike biological nerve tissue, they are only 2D. Thereby, it is possible to visually inspect the whole network and apply chemicals to it. The main disadvantage is that only the action potentials of a very small fraction of the neurons can be detected. A good overview of the work with MEAs can be found in refMarom2002.

The hypothesis

So cultured neuronal networks show spontaneous activity. Since activity in the net-
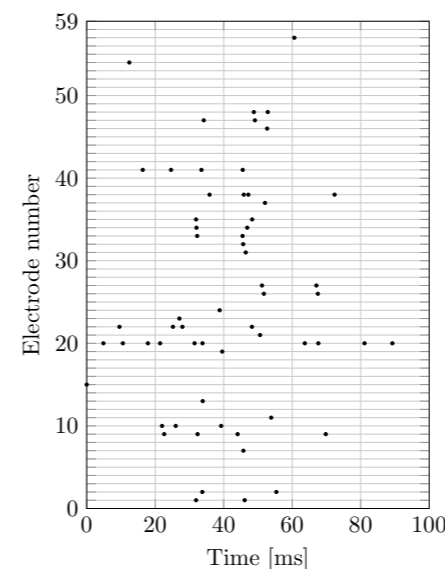

Figure 4a   *Figure 4b*
(a) shows a network burst that occurred during spontaneous activity of a cultured neuronal network (t = 0 is the time instance of the first spike in the burst), (b) shows a stimulus response in the same cultured network (t = 0 is the moment of stimulation). Every dot depicts an action potential detected at one of the 60 electrodes of the underlying multi-electrode array at a given time.
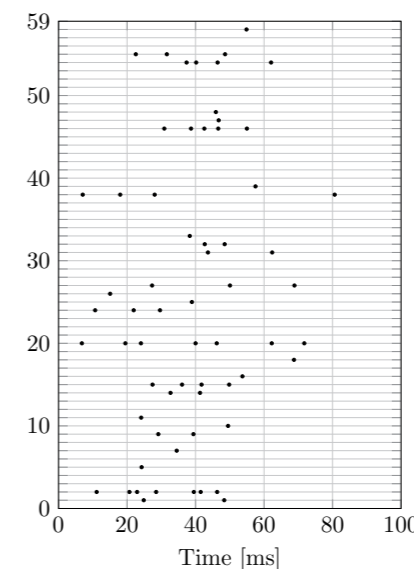
work propagates via the synapses in the network, it can be assumed that the spontaneous activity depends on the synaptic weights in the network. If a network has only few, weak synapses, the activity will die out quickly. With strong synapses on the other hand, the activity can snowball and activate the whole network. During network bursts, many neurons fire within a small temporal window. This in turn can lead to changes in synaptic strengths according to the spike-timing-dependent plasticity mechanism described before. A theory about memory in cultured neuronal networks therefore states that the connectivity

and activity in the network form a balance, such that the prevailing activity maintains the current connectivity.

Several studies on cultured networks showed that stimulating the network through its electrodes could sustainably alter the connectivity. Continuing on the theory that a balance between activity and connectivity forms in a network, stimulation may induce stimulus responses, which do not agree with the current spontaneous activity. The network may either be driven to a new equilibrium in case multiple equilibria exist or return to the original equilibrium after

some time. We hypothesised, that after stimulation, the spontaneous activity in the network should show traces of the induced activity.

Methods

Networks
The multi-electrode arrays used for the cultured networks as well as all the required measurement hardware are commercially available, since MEAs have become a standard tool in neuroscience. The MEAs are cultured at our university with cells from the cortices of new born rats.
For the simulations, we created a network with only 100 neurons. This is about 1000 times less than the amount of neurons in a cultured network. The computational network is therefore not supposed to accurately mimic a cultured network. Instead, it is a suggestive model for the mechanism that may take place in a cultured network as well as the data analysis techniques suitable to quantify them.

> "For the simulations, we created a network with only 100 neurons."

Experimental protocol
The protocol was fairly simple. We first recorded a certain amount of spontaneous activity in the network (1h in the experiments, 3h in the simulations because the networks were less active). After that, the

Figure 3a   *Figure 3b*

Figure 5: Overview of the measurement protocol used in the MEA experiments.

network was stimulated 900 times with an inter stimulus interval (ISI) of 8s, leading to 2h of stimulation. After the stimulation phase, the spontaneous activity was recorded again for 1h/3h. The ISI was chosen as a compromise between two issues. On the one hand we wanted to give the network enough time to recover from its previous stimulus before stimulating again, which takes approximately 10s in the simulation. On the other hand we wanted to avoid network bursts in between the stimulus responses, such that stimulus responses make up a substantial part of the network activity during the stimulation phase.

In the MEA cultures, we first need to probe the electrodes to see whether they yield a good stimulus response. The reason for the probing was twofold. First, it showed whether the network is healthy and responds to stimuli. Second, it allowed a first selection of electrodes showing a consistent and strong response to stimuli. This is important since in most cultures, only some of the electrodes can be used to induce stimulus responses. The total protocol for the experiments on cultured networks is shown in fig5.

Data analysis
Our protocol consisted of three phases: the spontaneous activity before stimulation, the stimulation phase and the spontaneous activity after stimulation. For every phase, we generated a list of all the measured action potentials, where every action potential is composed of a time-instance and an electrode/neuron number.

The first task in the data analysis is to isolate the network bursts within the spontaneous activity phases as well as the stimulus responses within the stimulation phase. Extracting stimulus responses is simple since we precisely know the moments of stimulation and can therefore define the stimulus response as all the action potentials in a small window right after stimulation. Network bursts are extracted by looking at groups of action potentials with small timing differences among each other.

We then needed a method to compare the similarity between the activity patterns. From now on, we will denote both network bursts and stimulus responses by synchro-
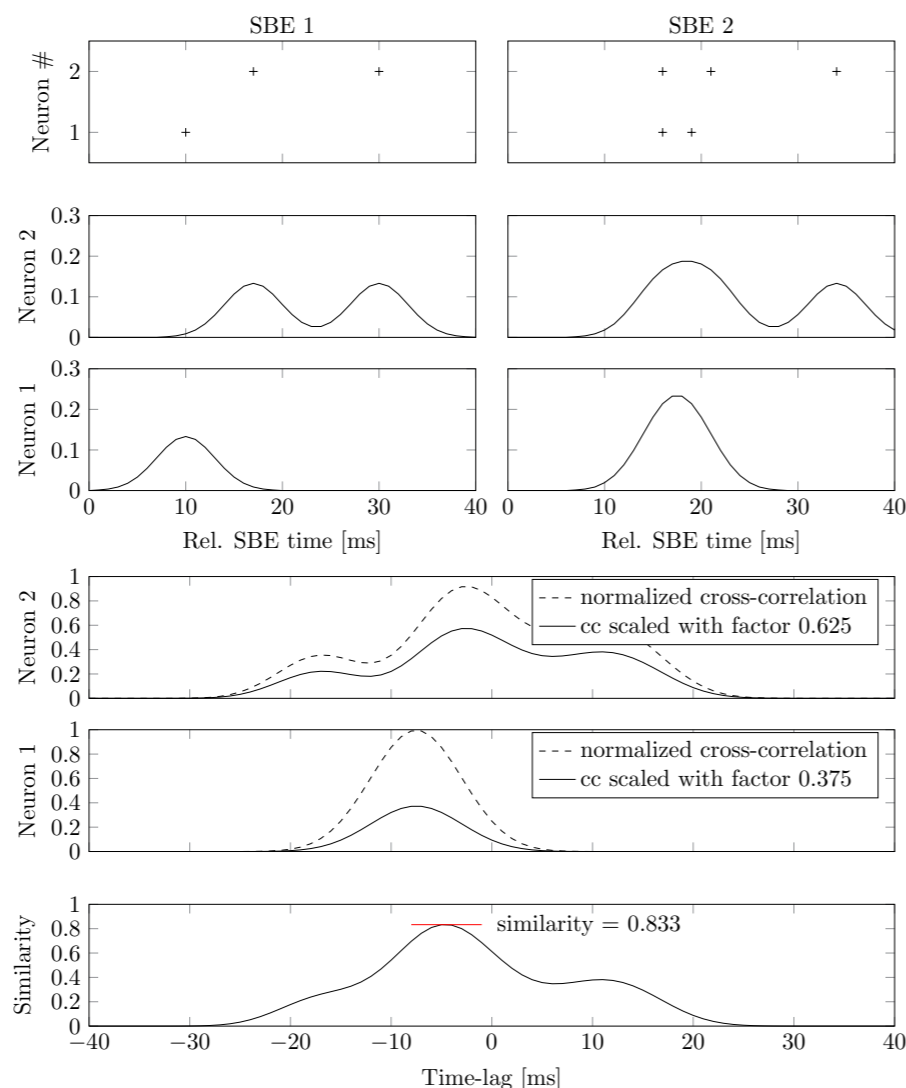

Figure 6: Calculation of the similarity between two synchronous bursting events (SBEs). The top row shows the spike raster plots of both SBEs. Per SBE, an activity vector is calculated for every neuron by smoothing a histogram of the timings with a Gaussian lter, as shown in rows 2 and 3. Per neuron, the mutual normalized cross-correlations are calculated and scaled according to the relative activity of the neuron as plotted in the two rows below. Neuron 1 spikes 1:5 times on average while neuron 2 spikes 2:5 times. Their relative activities are therefore 1.5 /4 = 0.375 and 2.5/4 = 0.625. The cross-correlations are summed and the similarity between SBE 1 and SBE 2 is defined as the maximum of this summed cross-correlation as depicted in the last row.

nous bursting events (SBEs). Two SBEs are compared by the method of inter-SBE correlation matrices refSegev2004 as demonstrated for two very small SBEs in fig6.

Results

Figure 7 shows an exemplary matrix with all the mutual similarities between the synchronous bursting events in one of the simulated networks. When looking at the square in the center that shows the simila-

rities of the stimulus responses with each other, it can be seen that the similarity between adjacent stimulus responses is relatively low at first and asymptotically increases. Apparently, a stable stimulus response is reached after a few hundred stimuli.

We can also use this matrix to calculate the average similarities between all the stimulus responses with all the pre-/poststimulus network bursts. This led to 12 pre- / poststimulus similarity pairs for the simulations and 7 pairs for the experiments. Our overall hypothesis, i.e. that the poststimulus bursts

contain traces of the stimulus response, was examined by testing whether the similarity of the stimulus responses with the poststimulus bursts is significantly higher than the similarity with the prestimulus bursts. Utilizing the Wilcoxon signed rank test on the similarity pairs, we found that in the simulations, the similarity between the stimulus responses and poststimulus bursts is significantly higher than the similarity between the stimulus responses and the prestimulus bursts ($p < 0.001$). In the experimental data, we saw the same trend but it was far from significant ($p = 0.29$).

Conclusion

The computational network perfectly supports our hypothesis. Without stimulation, the synaptic weights and the activity in the network form an equilibrium such that the weights do not significantly change anymore. When applying external input through stimulation, the synaptic weights adapt to these stimuli and asymptotically reach new values. These new synaptic weights temporary affect the intrinsic bursts in the network, such that they have a higher similarity with the stimulus responses than the bursts before stimulation. In the experiments, the results were not that clear. First of all, we did not observe a clear trend in the development of the stimulus response. Some of the cultured networks behaved exactly as those in the simulations, while others did not. Averaged over all experiments, the stimulus responses did have a higher similarity with the poststimulus bursts than with the prestimulus bursts but this difference was not significant.

Now the only valid conclusion from this discrepancy is that either the simulation does not accurately mimic the behaviour of a cultured network or that our experimental setup is flawed. But we already knew that our simulation is not accurately modelling reality, which leaves us with two options. Either the hypothesis is wrong for cultured networks, or the experimental setup fails to validate it. The positive trend in the experimental data tempts to state the obvious "more research is needed", since with more experiments, the trend may become significant eventually. I believe however that
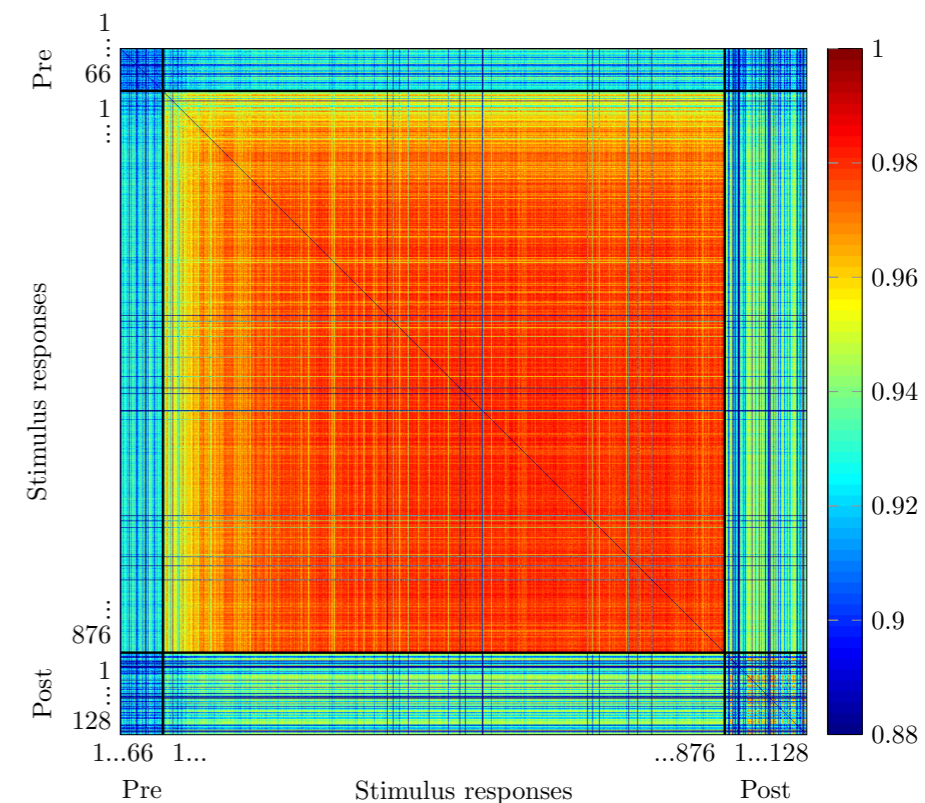
Figure 7: Matrix with the mutual similarities between all the synchronous bursting events (SBEs) in one of the simulations. The SBEs are sorted by time, i.e. the rst SBE is located at the top/left, and categorized according to prestimulus bursts (Pre), stimulus responses and poststimulus bursts (Post)

"The computational network perfectly supports our hypothesis."

instead of simply rerunning the same protocol, resulting in some experiments that do agree with the hypothesis and others that do not, and than averaging over all the results, we should go back a step and find methods to increase the reliability of MEA experiments.

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ThEA

Karaoke

12
Concurentie
bevat vlees spong van
pizza.

ScrapHeap

ALV

Di-Et-Tri

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The Kick-In and its back end

How simple actions can save a lot of time when automated

Author: Bob van de Vijver

It's that time of the year again. Do-groups are being formed, the SKIC has started the preparation of the program at Boer Frans and everyone wonders how many girls will start our study next year. The Kick-In of this year, with the theme "Open mindUT", already begins to take shape. However, the iDB-committee was already working on the digital systems since the end of the previous Kick-In. And there we have the subject of this article. What is the iDB? What does the iDB do? And how is the iDB built? Let's find out!

The iDB-committee is the committee that is responsible for almost all digital activities conducted before and during the Kick-In. If you have participated in the Kick-In after 2005, you have used the iDB. If you have ever been a do-group parent, you've used the iDB. And if you have ever been a SKIC member or an activist, you've used it even more! The iDB started in 2005 and was created to simplify several procedures during the first day and preparations of the Kick-In (think for example of the registration, and what would be the amount of work when everything is done manually). Ever since the iDB started, new functionalities have been added and it now contains almost all

vital information used to ensure a successful Kick-In.

I've joined the iDB-committee almost directly after my own Kick-In (which was in 2010) and have ever since worked to improve the system. The committee now consists of a mix of Scintilla, Inter-Actief, Proto and SNT members which work in harmony to ensure the operation of the complete system, but also have the task to create a complete new version of the system.

The iDB uses the Symfony framework [1] as a solid base for all its functionality. Symfony is an open source PHP framework, used already by many web developers, which makes it quite handy to use. It is developed

by SensioLabs [2] which originally used it for the development of web sites for its own customers. Symfony was published in 2005 under MIT Open Source license and today it is among the leading frameworks available for PHP development. Much documentation, components and support is available using many sources, which eases the development. When started in 2005, the original Symfony (version 1) was chosen to be the best solution. But now it's 2014, and it's old and weak. Therefore, since begin 2013, a new version of the iDB is being developed. Again Symfony is used as base, but now the new version 2. Unfortunately, this requires a complete rewrite
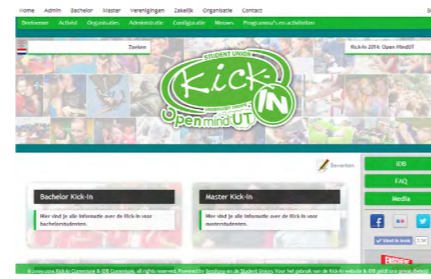
of the code as the new version is not backwards compatible (and the old code can be quite a mess sometimes).

The aim of this new version is to integrate even more functions than before. Some of you might recall the old web structure, which consisted of a frontend portal and the iDB as separate systems, but also had a mobile website and app. This was quite problematic, as nobody maintained the old portal and nobody even knew how it worked, but also a lot of unnecessary data-synchronisation was conducted. It was even more of a problem when it became clear that the old portal used a really old version of the Content Management System Joomla, which was quite a security threat. The new frontend portal (which is online since the last Kick-In) is integrated in the new iDB, but also a new mobile website and app will be integrated using the new Symfony 2 base. This integration results in a more flexible design with less confusion for the user, but also delivers more clarity for data selection methods and eases the maintenance.

How does Symfony work?

As stated before, Symfony is an open source PHP framework and thus is widely used by many online applications. But how does Symfony work internally? Of course, it handles web requests and sends the adequate response like every web framework should. To refresh your memory of how this works you can check Figure 4. Of course the client does not ask for today's comic, but for a specific URL.

Back in the days, every page on the web was a separate file on the server. However, as lots of code can be reused, this approach was mostly time consuming and not organised. Whenever working on a bigger site, you will
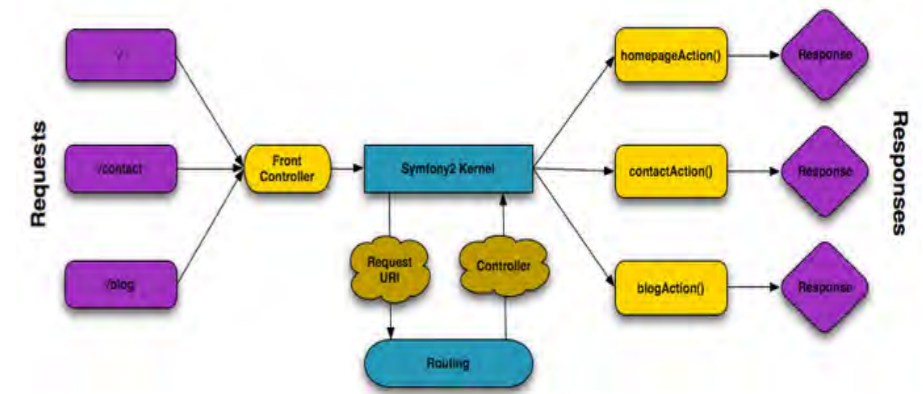

Figure 5: Symfony application flow

need to do a lot of dynamic things like sending emails, handling form submissions, saving things to a database, rendering HTML pages and protecting content with security. How can you manage all of this and still keep your code organised and maintainable? Symfony makes this really simple by introducing a single front controller, but also abstracting all requests and responses in objects. Thanks to this mechanism the application is more secure and easier in use for the developer.

All requests sent to the server go through the front controller which tries to handle them according to the pattern in the URL. This pattern is matched against a list of routes, which returns a specific controller function to handle the request. In the controller all needed data is prepared for the specific request, and then the controller returns a response which is sent to the client which requested the web page. Every controller has the same base to start with. Think of database or mail server connections, but also more trivial things like site localisation or even the base templates of the website. This application flow is pictured in Figure 5.

This structure also enables the developer

to do a lot of customisation in between the path. It is possible to define services which can be accessed again in every controller. Examples of such services used in the iDB are translations, doctrine (database) but also communication. This communication service is used to handle all needed communications with users (email and sms) in one central place and realises a message queue so that the user does not have to wait for the message to be really sent before the response can be generated.

A handy feature is the possibility to install third-party bundles using Composer [3]. Composer is a dependency manager for PHP which is integrated with Symfony by default. Many third-party bundles are available and Symfony itself is actually also a bundle! The iDB uses quite a few third-party bundles, but the most used third-party bundle will be the Doctrine Bundle [4]. It mainly consists of an ORM (Object Relational Mapper) and a DBAL (Data-Base Abstraction Layer) to ease the use of the database by abstracting it into simple objects. Another bundle used in the iDB is the Admingenerator Bundle [5], which can almost automatically generate all object related actions like lists, edit forms and more. But Symfony itself also provides lots and lots of useful components. In my opinion the most vital component combination are the form and validation components. With this component it is really easy to create the most advanced forms for your application, which are almost automatically validated when the right validators are given. The standard validators already have most cases covered [6], but when needed you can always add more self-designed validators. A simple controller with a form and valida-
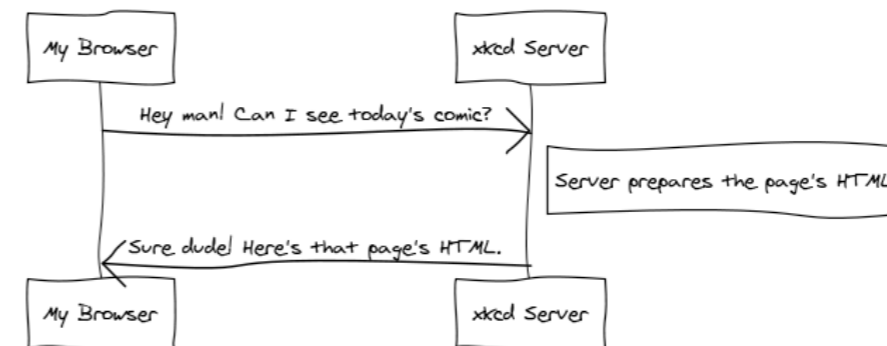

Figure 1: The old portal

Figure 2: The old iDB

Figure 3: The new website

Figure 4: Simple HTTP request and response.

```
public function subscribeAction(Request $request)
  {
    $formBuilder = $this->createFormBuilder();
    $formBuilder
        ->add('name', 'text', array(
            'constraints' => array(
                new NotBlank(),
            )))
        ->add('email', 'email', array(
            'constraints' => array(
                new Email(),
            )
        ));
    $form = $formBuilder->getForm();

    $form->handleRequest($request);
    if($form->isValid()){
      // Do something with the data and return another
response
    }

    return array(
      'form' => $form->createView(),
    );
  }
```

A simple controller with a form and validation embedded.

tion embedded can be found to the right. The given controller is used to create a simple page where a name and email can be submitted which can be saved whenever the submitted data is valid. But how does this resolve in a viewable page for the client? Earlier it was said that the controller should generate a response which can be send to the client, but this controller only returns a simple array. This is where another product of SensioLabs comes in, namely Twig.

Twig

With Twig [7], a template engine, the returned array is automatically converted to a response which can be sent to the client. By splitting the controller logic from the template logic, the application structure becomes clearer and easier reusable. Every template can extend another template which allows you to define the global page layout somewhere, while the selected template only fills the content. This is realised by using blocks, so that different positions can be defined which can be overwritten. A

Twig example for the earlier controller can be found below.
Very little code is given, especially on the form part. Only one function is used, which prints the complete form directly with all defined fields and buttons. And of course everything during this specific print can be customised with other templates, but also other functions to print forms exist.

In conclusion

The iDB is a large PHP web environment created for the Kick-In to ease many tasks during the organisation and the event itself. This environment uses Symfony as a base, which provides much ready to go code while it is still easy to customise each and every part of it. The general application flow (request, front controller, specific controller, twig) works great for bigger websites with lots and lots of data, but also for smaller websites. It even adds extra security and it greatly simplifies a lot of standard sequences. However, by starting the rebuild of the iDB this year, still a lot needs to be done within a few months and the Kick-In must trust on us even more than before.
Does this sound great to you?
Hopefully, after reading this article, you realise that the iDB is a great student web project and maybe you want to participate. That is possible! Just contact me on bob@kick-in.nl, and hopefully we can find an adequate spot for you in the iDB team.

```
{% extends 'IdbLayoutBundle::idb.html.twig' %}
{% block content %}
  <h1>{{ "Subcribe to our mailing list"|trans }}</h1>
  <a href="{{ url('home') }}">{{ "Back to home"|trans
}}</a>
  {{ form(form) }}
{% endblock %}
```

A Twig example of the earlier controller

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EPEE

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On the 19th of March the yearly event the EPEE was held. Or, in more understandable language, the Educational Prize Electrical Engineering. The goal of this event is to choose the best educator of EE. This way we show that students appreciate good education.

At our program it is a matter of fact that students and teachers spent pretty much time together. And it is not uncommon that teachers harvest criticism when students are walking to the SK for a coffee break. However, most teachers put a lot of effort in the preparation of their lectures but this is hardly seen (and appreciated) by students. Therefore, it is wonderful that Scintilla awards the annual Educational Prize Electrical Engineering (EPEE); this is really a nice gesture of appreciation to the nominated teachers.


Before the actual event every student had the opportunity to fill out a survey in which the student could explain which teacher they thought was the best. From these responses the three educators with the most votes were nominated for the prize. The nominees were interviewed to determine which of them really is the very best educator in the entire Electrical Engineering Programme.

The theme of this year was "a fraction interaction" and the nominees were Ali Tauseef (a PhD student at SAS), Arjan Meijerink (winner of last year) and Raymond Veldhuis (already nominated for the eleventh time or so, he lost counting). They were elected by the students of the program Electrical Engineering. All students had the opportunity to vote for his favourite teacher.

Of these candidates Tauseef Ali was the most unexpected because, unlike the others, he is a teaching assistant. The fact that he was nominated shows that good teaching assistants are appreciated by the students. The other nominees are better known and were also nominated last year. It's quite a feat that Arjan Meijerink and Raymond Veldhuis managed to remain two of the best teachers.

The jury, formed by Laurie Overbeek, Silke Hofstra and Jorrit Nutma, had an interview with three teachers who had the most votes. Based on those interviews they choose Arjan Meijerink to be the best teacher of the year 2014. Meijerink's attitude was the most
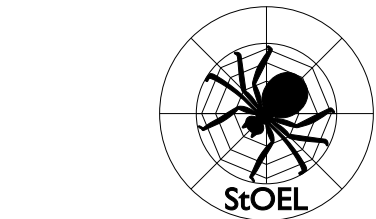
important reason for this choice. According to the jury, Meijerink is a hard worker who does everything to bring his message across as clearly as possible (and with the course Random Signals and Noise this is a real challenge). Also his open attitude for feedback is very valuable and next to that he has a good reasoning about interaction with international students.

The 19th of March the prize was awarded during the EPEE ceremony at Abscint. After the jury chair had awarded the prize, Meijerink gave a nice presentation which he started with the phrase: "Thank you for awarding me this price. However, I am certainly not the best teacher of the program". This remarkable phrase is characteristically for Meijerink's attitude because he always wants to keep on improving his teaching. This is what students appreciate and therefore we are very happy to have Meijerink, and of course many other very good teachers, at our program.

Arjan Meijerink will also compete for the UT wide educational prize. We wish him the best of luck!

The road to Rotterdam

Author: Sander Schotman
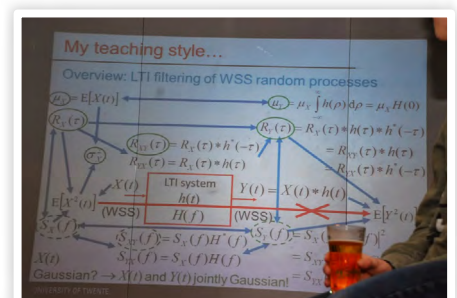
In the Vonk of last February Green Team Twente wrote about their plans for the Shell Eco-marathon 2014. How is the progress with the project, will they be able to reach the 1000 kilometers on an energy equivalent of 1 liter gasoline? Read more here, in the update of the road to Rotterdam. As experience has taught, a reliable car is worth more than a car which is potentially the best. Since September 2013, the team is busy with testing the different parts and building new systems. A lot of progress is made, although certain difficulties occurred. Now a good insight is present about the performance of the car.

Motor Controller

On the sensorless controlled in-wheel motor, four Hallsensor are now placed in one housing. By doing so, the angle of the motor is always measured correctly. In the previous version, the team had problems with accelerating when the car had stopped because the sensorless controller only works well when the wheel is turning. After many late night hours of programming in enjoyment of some loud happy hardcore we succeeded in solving our problems. The car now drives the first few meters on the angles measured by the Hall sensors. Then the systems turns back to the sensorless mode. Which isn't that easy by the way. By turning back to the sensorless mode, a difference in the measured angle occurs. Creating a smooth transfer between the two states was therefore not very easy.

Wireless Data Connection

In order to predict the efficiency of the UTmotive and to detect failures of the different systems, sensors are placed in the different parts of the car. All the data produced by the sensors is sent over the CAN network, filtered, encrypted and then sent to a computer using an XBee. Now we can measure voltages and amps on different places, the speed and more. The data produced by the network will be used in a computer model to predict the most efficient driving speed.

New hydrogen fuel cell

After measuring the efficiency of the old fuel cell, it became clear that more efficient ones could be purchased. After a long period of waiting on China to deliver the fuel cell, the new one came in. Soon it became clear that the quality of the peripheral equipment was of poor Chinese quality. Luckily this is no problem. The efficiency of a fuel cell is mostly determined by the electric consumption of the devices that control the process. Fans have to cool the stack and provide oxygen for the reaction in which electricity is created. The fuel cell stack is capable of producing a 500W output power. Only 100W is needed though. With replacing the fans a little more efficiency can be achieved.

Super Caps

The energy produced by the fuel cell is stored in a stack of 12 super caps. This is done because during acceleration more energy is needed and brake energy can be stored. In our new system, the voltage of all the super caps can be measured. This means overvoltage can be monitored and the caps are automatically balanced using this information. This results in a more reliable stack.

Is 1 liter at 1000 km possible?

With al systems of the car tested, calculations on the back of a beer mat show that the car is capable of delivering an efficiency of over 1:1000 when all the electrical systems meet their predicted efficiency. However

> "On the 23th of April, the UTmotive 2014 will be presented."

mechanically also a lot of progression is being made. The first tests are done with the production of rims made out of carbon fiber. When this succeeds, an even lighter vehicle is possible and the less rotating mass will help with accelerating.

New Design!

On the 23th of April, the UTmotive 2014 will be presented in the Waaier. Besides all the work on the inside, the car will get a new design. After the presentation, the car will drive the first rounds for the public on the O&O square. Excited to see the new car? Please come by!

Also we are already looking for members of the team of next year. Are you excited to bring the car to an even higher efficiency? Send an email to info@greenteamtwente. nl. Follow us for more updates on facebook (facebook.com/greenteamtwente) or look at our site (greenteamtwente.nl) for more information.

Important data

23 April 2014: unveiling of the new UTmotive

14/18 May 2014: SEM race in Ahoy, Rotterdam

27 May 2014: Report of the race

Finding your first job

Author: Derk de Graaf

The final year of your studies is one of growing up. While the first four, five (maybe more?) years of your studies feel like seriously having fun, 'seriously' of course referring to your hard work as an EE student, in the last months of the master program you start to realize that the next big step has to be taken soon.

After my internship in Vietnam, I thought it was about time to start looking for a job. My job 'wish list' was reasonably simple. I was looking for international opportunities after staying in South Korea and Vietnam during my studies. Asia offered me a great time during my stay there and living there for an even longer period is definitely something I want to do. When some future version of me is tied up to a house, a job, a family, etcetera, it could be the case that I am no longer able to do that, so the earlier the opportunities are there, the better.

Secondly, although studying Electrical ENGINEERING, I never saw myself as a typical engineer. While a lot of our fellow students are soldering awesome inventions or programming complicated software, I found out that I wanted more than that. Being a board member at both Scintilla and the umbrella organisation Overleg Studieverenigingen showed me that organisational problems are just as interesting to look at as technical problems are.

Last but not least, I want to grow as a person, both on hard and social skills. Don't think that finishing EE means you know everything about engineering, or electronics for that matter. It is just a great start for you to learn more!
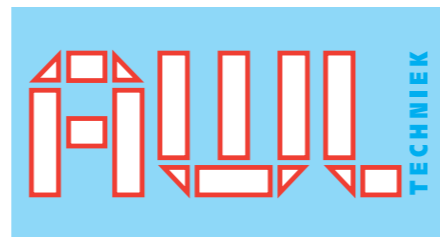
The easiest place to start looking for possible future employers is possibly the 'Bedrijvendagen', the two-week long event at our campus where companies present themselves. After two interesting days at the 'company market' I had a bag full of flyers, pens and other goodies. I also updated my LinkedIn profile to make sure that recruiters could find me there. Through the network of recruiters I had left from being Com-

> ## "I never saw myself as a typical engineer."

missioner for External Affairs at Scintilla, I arranged meetings at a few big multinationals in The Netherlands to see what kind of opportunities they had for people like me. It was also a great way of finding out the company culture: since I wasn't applying for a specific vacancy I could ask nasty questions like my personal favourite: 'what is the worst thing about this company?' You might hesitate to ask such questions when you are sitting there for a specific (dream) job and just want the recruiter to like you and give you the job.

So-called traineeships started to seem in-

teresting to me, but although most (larger) companies have such a program, every firm seems to have a different idea about what a traineeship comprises. Most traineeships comprise of having multiple roles in a fixed period of time (generally two years). One problem was that most mayor corporations have application deadlines in December, meaning that I was too late for applying in my graduation year and, with graduation set in August, meant that I would have to wait for months before the next application process started.

Through my LinkedIn account, the first job offers arrived. Or to put it more accurate: the first annoying group of staffing agencies started telling me that they knew exactly what I wanted (from just reading the LinkedIn profile and without talking to me). In one case, I was contacted by a company working on high power electrical systems for ships. Since I was graduating at BIOS on a chloride sensor, I did not really see the connection between their business and my background, but they asked me to come in for a job interview for a traineeship. One week later, I was called by the recruiter to ask why I was interested and to say that I should prepare myself for the interview as we would probably be talking a lot about my interest in high power systems and the

marine application. Since this was the guy who asked me to have the interview in the first place I was amazed. On the day of the interview, I was called again to tell me that they just gave a job offer to an applied university (HBO) energy graduate. When asking the recruiter why he contacted me in the first place, he told me that he got a fee for every new hire he brought into the company, so it was in his interest to have as many applicants as possible. A lesson learned for me: try to find out what is their interest when you're contacted by someone with job opportunities.

In the last months before graduation, I thought I had found a dream job at a certain manufacturer of semiconductor manufacturing equipment in the Eindhoven area. During the interview though, I found out that this probably wasn't the dream job I thought it would be. At the one hand you want to have the job as you don't want to be rejected, but on the other hand it is probably best if you look for something else. When I was called that they didn't want to proceed with my application, they gave me the great feedback that although I would fit in the company as a person, I probably wanted to do something else after just one year and that they didn't want to risk it. At least their application process is right I guess! What surprised me was that, although at most posters, in-house days and other recruiting activities it was mentioned that they were looking for talented students, they did not take any action on helping me find another position within the company. This is a problem that most large companies have though, and seems to be caused by the fact that the people responsible for 'job market communication' are not the ones responsible for filling the vacancies at a company. The recruiters (or vacancy-fillers as I started to call some of them) don't care so much about a specific candidate, but just need to fill the list of vacant positions while it is the job of the job market communication people to get as many applicants as possible. In general, the more words as 'high potential' and 'talent' are used in the job advertisements, the less interested they seemed to be in the individual talents (which I consider myself to be after graduating cum laude within six years from the start of my studies, with three board mem-

Figure 1: View from the top of a laser welding machine in a Polish car seat factory

berships and two internships for a total of nine months in Asia).

Graduation passed and I still hadn't found a job. Even worse, I did not have a clear idea of what I really wanted anymore. My master thesis project had been very successful and I was invited to talk about a PhD position in Germany. Although this ticked most boxes on the wish list, I decided not to do a PhD as I would do it for the wrong reasons: not because of an interest in academic research but because of the side benefits like being able to travel.

> ## "The head of engineering said that they would be happy to have me."

At the same time, I was contacted again by a staffing company, this time by one that had actually found jobs for some of the EE students that were graduating around the same time as me and I decided to see what ideas they could come up with. Interestingly, they matched me to a machine building company, which seemed a better fit to someone with a mechanical engineering background.

Although the company couldn't offer me a position as they said they did not have the people at that time to support me in the transition from micro (electrical) systems to mechanical systems, it opened my eyes to look outside the semiconductor and sensing industries that seemed the best fit to my master thesis project.

I started to make a new list of companies that I would like to work at. (The Scintilla website proved to be a great place to start making this list!) As I hadn't found the right company yet, I decided to have job interviews at different kind of companies, such as an engineering company, clearly violating the 'no engineering job' wish on my list. After an interview where I knew within ten minutes that this wasn't the job nor the company for me and I sent out a lot of negative vibes, they asked me back for a second interview with some of the engineers working there. The work of the engineers seemed boring to me and I asked a lot of critical questions, but they still liked me. The head of engineering said that they would be happy to have me and that it was up to me whether I would start working there or not. This leads to the strange situation where you are no longer a student, unemployed and starting to be bored with doing not much more than watching tv series all day

and still turning down a job offer without having an alternative plan ready.

The big break in my job search came from a somewhat unexpected place. Through some contacts I made an appointment at a staffing agency specialising in higher management (the kind of people with ten year plus work experience and MBAs). They had a special 'starters' day to help young people find a job. During an interesting conversation with one of their recruiters, I was told that I was basically looking in the wrong place. Small companies, so-called pocket sized multinationals, would be much better suited for me, as I would have a lot of opportunities to grow in any way I wanted while still being able to work internationally. With large corporations, chances are that while you are growing into your function and your job title changes from junior something to senior something, the work itself doesn't change much as the company isn't that flexible. Smaller companies on the other hand have less specified job descriptions, making it easier to take on side projects or get more responsibility quickly. The recruiter told me he knew of a small multinational company

which could be interesting for me and that he would send my resume to them.

And that kids, is the story of how I met AWL-Techniek. AWL is located in Harderwijk and manufactures automated welding machines. The biggest market for welding robots is of course the automobile industry and while we do make a lot of machines to produce car seats or car body parts, there are also machines to for example that manufacture fences or radiators (for the heating system at home).

> "The big break in my job search came from a somewhat unexpected place."

From the first job interview on, I liked the company a lot and last November I started as Trainee Engineering. As I have no background in welding, robotics or mechanical engineering, we decided to start in the as-

sembly department. And yes, that means using a screwdriver and drilling tools to build a machine by hand. During a three month period, I not only improved my practical skills (which was really needed!) but I also had the opportunity to install two machines at the customer's location. If you like watching 'How it's made' on Discovery Channel like me, you might understand how cool it is to be in the middle of a factory producing car seats or car body parts.

When I started to get bored by the assembly work, I switched to the robot control department at which I am working now. The department is responsible for programming the robots, which meant that I had to start learning how to program them. As I'm currently waiting for my project to be physically built, I'm taking on some side projects as learning how laser welding is performed (with 6kW lasers apparently) and helping the department's team leader with brainstorming about how the robot programming process can be improved. Next November, I will change to another department, although it is not yet sure which one that will be.

Although I am currently still not working at academic level, AWL has ticked all boxes on the wish list. The company has subsidiaries in the Czech Republic and China and the customers are located all around the globe (including places such as South Africa) so enough international opportunities available. A coach helps me with finding the right place for me at the company and identifying which of my skills I want to improve.

What I like most though, is the flexibility there is within my traineeship program. Since they haven't been running it for a long time and they do not hire a lot of university graduates for a traineeship, it is not a fixed program. If I want new challenges or don't like how things are going, I can discuss it and things are quickly adapted to my needs. Making this the perfect place for me to start my career!

Figure 2: Me doing assembly work in a client's factory

The code of music

Authors: Tim Broenink & Robert Fennis

During a boring evening we decided that we were not happy with the current availability of music in the SK. This is why we decided to create some new music in a way befitting for engineers, with references and matlab.

The musical notes are divided in groups called octaves. As you might recall, one octave up is twice the frequency. Within one octave there are 12 notes. One step(musically a semi-tone) up is done by multiplying your frequency by 2 to the power of 1/12. Similarly, going 7 steps up(a fifth) is 2 to the power of 7/12 etc. Chords are basically playing multiple different notes at the same time. In a chord progression, musicians try to make the notes follow up in such a way that the progression sounds good.

When writing a progression you first pick your harmonic centre(a centre frequency like 440Hz). Stravinsky stated that when choosing the root notes on which you stack your chord tones, the octave can be divided into 3 different groups, the tonics(T), sub-dominants(S) and dominants(D). Your tonics are your harmonic centre, 3 steps up, 6 steps up and 9 steps up. The subdominants 2, 5, 8 and 11 steps. At last, your dominants are 1, 4, 7 and 10 steps up. Stravinsky said

that the right way of cycling through your categories would be T-S-D-T-etc. Staying in the same category could sound good but doesn't necessarily feel as if you are progressing. Going in the counter direction could feel uncomfortable.

Based upon this theory, we let Matlab randomly jump through a two octave span of notes where the odds of cycling through the categories in the right direction is a lot bigger than going in the counter direction. When building chords, we simply took a root frequency, the note 7 steps up(the fifth) and a either the note 3 or 4 steps up. Choosing 3 would make the chord a minor chord and 4 a Major. According to Stravinsky, it should not matter which one you pick.

This means that we are generating a set of three different tones for one chord. This is a little more complex then the creation of a simple sine wave. In order to create better sounding notes we added a bit of higher order distortion. To make sure that
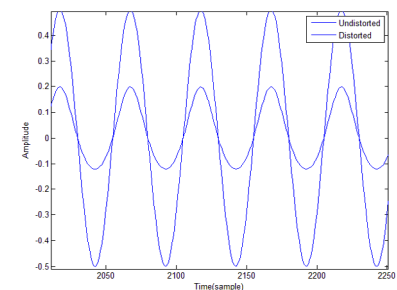

Figure 2: Distortion of a single sine

the transition between notes does not result in a plopping sound we also applied a tapering. This can be seen in figure 1 and 2. These chords are then generated with the selected tones and are concatenated into a music track.

We also implemented a melody line. The melody line jumps from any chord tone to any other chord tone when the chord is being played. The intermediate notes could be any of the 12 notes in an octave. It should sound decent as long as the melody hits one of the chord tones when the chord is being played. This is implemented in matlab by selecting a tone from the current chord and a tone in the next chord. We create a linspace between these tones and then round this linspace to create the intermediate tones. These tones are generated the same way as the chords, except that they only contain a base tone.

As last element we have created a percussion line. This is done by generating high amplitude white Gaussian noise which is amplified by a exponential function. This results in a sharp tapping sound.

Al these elements together create a randomly generated song. To show you how this sounds, we have uploaded a sample here:
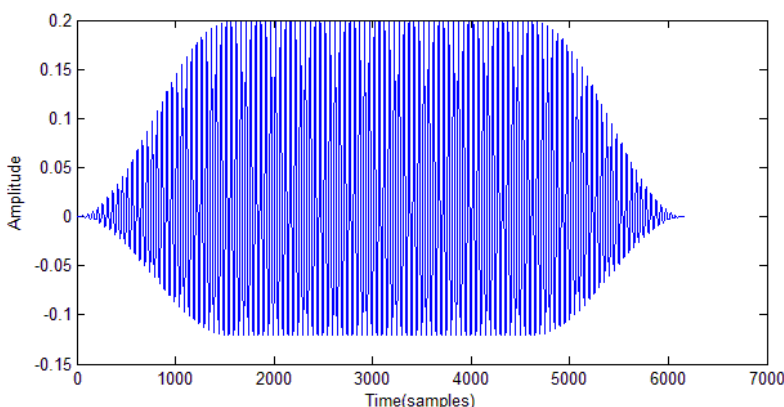http://tinyurl.com/clip1VVV
http://tinyurl.com/clip2VVV

Figure 1: A tonal sine with the tapering applied

Junction

Ilka Dove

Authors: Fieke Hillerström & Tim Broenink

Ilka Dove is a master student Electrical Engineering. During this interview we ask her a few questions about het education and how she ended up studying in Enschede.

What did you do before your master?

I studied Electrotechniek at the Saxion in Enschede. In my minor I did my premaster for Electrical Engineering so that I could do my master here.

Why did you want to study in Enschede?

I wanted to go to a german school, so I visited a few of them, but all of them were too large for my taste. Then you had lectures with 400 people in a room, and I did not like that. I also had the problem that I needed to have done an Internship during highschool, which I could not do with the exams coming up.
Thats when there was an open door day at the Saxion in Enschede, I did not expect to go there, but it couldn't hurt to look. So I visited Saxion.

The program at Saxion seemed right. I especially liked the structure of a quartile with eight weeks of lectures and after that the exams, so I said to myself, "why not?"

So I went to another country for my education, something I thought I would never do, but I did and it worked.

After HBO I did not have the feeling that I was finished, so I chose to do a master. I could just as well stay in Enschede, for I had already done the premaster.

### Why did you choose to study Electrical Engineering?

I had noticed that Technical courses came a lot easier to me than languages for example. Even though I wasn't really good at the technical stuff either. It is a bit strange that I do so well now, but I think the difference is that I had to do the courses in school, but that I have chosen for them now, so I am a lot more motivated, even thought it still takes work.

What do you do besides your study?

For one, I work on my house. We have just moved and there is a lot that has do be done on it.
I also play volleyball at Harambee, but I think that I will go back to playing in Schüttorf next year. That is a lot easier with traveling.
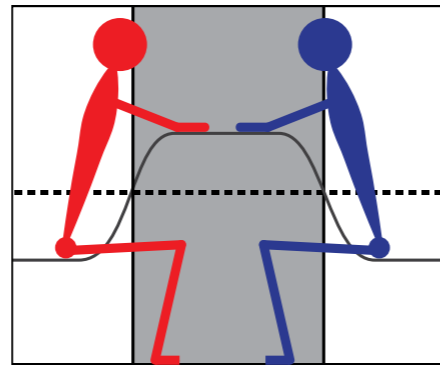
On that note, do you have to travel far?

I usually come here in the mornings and go back in the evenings, then I can travel together with my boyfriend. If we take the car together it is only half an hour. That is shorter the time that some people have to cycle to get here. So the traveling isn't that long.

You joined the MEEKI last year, how was it and why did you join?

It was fun. I had already done a premaster at this university so I had already done the master-kick-in. At that time it was very boring. Some people heard this from me and that is why we decided to improve it. That is why we created the MEEKI with the six of us.

Would you join the MEEKI again next year?

Maybe, I might help them again during the next kick-in.

What are you planning to do after you finish your master?

Find a job. I don't know where exactly. Thales and Xsens seem to be interesting. But I am still looking around. With Electrical Engineering I have that option and I will have to learn new things with all jobs anyway.
I enjoy most things technical, so a new subject would be fun to learn and I think I could do that just fine. I do want to make new things though, that would be the best.

Have you thought about where you want to work?

Definitely in this area. So that means Twente or less then an hour from home. I don't know many company's in Germany, because they aren't really present at the University and people don't really look there. That goes to show that the border can sometimes still be a border.

Ilka Dove	
Age	Twenty-five
Study start	2008
Birth place	Schüttorf
Country of origin	Germany

A Valentines day gift

Author: Leon Schenk

Approximately two weeks ago it was half a year since me and my girlfriend got together. To celebrate this jubilee we went out to the Zoo to watch some monkeys groom. When we finally arrived back home she handed me a nice homemade card and a picture frame with five nice pictures of the two of us. I'd better had something in return for her, but unfortunately I hadn't.

So I thought, what is it that I am able to create for her? Not much later I came to the conclusion that creating something with LEDs would be just that. A LED device can look very nice and certainly draws your attention when it is blinking and shining in your room. An additional benefit of creating something would actually give me a nice opportunity to display study evasive behaviour (soggen in Dutch).

Last Monday I went to the STORES to buy the necessary goods, two bags of LEDs must be enough for a nice LED cube. When the STORES volunteer advised me against creating a cube of 8x8x8 LEDs, but a 4x4x4 cube instead, I thought about a smarter way to project a nice 3D figure without filling the whole device with LEDs, because the abilities of a 4x4x4 cube are rather limited. So I decided to create a heart shape of 8x8 LEDs, 8 on each column and 8 on each row, attaching each row and each column via a resistor to a pin of a micro controller.

Creating the LED matrix only took one hour, but getting all rows and columns in place another three, involving iterative steps of taping everything together, calculating the circumference and soldering the wires of the LEDs. By the way, you should solder the micro controller only at the wrong side of the board when you are unable to get the pinout correct...

The micro controller wasn't very hard to program because I had connected the rows to one output port and the columns to ano-
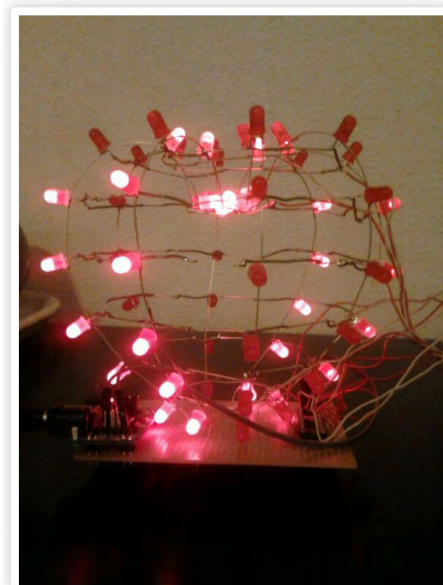
Figure 1: The result

ther output port. With every LED in place and able to switch on or off, it was easy to create a rotating heart, which waits at a certain position after some time and has some random flashes afterwards. This was just one of the unlimited patterns possible with the LED heart.

The LED heart has been given to my girlfriend and is now proudly flashing on her table. When I am at her apartment again next weekend, or another weekend, I am going to take my soldering iron and add a push button, so she can choose different patterns. There are many extensions I can think of which will make both me and her very happy.

Figure 2: The schematic of the

Study Tour

Sakura Zensen

Authors: Mark te Brake &
Mattanja Venema

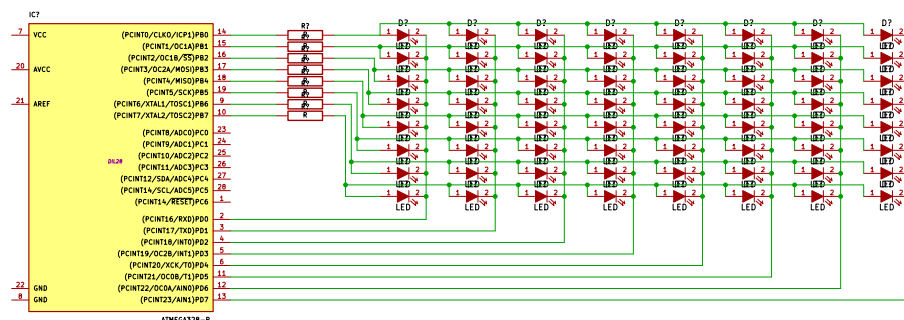**21 brave electrical engineering students came back from a long journey to Japan. There they visited many companies, institutes and universities, while at the same time experiencing one of the most intense, exciting and unique cultures of the world. But before we will elaborate on those three hectic and amazing weeks let's go back to about a year ago, where it all began.**

桜前線

When the participants for this year's study tour were selected they were all eager to start with this big project, but where to start? First they decided on a name and research theme. After careful consideration and consulting professor Wilfred van der Wiel, who did his PhD in Japan, the name of our study tour was formed: Sakura Zensen. This means Cherry Blossom Front in Japanese and the term describes how the cherry blossoms start to bloom all over Japan. The accompanying theme is Blooming Technology. A fitting theme, since technology in Japan really blooms. It describes the stage most Japanese technology companies are in right now. The small Japanese companies that were just founded in the beginning of the previous century, are now big technology players, not just in Japan, but in the world. Blooming Technology.

Next up was creating a corporate profile which included, among others, a website and a company brochure. This was required so we could show companies what our skills are and what we could mean for each other. A lot of companies were contacted. Via email, telephone and most of all perseverance, we interested companies in our study tour and how our bright students could help them tackle all kinds of problems, formulated in the form of case studies.

Weekends and holidays were sacrificed and some participants even had sleepless nights over the case studies. Translations of lecture notes, optimizing Matlab scripts, building websites, performing literatures studies, creating demonstration setups and performing some really top secret research were all among this year's case studies.

With the sponsoring sorted out we could finally plan our trip. Under the watchful eyes of our treasurer a lot of money was spent. Tickets, hostels, excursions and local transportations, everything was planned in the highest level of detail. Nothing can go wrong now, right? All these preparations and hard work culminated in the pinnacle of the whole project, the trip to Japan itself!

These are our experiences and funny stories of three hectic and amazing weeks in Japan.

February the 6th 2014 at 4am in the morning. It rains. The participants walk to the train station and when they get on the first train to Schiphol, they are completely soaked. There are better kickoffs. However, things would completely turn around when the day advanced. With a bit of a delay, as can be expected from the Dutch railway system, they arrived at the airport still in time for their flight. From now on the journey could only get better. And it did! When they arrived in Zürich a surprise was awaiting them at the gate of their flight to Tokyo Japan.

At the gate apparently a party was organised where free drinks and snacks were handed out. Having no clue what happened, but enjoying a cold beer we tried to figure out what was going on. Turned out it was a party to celebrate the 150th anniversary of a diplomatic relation between Switzerland and Japan. Not only at the airport were we

Our conversation with the representatives fram ANA and Swiss air

Spockers in their non-native environment, also snow in Tokio

surprised, right before leaving the airplane everyone received a moleskin notebook with an imprint of the Swiss Air logo. A great way to start the journey.

When arriving in Tokyo the next surprise was waiting for us. All we could see was white. The whole of Tokyo was covered in a thick blanket of snow. This hadn't happened in the past 14 years. Dragging our luggage through the snow we arrived at our first hostel. A nice place with comfortable beds in one of the many districts of Tokyo.

Because it was still weekend we didn't visit any companies yet, but started with some sightseeing and cultural enrichment in a nice place called Nikko. This is a cultural heritage site in Japan where a lot of temples

are situated which are open to visitors. Now we were settled in Tokyo and the main part of our journey could start.

One of the many companies we visited was Riken. At their campus in Kobe a large supercomputer is situated. The K computer, manufactured by Fujitsu a company we also visited, is one of the fastest supercomputers in the world. The name is derived from the Japanese word 'kei' which means 10 quadrillion (10^{16}) which is also the amount of FLOPS the K computer can perform. When arriving in the building we were showed a scale model of the entire complex. This is apparently quite common in Japan, because most of companies and universities we visited had scale models of their sites.

We were seated in a presentation room where the design and production of the K computer was explained. When the presentation finished the curtains in the front of the room were opened to reveal the K computer itself behind a large glass window. Apparently we had been sitting right in front of it all the time!

Another day at another part of the Riken institute we found a familiar face to show us around. Freddy Gunneweg was there to tell us all about his internship involving some peculiar experiments in neuroscience. At the institute they developed a chip on which a piece of a rat's brain can be grown to study the signals flowing through the neural network.

Besides his study about neural networks Freddy was also interested in Japanese fauna. To that end he joined us on a cultural day when we went to visit the Iwatayama Monkey Park. A hill with at the top a beautiful view of Kyoto, home to about 130 monkeys. These monkeys were free to roam around the hill while we had to sit in a cage to be able to feed them. It looked all quite natural right up until feeding time. When a musical tune started to play a wave of monkeys, which were well trained to respond as Pavlov described in his most famous experiment, came running down from the hill to a small place where the keepers distributed food while we were free to walk amongst the monkeys.

The Riken Super K computer is all its glory.


The aftermath of the robot restaurant.

Instead of being on a mountain we also visited a place under a mountain. The super Kamiokande is a large underground complex situated deep in a mountain near Hida city. When we arrived we met an enthusiastic American scientist in a Hawaii shirt who had been inside the mountain for nearly 20 years. He gave us the grand tour and told us all we wanted to know. The super Kamiokande is a neutrino detector which consists of a huge stainless steel tank with a 40 meter diameter which is also 40 meters high. It contains 50000 tons of ultra pure water, which according to our guide is a very dangerous liquid. Almost everything you put in there will dissolve over time. The wall of the tank is lined with hundreds of photo multiplier tubes. Weird things that look like giant light bulbs which can detect single photons. Each of the detectors is wired to one of the four acquisition stations. These are small houses the size of a shipping container in which hundreds of cables come in and connect to racks full of amplifiers and other instruments. A real wiring nightmare which could use some cable management.

Our final excursion of the study tour is a robot show at the Robot Restaurant. As real seasoned Japanese commuters we travel through the undergrounds of Tokyo without leaving anyone behind in the busy underground crowds. After a short walk through the rain we arrive at the place. We are welcomed by two persons sitting in

huge robots and a band all dressed like robots who are playing their instruments. By now we are already blinded by lights everywhere all around us, so of course the only way to counter is making photos with flashes of the band and the huge robots. Then we were lead to some kind of waiting room. What's this? We are just being dumped here paying for overpriced drinks and we can't even get to the show room yet? Our supervisor Backstreet Boy Wim speeches about his good times during the study tour and then we are lead all the way downstairs to the dark basement. We go to our seats and get a meager bento box. We think it's not a real good price quality ratio, but then the

show starts...

What we saw is impossible to explain, this is just a tribute. The stage in the basement was surrounded by seats at both sides. Every inch of the floor was packed with remote controlled moving platforms carrying girls with a nice amount of clothes and musical instruments of the band. Other vehicles seemed to come right out of a parade in an exotic country. Of course everything was completely covered by flashing lights. The show took us along a wonderful journey and told us the story of a tribe fighting against invading aliens, moving from the one amazing scene to the next. A overwhelming tsunami of sound and light you have never seen before!

Like they say in the Matrix: everything that has a beginning has an end, and so also our trip came to an end. The robot show was a great conclusion of an amazing journey. Because the limited amount of space for this article, it is impossible to tell about all our adventures in Japan. We have seen beautiful parks and nature, went skiing for one day, visited a mass production clean room facility, walked around universities famous all around the world, conquered the most extreme roller coasters in the world, and still much, much more! For half of the participants this point is only half of the journey. They will go on travelling in Japan and the rest of Asia with separate smaller groups, but the study tour is officially ended. . It was an amazing experience.
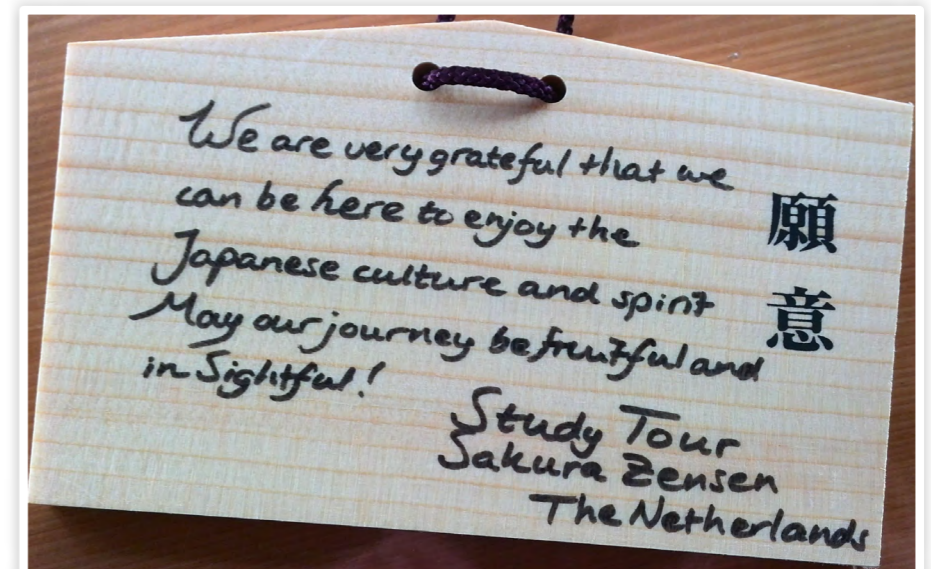
Skittles

Author: Dieuwertje ten Berg

I like skittles. For me they have something magical. When I was a little girl (think primary school) we had a school-trip every year. And on that special day we always got skittles. So for me skittles have a vibe of excitement, of joy and they still feel very special. But there is one thing that has always bothered me about skittles.

If you have ever eaten skittles you have probably seen the issue that I'm going to address. Otherwise imagine the following situation: you are a young kid and you are going to the zoo that day. You got a package of skittles from your mom, you have been saving them till the moment you could really enjoy them. But then you open your bag of skittles and there are only two purple skittles. And that happens to be your favourite skittle.

This is of course a very sad story. But it is not only a story, it is actually the truth! Every time I ate skittles I noticed that the colours were not evenly distributed. Most people will probably think 'whatever', but every colour skittle has a different taste. So if you have a favourite taste of skittle, you are screwed if that colour is represented less in your bought selection of skittles. Personally, I like the purple skittles the best. They have the prettiest colour, the best taste so they are clearly the best kind of skittles. Unfortunately they are also the kind of skittles who are the most rare.

This is not just some uneducated claim.

One day I decided to make a dull moment less dull by researching the division of colours in bags of skittles. The results were terrifying. As you can see in the photo, the distribution of colours is very uneven. This result comes from eight packages of skittles. These packages come from two different boxes.

But first some numbers, someone once told me that EE'ers like numbers, so I'll do my best. The total amount of skittles is 338. The distribution is shown in the pie-chart. So there is not enough purple and way too much green. In real numbers it is: purple 37, red 75, green 95, orange 60, yellow 71.

There is a lot you can calculate, which I'm not going to do. Some people might say that a sample size of 8 is too small, however when a normal person buys a package of skittle they expect an even distribution of colours. Unfortunately this is not the case. You may think, nice but what is the point? Well very simple: if you have wondered about this and thought you were crazy: you are not crazy! And hopefully, one day, I'll be able to buy only purple skittles. But until then, enjoy your skittles!
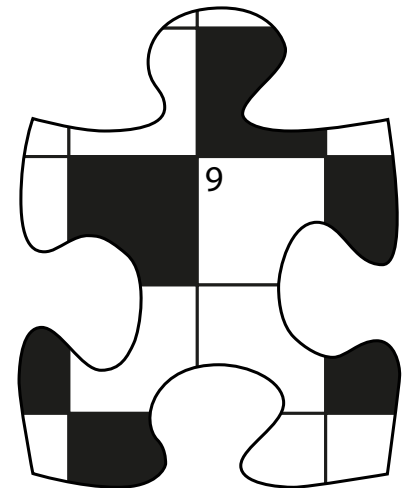
Skittles distribution

- purple
- red
- green
- orange
- yellow

11% / 22% / 28% / 18% / 21%
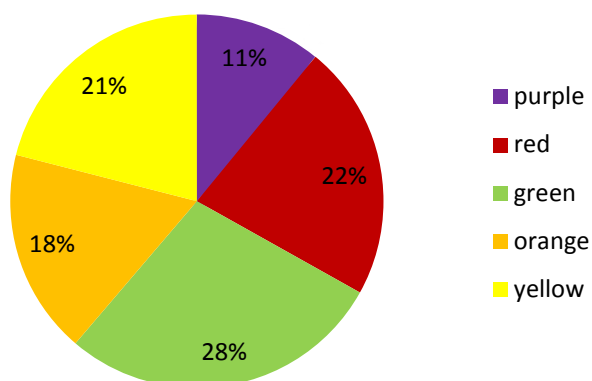
Puuzle

Author: Truusje

Now that the weather is starting to get better, it is the perfect time of the year to sit in the sun, relax, drink a cold beer and train your brain with the following riddles. If you know the answers to the riddles, send an email to truusje@scintilla.utwente.nl. I will chose a winner from the submission, who will receive an apple pie.

Where does Wim live?

Wim lives in a street with numbers between 8 and 100. Trudy would like to know where Wim lives.

She asks: 'Is your house number greater than 50?'.
Wim answers, but lies.
Trudy's next question is: 'Is your house number a multiple of 4?'
Wim answers, but lies again. The bastard.
Then Trudy asks: 'Is your house number a square number?'
Wim answers with the truth.

With this information, Trudy replies: 'I know your house number if you tell me if the first number of your house number is a 3.'
Wim answers again, but we don't know if he lies.

Trudy then tells the number she thinks Wim lives, which is of course wrong.
What is Wim's real number?

Series

What is the solution to the following assignment?

$$(p-a) \times (p-b) \times (p-c) \times \ldots \times (p-z)$$

Red cube

A wooden cube is painted red on all sides. After this, the cube is sawed is 125 small cubes, all equal in size.
How many of these cubes have no red side?

Groeten uit...

Zwitserland 2009

Litouwen '0...

Vietnam

Rio de Janeiro 2008

Maleisië '10

Dubai 2007

Maak uw bijdrage over op banknummer 59.27.19.189 ten name van Stichting Universiteitsfonds Twente.

Op onze website www.utwente.nl/ufonds kunt u makkelijk en veilig via IDEAL een bedrag overmaken.
Daar vindt u ook meer informatie over notariële schenkingen.

Hartelijk dank namens de studenten van de Universiteit Twente.

Met het Universiteitsfonds Twente komen ze verder.

Word nu donateur!

UF Stichting Universiteitsfonds Twente

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