
Inside view
The strange case of sticky gold
Theorist vs. Engineer
Random vectors for robust representations
Koke met Sjoke
A quarktaart recipe
FRANCKEN VRIJ
STRANGE
27.1 Strange

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Editorial
A strange thing has happened: the Francken Vrij has reached a new era of motivated editors to reinvent the magazine. I have already gotten an idea of the creativity and ideas of the new committee and am very enthusiastic to bring you three editions presenting these ideas.

If you are wondering why we chose the theme 'Strange', because you might experience it as strange that Sibren is no longer editor in chief and that the rest of the previous committee has retired. I would like to thank them for their dedication to the magazine and hope they like to read the Francken Vrij just as much as writing it!

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Chair's preface

By CsillaTijssen

While trying to find inspiration for writing this piece I've been staring out of the boardroom window and wondering at how fast autumn has come. We have been board for almost 5 months now, it feels strange to think how many events we have already had and how much we have already done.Now moving onto the topic of this first edition of this year's Francken Vrij, I would like you to bare with me for a paragraph and consider the following:

If we want to determine the strangeness of Francken we will have to consider the net number of strange and anti-strange Francken members. This, you might think, does not seem like the hardest task, just go to a borrel and see how the members behave. However, when some beers get involved, the beers might just act like the nuclear weak force and the net strangeness of Francken might change. But what if these beverages do not act like the weak force, but rather the nuclear strong force? Then the strangeness will not change. This might lead us to the conclusion that a borrel does not change the strangeness of Francken, it is and will always be the same. I will leave it up to you, the reader, to determine whether this strangeness is positive or negative. I hope I didn't crack your brain too much with this little thought experiment and I hope you enjoy this year's Francken Vrij editions as much as I will!

News of the Association

By Filippo Carretta

Dear Francken members, it is my first time writing the beloved 'News of the Association' in the amazing magazine of the Francken Vrij. I have already helped sending two Francken Vrij magazines, of which I had not written this specific part which technically means that this will be the third Francken Vrij sent by the new board. This is strange as each board is officially supposed to only send three in their board year. This of course means that the biggest news since the previous edition is that a new board, named Fusion, has been running the association since June. Other than this I am not sure what else to write here other than enjoy the following brief description of the amazing events we have already had.

Pienterkamp

The academic year started with a fantastic weekend at the introduction camp Pienterkamp organised by the likes of T.F.V. 'Professor Francken', FMF, and Sirius A. Here the first years enjoyed a variety of activities ranging from an exciting pub quiz, to a sports day, to a treasure hunt, to a late night (possibly all night) party. However, the best part was when the first years played one of the best sports out there Flabi. Here there was a series of matches played by the exited first years. Following these matches three important matches of Flabi were played, that of the association matches. Here I am proud to say that Francken won against both FMF and Sirius A in this amazing messy game. Pienterkamp came as a great opportunity for the new first years to relax as their first week of university starts.

Introduction week: Pub quiz, Crazy-88, AP picnic

Following Pienterkamp Francken decided to organise multiple events for the first-year students. The first event was with the likes of FMF and Sirius A, which was an exciting Pub quiz held in the ACLO. This event brought a huge number of first-year students, and they all showed their unique intelligence in answering the questions we gave them. After this Francken decided to host another test for the new young Francken members. Francken organised a Crazy-88 where 88 different tasks and questions were asked and given to the first years. Here we were surprised to see how well everyone did, where they went above and beyond in achieving the tasks we set for them. The first years finished off the week with an event purely aimed at Applied Physics students, that of the Applied Physics picnic held outside the NB. Here the first-year Applied Physics students got to interact more with each other and even meet some older Applied Physics students. Overall I think the first week was packed with events for our members but a huge success, and of course huge fun.

Start of year BBQ

The second week of the academic year had a highly anticipated event, the Start of year BBQ. The Start of year BBQ was held outside in the central grass garden between the Bernoulliborg and the Linnaeusborg. Here the members of Francken enjoyed the last bit of summer weather, amazing food, and free beer. Nothing special happened other than there were almost 100 people there and all the food at the event was finished leading to an extremely successful event.

Francken Friday Lectruce

On the 30th of September, there was the first Francken Friday Lecture of the academic year. Here a member of the Micromechanics group, situated in the same building as the Francken room, gave a lecture on the research they are conducting there. Maurice Dekker explained his research in

Nuclear transport between the cell nucleus and cytoplasm and members gained an insight into what research is being conducted in the halls of the university they are studying in.

Oktoberfest borrel

The first borrel organised by the Borrelcie was that of the infamous Oktoberfest. Here Francken members could enjoy a beer while celebrating this great beer festival. It was safe to say the event did not disappoint in creating amazing memories, through eating Frankfurter Sausage, drinking beer and talking to fellow Francken members. It was also fun to see that certain members decided to dress up for this event.

Dies Natalis

On the 12th of October 38 years ago the association of T.F.V. 'Professor Francken' was founded. Therefore on the 12th of October 2022 certain active members decided to organise a jungle-themed party for this wonderful association. This event was held at Dorst where members enjoyed free entrance shots and a large amount of free beer. Here we saw amazing costumes of some truly dedicated members and some less amazing costumes of less dedicated members. I am ashamed to say that I was one of the members that had to be given a tiger-themed tutu to be in the jungle theme. Regardless of this, the event attracted many members that truly enjoyed the event and their love of the association could be seen.

Costume Contest

The costume contest strikes as the first Fraccie-organised event of the year. This event was held right after one of the first-year exams, however here once again showed the dedication of Francken members to sit their exams in a costume in order to immediately join this Francken event. The costume contest motivated members to dress up in many different things such as a full-on Pikachu suit, or in Hogwarts Slytherin robes, or as Jack Skellington, or as Pirates. Here the main thing that shocked me is that Francken members sat their exam fully dressed up for the costume contest which is indeed strange.

I-GMA

The Intermediate General Members Assembly was the first GMA of the academic year and the first solo GMA of the new board Fusion. Held in the Francken room the board provided news to its members but most importantly the previous board 'Half-Life' provided their Annual Year Report for members to read and remember the previous board.

Nedap excursion

The first excursion of the year was one to the company of Nedap. Here we visited the headquarters of Nedap where they research and operate a large variety of different sectors in the world. One such sector is that of security, where we learnt that Nedap is one of the leading companies in the security of card passes. Here we learnt that Nedap provides this service to even the Eiffel tower. After this Nedap constructed an interesting case study where we had to understand, through a python code, the location of certain sensors. Even after the actual excursion the fun didn't stop as there was a paid dinner at a restaurant in Groningen for the members present.

White lies borrel

The white lies borrel is where Francken members could write on member's shirts white lies about the member. This led to a variety of funny and truthful comments about members. Here we could really see what Francken members think about each other, which led to many fun arguments between members. This event was so fun that even a variety of older board members joined in to write things about each other.

General Physics Knowledge

By Wout Trox

Dear Francken Members,

We have been busy thinking about physics for the past couple of weeks. But not only the thinking part. We have used our knowledge to pass it on to people we don't know or don't study physics. We did this by asking people General Physics Knowledge questions. To let them think about *the keystone* of life. It is not the knowledge about Quantum Physics or Solid Mechanics. It is about knowledge somewhat easier to digest. Have fun reading:)

'Hey Hanna, how do scientists cool objects to 0 Kelvin (absolute zero)?'

"With that matter. I don't know the name of it but that thing with which you can frost things. It is FLUID NITROGEN! Otherwise, there is also something extraordinary only physicists know. "
- Hanna is a 2nd-year International Relations student who loves art.

'Hey Tayfun, what is the speed of light?'

"Ohhh, let me think. Like 12 billion kilometres per hour or something. Haha." Then he tried to rectify his answer by saying that he didn't learn about light in mechanical engineering.
- Tayfun, a 2nd-year Mechanical Engineering student, loves taking pictures.

'Hey Hester, where was Albert Einstein born?'

"I HAVE MY BACHELOR!!!"
- Hester, finished bachelor, loves Francken Vrij

'Hey man, may I ask you a question? It is for Francken Vrij.' "OK". ‚What is the speed of light?'
"Fuck you. Haha. Stupid question. I know the answer, but I learned that a while ago." I said: 'Yeah, it must be a long time ago. Not the easiest thing to know… I can tell you that it is pretty fast…' I had my MacBook in front of me. He said: "Search it on google, then ask the question again, and I will give you the answer." Afterwards, he pointed to the answer full of pride on my screen.
- Polish guy from east Germany discovering the Netherlands and vibing on Charlotte de Witte techno music. The guy in front of me is from Brazil that lived in Berlin for a while; also a techno fan. They are friends or partners. It was on the train from Groningen to Rotterdam.

'Jason, in physics, multiplying the mass of an object by its velocity gives you what property?'

"Pfoehh. Ummm. Mobility or something? Mobility. Or is it energy? Not energy?"
- Jason, a 2nd-year medical science student, plays hockey.

'Hey man, I heard you were talking about the speed of light (middle of the night in front of a bar). I am writing a piece for my study association, so I have a question for you. Haha, what is the speed of light?'

"Ah, it is c. It is always c and 1 in theoretical physics." Then I said: ‚Yeah, right!' He said: "Which association are you a member of?" I said, 'Francken', full of pride. He said that he was probably still a member of FMF and Francken.
- A physicist in a group of 3 people in front of a bar at Zuiderdiep at 02:36 in the morning.

"A dumbell you use in the gym is 362 times dirtier than a toilet seat."

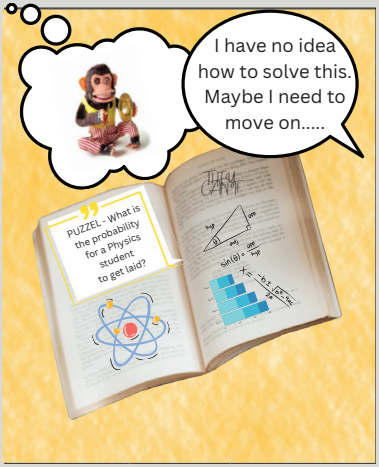
'Hello ma'am; I am writing an excellent piece for the Francken Vrij, a magazine of my study association. Therefore I ask people physics questions. Do you know the speed of light?'

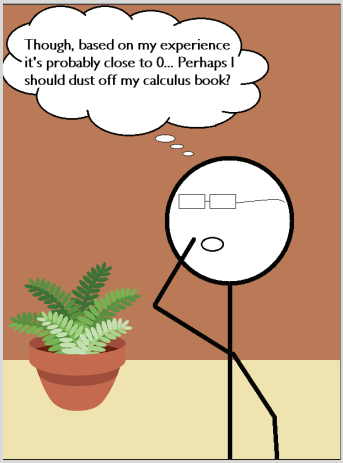
"Haha, how should I know that? Well, I don't know… But did you know that a dumbell in the gym is 362x dirtier than many toilet seats? Of course, that's because so many people are touching those dumbells. The staff here at the gym are also just barely ill from November to March. That's how you build up resistance."
- Recipient at Basic Fit

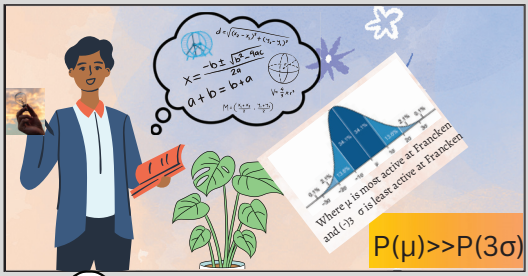
Hey S.V. Cover, what is the speed of light?

"Lightning Queen"
- Thomas, history student, Cover fan.

Comic







So did the sjaars got laid you may wonder? Just like Schrödinger's cat, you will never know unless you come to the Francken event and check...

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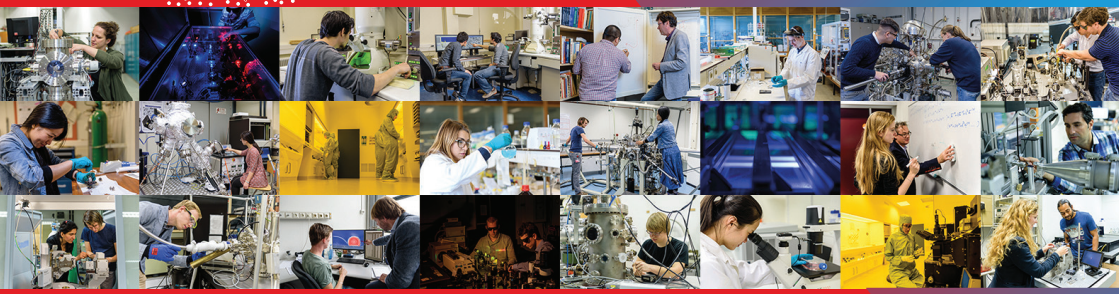

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Unconventional computing: random vectors for robust representations

By Madison Cotteret

Representing objects and concepts with random vectors might seem ludicrous, but bear with me for approximately 1500 words. The colour yellow? Random vector. Norway? Random vector. The notion of random vectors itself? Random vector. Although introducing randomness just for the sake of it might seem like a fruitless exercise, the studyof *Vector Symbolic Architectures* (VSAs) has exploded in recent years, and has produced myriad evidence to the contrary. They boast the offering of a unified, flexible, and incredibly robust knowledge representation framework, which any {evolutionary process, intelligent designer, lost PhD student} would be silly to ignore without careful consideration.

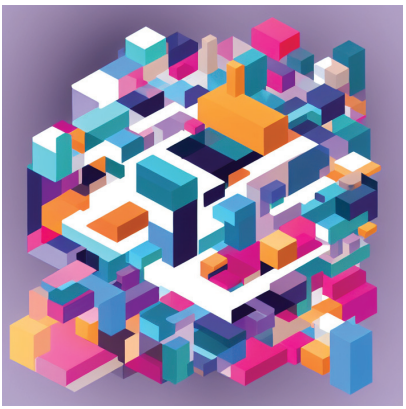

Figure 1: I asked DeamStudio for a picture of a vector symbolic arhcitecture. Not related to any ongoing research, but this article didn't have enough colour.

VECTOR SYMBOLIC ARCHITECTURES

In VSAs, any new basic primitive is represented by an independently and identically generated (IID) random vector. Let's say we're using bipolar vectors, $\boldsymbol{x} \in \{-1, 1\}^N$, where N is the dimensionality of the vector, and is very large. Whenever we wish to represent a new independent primitive, we IID pick a new random vector uniformly from the set of bipolar vectors. We must then also introduce a measure of the similarity between vectors, which may then serve

as a measure of similarity between the objects they represent. The normalised inner product should suffice, $sim(\boldsymbol{a},\boldsymbol{b}) = 1/N\ \boldsymbol{a}\cdot\boldsymbol{b}$. The similarity is then maximum when the vectors are identical, i.e. $sim(\boldsymbol{a},\boldsymbol{a}) = 1$.

HYPERDIMENSIONAL COMPUTING

Why did we demand that N be very large, you may ask? This requirement arises from demanding that independently generated vectors be almost surely orthogonal to each-other, and so have a similarity of approximately 0. A quick back-of-the-napkin application of the Central Limit Theorem tells us that the similarity between any two random vectors is given by $sim(\boldsymbol{a},\ \boldsymbol{b}) = 0 \pm 1/\sqrt{N}$, and so for a large enough N, say 10^4, ignoring the tiny residual error should't keep us awake at night. For some set of hypervectors $\{x^\mu\}$ these relations can be summarised by $sim(x^\mu,x^\nu) = \delta^{\mu\nu}$, which should already start to get the more imaginative physicists thinking.

A somewhat sobering perspective on this result is that although all possible vectors are uniformly distributed in 10,000 dimensional space, given a certain vector, almost all other vectors exist approximately 5000 bits difference away. This means that if two vectors have a similarity of, say, 0.1, we might at first think this a bit low, insignificant even. But if we assume that the vectors are unrelated, then a similarity of 0.1 is 10 standard deviations away from the mean, and so is astronomically unlikely. We can thus be very sure that these vectors are deliberately and meaningfully related. In short, although almost all the space is far away, any vector has a vast personal playground of space near to it, which for all intents and purposes belongs to that vector and that vector alone.

The requirement for high dimensionality should by now be evident, and is why VSAs are often known by a second name: *Hyperdimensional Computing* (HDC). Although you may think that such dimensionality is a bit of an tall requirement, remember that such numbers are still miniscule compared to the number of neurons in any selfresecting region of the brain.

VECTOR ARITHMETIC

So we have a set of set of hypervectors which we're very pretty sure are orthogonal to each-other, and represent some set of irreducible primitives. Though interesting, this isn't terribly useful. What is more interesting is how these vectors can be composed into other vectors, which may then represent the relationships between their constituents. VSAs thus also come with a few simple arithmetic operations attached, of which the most important are *bundling and binding*.

Bundling, or for fans of simple terminology, addition, is the operation by which multiple vectors can be superimposed into one

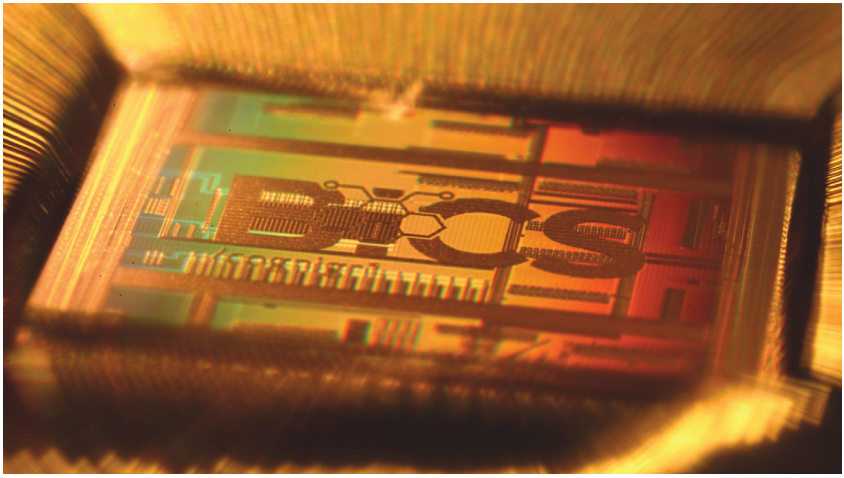

Figure 2: Our recently fabricated spiking neural network integrated ciruit, just to prove that we actually make things sometimes.

vector. The output vector $\boldsymbol{s}=\boldsymbol{a}+\boldsymbol{b}$, where $+$ denotes element-wise addition, is then similar to its constituents $\boldsymbol{a}$ and $\boldsymbol{b}$. As you might imagine, this is a natural way for a vector to represent a set of objects. There is then the question of whether or not you re-threshold each dimension to ensure that $\boldsymbol{s}$ is bipolar again, rather than having twos and threes floating about, but that's not very interesting so let's not talk about it.

Binding is the cooler and more enigmatic of the two elementary operations. In general, binding two vectors in a VSA produces a vector that is entirely dissimilar to each of its constituents, but which is invertible by either of them. This vector $\boldsymbol{m} = \boldsymbol{a} \otimes \boldsymbol{b}$ is then a unique and decodable record storing the association between a and b. For our bipolar vectors, the $\otimes$ operation corresponds to element-wise multiplication, and so it is easy to convince yourself that $\boldsymbol{m}$ is entirely uncorrelated with its constituents, yet represents the relationship losslessly. The operation can be inverted (unbound) by binding $\boldsymbol{m}$ with either $\boldsymbol{a}$ or $\boldsymbol{b}$ again. Since we have convinced ourselves that $\boldsymbol{m}$ has zero similarity with any earthly number of hypervectors, we can thus think of $\boldsymbol{a}$ (or $\boldsymbol{b}$) as providing a unique invertible map from any vector to an uninhabited region of state space, which really should begin to highlight the generality and flexibility that VSA models present.

LARGER CONSTRUCTS

Despite their simplicity, these elementary operations let VSAs represent complex knowledge structures very naturally. The first example is data binding and figurative reasoning. Imagine we have hypervectors **U**SA, **D**ollar, **M**exico and **P**eso, as well as $\boldsymbol{X}$ for Country and $\boldsymbol{Y}$ for Currency. The sum total of our human experience and wisdom pertaining to land of the free could be expressed as the hypervector $\boldsymbol{B}=\boldsymbol{X} \otimes \boldsymbol{M}+\boldsymbol{Y} \otimes \boldsymbol{P}$, while our data entry for America would be given by $\boldsymbol{A}=\boldsymbol{X} \otimes \boldsymbol{U} + \boldsymbol{Y} \otimes \boldsymbol{D}$. Given $\boldsymbol{A}$, we could then unbind with the hypervector $\boldsymbol{Y}$ in order to find out the currency vector stored within it, since

where the residual triplet term produces

$$\mathbf{Y} \otimes \mathbf{A} = \underbrace{\mathbf{Y} \otimes \mathbf{X} \otimes \mathbf{U}}_{\text{Noise}} + \underbrace{\mathbf{Y} \otimes \mathbf{Y}}_{1} \otimes \mathbf{D} \approx \mathbf{D} \tag{1}$$

only the tiny amount of noise which we earlier all agreed we could ignore. We would thus find that $sim(\boldsymbol{Y} \otimes \boldsymbol{A}, \boldsymbol{D}) \approx 1$, which in the empty void of hyperspace is quite a definitive response. We can also utilise weirder interactions between our data entries, by "asking" our data a question like "what's the Dollar of Mexico?", or rather "what in Mexico is the equivalent of the Dollar in the USA?". The answer can be recovered by unbinding Dollar from $\boldsymbol{A}$ and then binding with $\boldsymbol{B}$, i.e. $\boldsymbol{D} \otimes \boldsymbol{A} \otimes \boldsymbol{B}$. If you run through the maths, which is mostly an exercise in identifying which terms we can ignore, you will find that $\boldsymbol{D} \otimes \boldsymbol{A} \otimes \boldsymbol{B} \approx \boldsymbol{P}$, and so the hypervector corresponding to the Peso is the only vector that will give a nonzero similarity with the product. Obviously this situation is a little contrived, but it should serve as inspiration for the types of flexible reasoning and comparisons that VSAs natively enable.

A STEP BACK

Before getting carried away with all the constructs that VSAs enable, we should take a moment to reflect upon their majesty in general. The data representations are entirely *distributed*, meaning that no dimension is more or less responsible for any single piece of data, and so are incredibly robust. New ideas and relationships are constructed out of old ones in a way that is massively parallel and relies only upon simple element-wise operations. No discrimination is made between the representations of concepts, objects and relationships alike. When one wonders about how the brain might continue to function while neurons are constantly growing and dying, synapses learningand unlearning, suddenly these funky VSA things start to seem less like abstract nonsense, but rather perhaps necessary to begin to answer questions about how knowledge might be represented in the brain.

LUKEWARM TAKES

My research focusses on finding ways to exploit VSAs in recurrent attractor networks in order to make neural building blocks that

can be used to make larger, more interesting and capable cognitive architectures. This is the physicist in me talking. How can we get interesting emergent phenomena arising from just simple interactions? What properties do they have at a higher level of description? Their computational capabilities? On the other hand, there is the engineering aspect of all of this that must be sated. In the Bio-Inspired Circuits and Systems (BICS) group, we must always keep in mind whether the models we develop are plausible for implementation in biology. Quite convenient is that if the answer is yes, then there's a good chance we can build a chip of silicon spiking neurons to test the theory and, if we're very lucky, emulate cognitive functionalities.

So we really do have feet in both the engineering and physics camps, and reap the benefits of both. We take the approach neither of a purist theoretical physicist, nor that of a battle-hardened engineer. Elegant though a stringbased interpretation of consciousness isomorphic to $SU(\pi)$ may be, if it doesn't correspond to anything physical, then I'm not particularly moved. Developing a synapse circuit with a 0.3 femtojoule per furlong power saving compared to last year's model? Not for me. But theory motivated by real-world applicability, confirmed by the building of novel architectures? Now we're talking.

Thanks to Michele Mastella and Hugh Greatorex for their editorial input.

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Puzzle

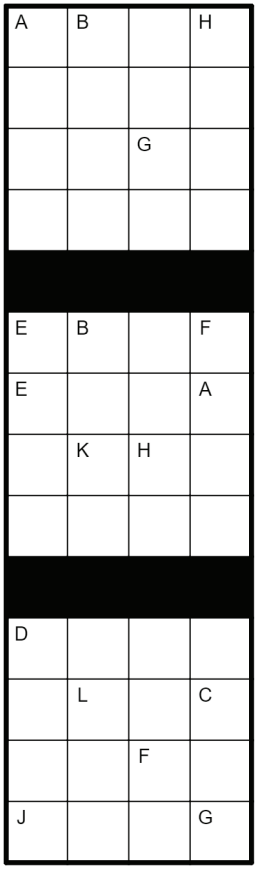
By Arjen Kramer

There are many different puzzle types, with incredibly creative rule sets. But using very strange rules is often constraining in puzzle design, leading paradoxically to simpler puzzles.That is why I've chosen to use the "relatively" basic rules of a "Gemini loop", with the twist of adding a third dimension:

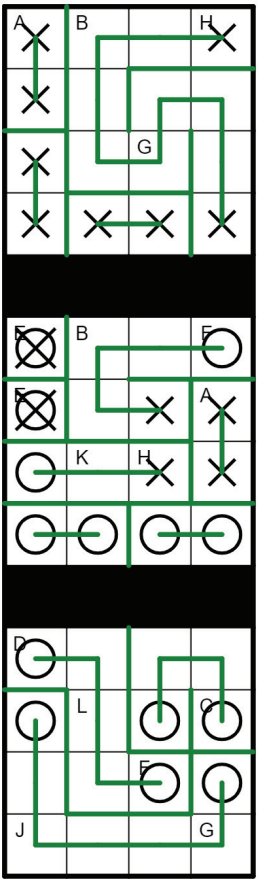
- Draw a single closed loop that moves orthogonally between adjacent cells.
- The loop must visit every non-black cell and may not cross or overlap itself.
- In cells labeled with the same letter, the loop moves in the same way.
- In cells labeled with different letter, the loop may not move in the same way.
- The three grids are three floor of one maze, the first grid is the top floor, the third grid is the bottom floor.
- The loop can move from floor to floor through cells that are directly above and below each other.

In the example you can see how this works, I've labeled the loop going down a floor with 'X' and the loop going up a floor with 'O' in the solution. The possible loop-shapes have been given, so you can label them as you go through the puzzle. This ruleset turned out to already be more than complex enough, as I spent too many hours trying to build a puzzle where the labels spell out funny words. Sadly, the third dimension kept messing things up. So unless your spatial reasoning capabilities are much better than mine, this puzzle will mess with your head. If you get stuck, do try the example puzzle, which is already quite a challenge. The first to send in a picture of the correct solution will be given free coffee in the franckenroom for a whole year!

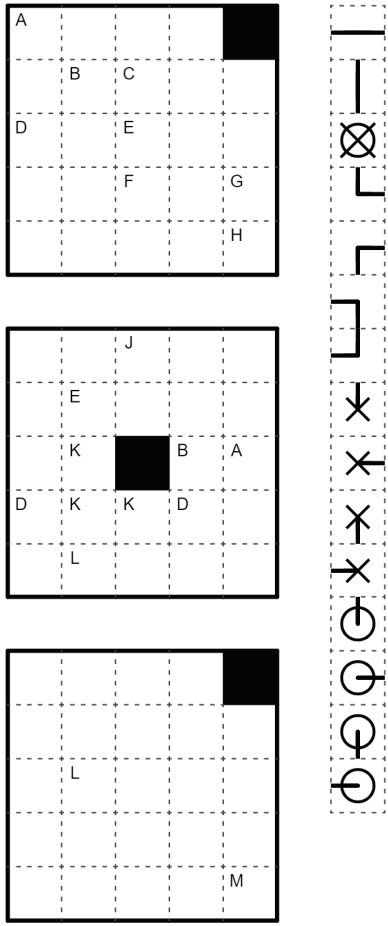
Bonus challenge: Why does the puzzle need at least one black cell?
Bonus bonus challenge: Why did I set myself up for failure by trying to have that black cell in the center of the middle floor.



Strange Loop Demo



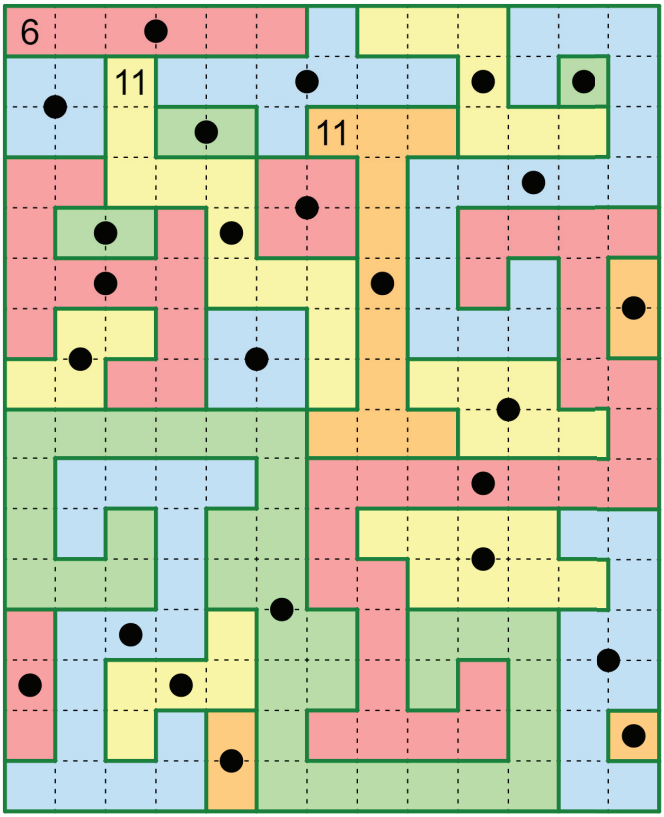
Strange Loop Demo Solution



Strange Loop

Solution to 26.3

The chaotic universe that needs organizing:



Life after Francken, abroad

By Anton Jansen

Hello everyone! My name is Anton Jansen, I studied physics from 2013 to 2020 and was chairman of the board in 2016-2017. This is the story of how I started my PhD in Sweden and how life has been for me up in the far north.

After finishing my master's in February 2020, I was unsure what to do next. I had saved some money and wanted to travel for a number of months in Southeast Asia. However, with the onset of Covid (measures), it quickly became obvious that travel was not going to be possible for the foreseeable future.

I was also doubting whether to do a PhD: I enjoyed my master project and realized that it's unlikely you'll ever do a promotion after starting a regular job. On the other hand, I consider(ed) four years a long time to be stuck in the same place doing the same thing when you're still in the most flexible and physically fit part of your life. In the end, I decided to go for it because I figured I could always do something else for 30 more years if I wanted to.

By May 2020 I was in the luxury position of having been offered multiple PhD positions in Groningen, but in the end decided to accept a position in Stockholm because this seemed a more significant challenge and therefore an opportunity to learn and grow.

I immigrated to Sweden and started my PhD on June 24th 2020. Getting my life set up (the paperwork, opening a bank

account, etc.) was relatively streamlined as everything is well organized in Sweden. Furthermore, the university offers housing for up to one year for all university staff moving from abroad, which also makes things easier. Despite this, I would still describe the first year as very tough: I didn't know anyone, and Covid measures meant that working from home was the norm and most social activities were cancelled. Additionally, the Swedes, although relaxed, friendly, and civilized, are significantly more indirect and introverted compared to the Dutch, and tend to be more individualistic. For these reasons, it was difficult to meet and connect with other people. Although life has gotten better over time, especially after covid measures were relaxed and working on-site became the norm again, socially it is still not what it used to be and I do miss my Dutch friends and family.

Anyway, as my PhD is essentially in applied physics, it's maybe nice to briefly explain what I'm doing: my research project is primarily in the field of molecular dynamics (MD). MD is a computational method for

studying the behavior of (macro)molecular structures such as proteins. I am doing my PhD in Stockholm at the Royal Institute of Technology (KTH) in the biophysics group (biophysics.se). Our group (amongst other things) currently maintains GROMACS, which is one of the fastest and most popular MD packages and was originally developed in Groningen during the 90s (it stands for GROningen MAchine for Chemical Simulations).

So far, my PhD has revolved around developing and implementing a constant-pH algorithm in GROMACS (in collaboration with others). Without going into detail, this addition will allow the pH-dependence of proteins to be captured more accurately whilst maintaining roughly similar simulation performance. This novel method is mostly finished at the time of writing and has led to two publications. I am currently applying our new method to a protein called GLIC, which is an ion channel. Ion channels are large proteins embedded in the cell membrane and regulate the influx and outflux of ions. They are especially important in nerve cells. GLIC is a proton-gated channel, meaning the channel is activated (opened) upon a lowering of pH. For this reason, it is an excellent candidate not only for testing our new method, but also to hopefully provide additional insight into the gating mechanism. Finally, I am working on a Python package called phbuilder, which will allow GROMACS users to more easily convert

or set up constant-pH MD simulations.

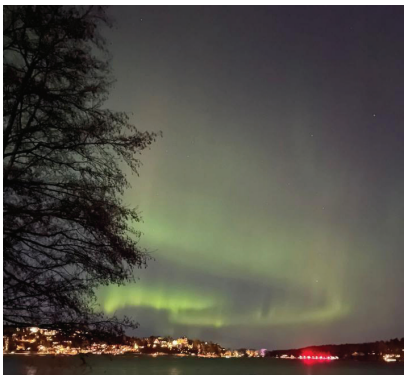
One of the highlights of my PhD has definitely been the opportunity to give a talk at the Biophysical Society in San Francisco. Biophysical Society is the largest biophysics conference in the world, and I was selected to give a 15-minute talk about my research to an audience of roughly 150 scientists. This was not only my first conference but also my first visit to the United States, and left quite an impression. I expect to have the opportunity to go to the US at least once more during my PhD, which I greatly look forward to.

Another cool thing worth mentioning was the recent visit of Willem Alexander and consorts to SciLifeLab (our institute) as part of a Dutch state visit to Sweden (one of the visit themes was life science). Given the fact that they could have chosen any of the many other life-science related companies or institutes in Stockholm, it felt like a nice compliment to see they decided upon SciLifeLab. Although I wasn't able to meet the king, I managed to speak briefly with Robert Dijkgraaf, whom I'm sure you've heard of. He was friendly, shook our hands, and told us to "keep up the great work in science".

So how do Sweden and Swedish cultures differ from ours? Generally speaking, Sweden is quite similar to the Netherlands in terms of prosperity, societal organization, and political climate. One of the more obvious differences is that Stockholm lies at a significantly higher latitude, which means the days are much longer during summer

and much shorter during winter. It's not uncommon for it to be pitch black by 15.00 in December. Furthermore, the Swedish winters are colder and longer compared to the Dutch. Winter temperatures as low as -20 are not uncommon, although they usually fluctuate around freezing (thank you gulf stream).

Sweden is also one of the largest and least densely populated countries in Europe, and therefore feels a lot more spacious and open compared to the Netherlands. Even though around one million people live in



Stockholm, it never really feels that way. The city is much more spread out compared to a typical Dutch city, with many lakes, parks, and forests scattered throughout. I personally like this a lot, as I for example basically live in the middle of Stockholm but am also only 200 meters away from Norra Djurgården. It's easy to go for a run in the forest this way!

The fact that Sweden is much colder and more spacious compared to the Netherlands is reflected in its people: as mentioned, Swedes tend to be more relaxed and civilized compared to the Dutch. They're also more introverted (unless they get drunk). These characteristics are reflected throughout Swedish society and as a result life in general is more slow and relaxed, and things like (mental) health and a good work-life balance are deemed very important. The flip side of this is that life can be a little tame and conventional, and I do sometimes miss the typical Dutch chaos and *gezelligheid*.

Although not nearly as bad as the Germans, the Swedes tend to be a little more obsessed with bureaucracy and rules compared to us. This has its positives, but sometimes things can also feel a little *betuttelend*. For example, the sale of alcohol is only allowed through a state-owned company called Systembolaget. Systembolaget has rather restrictive opening hours: it's only open from 10.00 to 19.00 on weekdays and 15.00 on Saturdays, and you cannot buy anything cooled or in sixpacks/crates. Alcohol is also a lot more expensive. In fact, alcohol is so expensive that people have made websites where you can figure out what to buy to achieve the highest *APK* (alkohol per krona). Check for example alkolist.github.io.

Sweden has a reputation for being rather li-

beral and progressive, which I think is largely justified. You can definitely notice that themes such as global warming and gender equality are considered (even) more important than in the Netherlands. Strangely enough, Sweden is very traditional when it comes to cannabis legalization/drug policy, and in this aspect, they are decades behind most other countries in Europe. As a result of their strict policies there is a massive organized (drug) crime problem (just watch Snabba Cash on Netflix).

I can safely say that starting a PhD in Sweden has been the toughest thing I've attempted so far. It has helped me learn and grow a lot, not just in terms of scientific knowledge and skills, but also in terms of what it's like to work full-time (dealing with supervisors, managing expectations, etc.), as well as on a personal level. I hope to defend somewhere in late 2023 / early 2024, after which I plan to at least make my big world trip. I plan to leave Sweden and will most likely come back to the Netherlands, or possibly attempt to work in the UK or USA for a few more years. I hope you enjoyed my story, and please don't hesitate to contact me if you have any questions or want advice on doing a PhD abroad.

Hej då!

The strange case of sticky gold

By Antonija Grubišić-Čabo

Gold is everywhere…

We are all familiar with gold from our everyday life: It is one of the most popular - if not the most popular - metals for jewellery thanks to its chemical inertness, shine, tarnish resistance, and the fact that it is the most malleable metal. These properties make it easy to shape into intricate patterns. Of course, the nice, yellow colour, which is uncommon in metals (and is a consequence of quantum relativistic effects), is also a plus when it comes to using gold for jewellery. But it is not just jewellery making that gold is used for in everyday life. Gold can be used for many other things: It is used as an investment in finance in the form of gold bars, in Olympic medals, and Oscar statuettes. We can also often find food decorations made of gold and, more importantly, gold is also used in our electronic devices. An average cellphone contains 1/35th of a gram of gold, while laptops have around 1/10th of a gram - or 6 Euros worth - of gold in them.

Gold is also often used in medicine, but there it is more often used in nanoparticle and colloidal forms. Gold nanoparticles are used as drug delivery systems, in bioimaging of tumour cells, as contrast agents in diagnostics, and even to treat cancer with photothermal therapy. It is perhaps more likely; however, that you have encountered gold in its colloidal form; especially during the COVID 19 pandemic. Many COVID 19 antigen tests, such as the one in Fig. 1b), use colloidal gold bound to COVID 19 antibodies in the test pads. So if you had the misfortune of contracting COVID, it was most likely colloidal gold that let you know about it through a positive test.

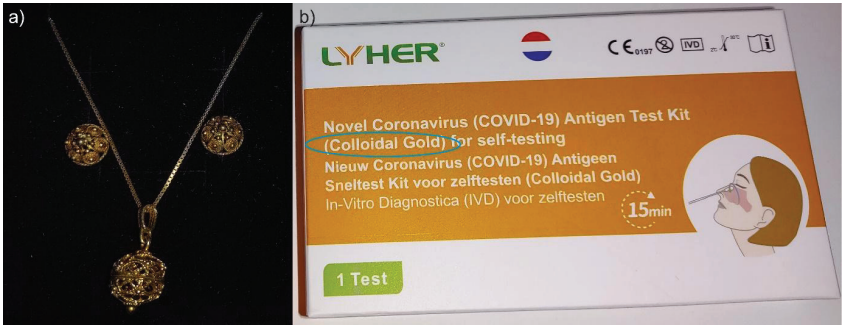


Figure 1. Some of examples of gold in our everyday life.
a) Gold jewellery and b) COVID 19 test containing colloidal gold.

Including science…

Of course, gold is not only important in our everyday life, it is also important in science. In surface science, my branch of physics, gold 111 is one of the most well-studied materials.

But what is gold 111?

At room temperature, gold crystallises into a face-centred cubic (or FCC) structure – one of two close packed structures, which maximise the density of atoms in the material. If you take an FCC structure and cut it in half across the volume diagonal, you will get a 111 surface – see Fig. 2a).

In the case of gold, a 111 surface consists of hexagonally arranged gold atoms, Fig. 2b), which is the most energetically stable configuration for the atoms to be in. To make things a bit more complicated, the gold atoms are still experiencing strain in their hexagonal arrangement, despite this surface being the most energetically stable one, so the first few layers shift a bit in in relation to each other, which forms a so-called herringbone reconstruction, Fig. 2c). A herringbone reconstruction is a periodic superstructure, with a huge unit cell compared to that of gold ($22 \times \sqrt{3}$), and despite having been studied for a while [1], new things are still being discovered about it [2,3].

Science uses gold not only in its pure form, but often also in combination with other materials. Gold 111 is one of the most commonly used substrates to grow various things, such as molecules and 2D materials, both of which are topics actively pursued by researchers at Zernike Institute for Advanced Materials [4,5].

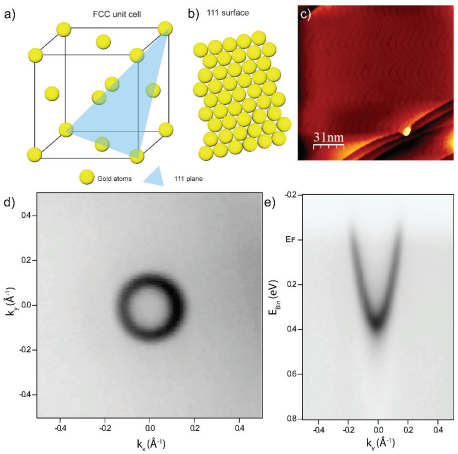


Figure 2. Gold 111. a) FCC unit cell with 111 plane indicated. B) 111 surface showing hexagonal arrangement of atoms. c) Scanning tunnelling microscopy image of gold 111 showing herringbone reconstruction and several atomic terraces of gold. d) and e) angle-resolved photoemission spectra showing circular Fermi surface of gold 111 surface state and parabolic electron band, respectively.

Beyond this, gold can also be used to calibrate your scientific instrument. If you are working with a scanning tunnelling microscope, and want to know if your tip is properly conditioned to do spectroscopy, the best way to find out is by measuring on very clean gold 111. You can also use gold for calibration if you are working with angle-resolved photoemission spectroscopy. The gold 111 surface state, which is a parabola-shaped electron band, can be used to calibrate your angle-resolved photoemission equipment, Fig. 2d) and 2e), and to test if your software is running properly. As you can see, both in everyday life and in science, there are many different uses for gold.

And it is oddly sticky….

But what is currently the most interesting use of gold in science?

The thing that is most interesting to me, and something that I am now working on in my lab, is to take advantage of gold and its stickiness [6] to develop a new method for creating 2D materials [7].

But how, and why, do I do that?

One of the most common methods of creating 2D materials is to simply take a bulk (3D) crystal and a piece of sticky tape, and then peel off a part of the crystal with the tape. You then keep using the tape to make the exfoliated flake thinner and thinner, until you finally reach a single atomic layer. This method of tape exfoliation is very popular, as it produces 2D materials of the highest quality, and as long as you can find or purchase nice bulk crystals, you can create very nice 2D materials this way. One of the downsides of this procedure is that, unfortunately, the 2D flakes you obtain are usually very small - tens of micrometres in size - and this is often too small for applications and spectroscopic measurements. A breakthrough in exfoliation happened a few years ago, in 2016, when scientists from Belfast discovered that if you prepare a fresh layer of gold, you can actually use it to exfoliate 2D transition metal dichalcogenides [8]. The exfoliated flakes were huge (centimetres in size), but the gold only stayed sticky for around 10 minutes in air. So what is happening here, and how come the gold is sticky enough to behave like a piece of sticky tape? Well, it turns out that the stickiness of clean gold comes from a recently discovered covalent-like quasi-bonding interaction [9], which makes gold very sticky while clean. The topmost layer of various materials [6] can "stick" better to gold than to the deeper layers of the material itself, which makes it very easy to exfoliate only one atomic layer.

All of the work done to discover this mechanism and expand on its use has so far been done in air or in the inert atmosphere of a glovebox [6,8], but it turns out that we can do some new things if we try to exfoliate with sticky gold 111 in (ultra-high) vacuum [7].

One of the big, and obvious, advantages is that we can now prepare 2D materials that are extremely sensitive to oxygen and water, such as WTe2, and we can perform spectroscopic measurements on these materials as soon as we exfoliate them [7], see Fig. 3 for an example of gold exfoliation in vacuum. This allows us to study materials that cannot survive even brief exposure to air, which would otherwise not be possible. We also have an additional advantage when exfoliating in vacuum: Our interface will be much flatter and cleaner compared to other approaches, which tend to suffer from trapped gas bubbles at the interface. If there is no gas, there can be no bubbles! This is something that greatly improves sample quality, as trapped bubbles induce strain and reduce the quality of 2D materials. A couple of other surprising things happen when you exfoliate with very clean surfaces in ultra-high vacuum. Maybe the biggest surprise is that if you have an extremely clean surface in vacuum, it is not just gold (and gold 111 specifically) that is sticky, but you can also prepare sticky silver

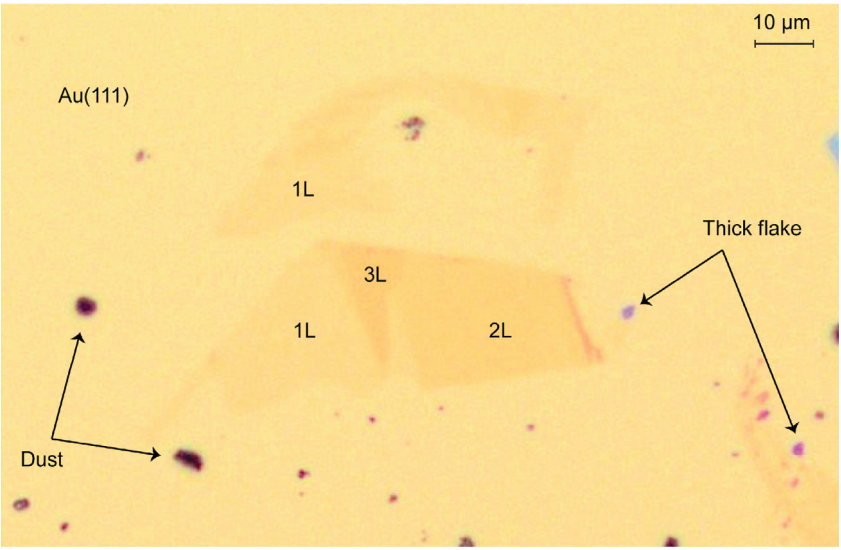


Figure 3. Gold (Au) 111 with 2D flakes of MoS2, with flake thickness indicated by layer numbers (1-3 layers).

111 and germanium 001. This is very exciting, because it means we are not limited to just using gold. If we feel like it - or if our experiment requires it - we can also use silver or germanium as our substrate, which is not possible to do in air as both silver and germanium oxidise very quickly, making their surfaces both unreactive and un-sticky. This also nicely expands our sticky tape toolbox, as we can now use both metals and semiconductors, and we also have different surface terminations available: 111 for gold and silver, and 001 for germanium. It seems that when it comes to using this stickiness property, if we do the exfoliation in vacuum we can be quite flexible regarding the nature of our sticky "tape" [7], and we can now create a wide range of 2D materials, or even heterostructures, that it was simply not possible to make or measure on before.

In conclusion

Gold is an amazing material that is used for many different things, both in everyday life and in scientific research, and it will likely stay relevant for many, many years to come. Despite many years of research into the

properties and applications of gold, new innovations are still being made, and surprising things are discovered - such as gold being sticky. Using gold as sticky tape is a very hot topic at the moment, and many different approaches are being developed to make this method more diverse. One of these approaches is to use gold exfoliation in vacuum to improve the quality of the sample-substrate interface and perform measurements on air sensitive samples. Here at Zernike Institute for Advanced Materials, we have several different projects working with sticky gold, so maybe in one of the future issues you will get to read about all the new things we will do with this method!

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gossip rubric

By Hester Braaksma

With the Franckenroom being open again just like in the good old days and a new generation of sjaars starting their student experience, a lot of things are happening as we speak. What good would a female editor in chief of the Francken Vrij be if we cannot have room to discuss these events that may or may not have happened, better known as gossip? Juice, spilling the tea, however you want to call it. Exactly, none. During the last couple of weeks it was possible to anonymously send in gossip to Francken's very own Yvonne Coldeweijer aka me. Taking everyone's privacy in consideration and to make it even more fun to figure out who and what I am talking about, I will leave out names and details. Let's get into the gossip and get you all talking.

FMF-Francken crossover?
Did you know that one of the board members is doing a committee at FMF? I have also heard that the board member only showed their interest and the FMF board has not acted on it yet, but who knows. I also heard that this board member is a huge fan of this rubric, which I of course appreciate!

A Buixie just across the border?
Then something we have all been waiting for, Buixie tea! My little birds whispered to me that the Buixie committee flashed a Belgian flag in one of their videos. Is this the next destination of our beloved foreign excursion? Will we be going there? Or is it just to mislead us? Nonetheless, it is a perfect opportunity to hype the upcoming Buixie destination announcement borrel!

You go sjaars and committees!

I received a lot of gossip about various members being a bit more than friends. This kind of gossip would not be fun if I didn't go into a little more detail. There were whispers about different pairings of sjaars that got lucky during or after a Francken event. Also within committees it has not been purely professional. Even two committee members got together at the event they organized. If that does not mean that your event was successful then I don't know what is. Also a private meeting between two members of a different committee occurred and one of their activities is coming up. I hope I'm able to spill more tea about this after the event.

Family first

As many members may have noticed, a family member of a Wijze Heer is a new active member of Francken! This family member shows a lot of potential not only of doing a board year in the future, but also with their study results. This has gotten people talking that the family member, now a sjaars, will graduate before their sibling, a fourth year bachelor student. We don't mind them having some study delay, since having these siblings around at Francken is equivalent to a good time, as multiple members of the Francken Vrij committee are very fond of these siblings.

XOXO

Bob's advetures

By Annabelle van Berlo

On Wednesday morning me and 14 others gathered at Hoofdstation to go on the Nedap Excursion. There I met a cute dog who seemed very enthusiastic about joining us. On the road this fluff was named Bob. Two hours later we arrived in Groenlo and were introduced to Jaap and Vera who told us about what Nedap does and showed us around the office. After a very exciting case study about retail we traveled back to Groningen to have some pizza. The next day was no less exciting than the first one, again it started by gathering at Hoofdstation, but this time the destination was ASML headquarters. After waiting for our van for an hour (but making up for it with starbucks) we drove three hours to Veldhoven. Here Bob, Sjoerd and I learned about ASML, inquisite leadership, the making of chips and what the ASML campus looks like from

the 19th floor. We had pizza (again) and headed home.Unfortunately Bob told me he was tired and wanted to sleep so I went out alone. Of course Friday turned out pretty rough after drinking so much beer, but Bob pulled me through. We had coffee with a friend and went shopping. Let

me tell you, no one gives better fashion advice than Bob. After spending all my money on clothes we went back to the Francken room for the white lies borrel, unfortunately Bob did not fit in any of the shirts but he inspired others to write fun things on eachother. The weekend has not been very eventful, Saturday was spent reviving from a hangover yet again until we went to get a pokébowl with Tanya. We walked around the city centre for a bit and then watched Don't Worry Darling. We went back home and had a very nice night dreaming about Harry Styles. Right now we are sitting in the University Library, he is helping me write this piece and we are preparing ourselves for our parting. I feel like I have gained a new friend for life and I hope you got to know Bob somewhat through my story. I am curious to see who he will join on an adventure next time and happy to see him make new friends.

Bob enjoying his cappucino

Members input

By Thies Ristjouw

Hello my name is Thies, I am (still) a first year Physics bachelor student and more importantly a sjaars at Francken. In the short period that I have been at Francken I might have spent a little too much time in the Franckenroom and too little focusing on my bachelor's. My first experience with the fun and craziness of Francken came at the Crazy 88 when all of a sudden I was standing in the Franckenroom eating a whole lemon to eventually end up losing to a group that had double our points :(.

Then everything went very quickly. From an introduction to klaverjas to now playing klaverjas as soon as there is a vierde man in the room. Then there is obviously my experience with older members and not to forget the 38th Francken board. Starting with the latter I'd like to tell you a little bit about how I got into the Sjaarscie and Fraccie... Thanks to the enthusiasm of Annabelle (I was totally not forced) I quickly became part of both committees and to this day I am very much enjoying being part of them. One of my proudest moments at Francken came at a VrijMiBo when it became clear that I am a way faster chugger than Sjoerd. I had to chug, because of a bet during the Nedap excursion that I lost.

Another of my better moments at Francken was with Christian as it was a Friday night and Christian offered me a place to crash at both of his homes. For me, this choice was an easy choice. I guess I have Filippo and Csilla left. Csilla drove us to Nedap which went very well but the way back was a little more bumpy. And then only Filippo is left to talk about. About him I

only want to say that I'm having and already had a great time at Francken with him, but not anything else. Just kidding, obviously I have some words left for Filippo. He is thé vierde man when he is in the room. I can just say 'klaverjas' and he looks at me and joins in. I have one goal for Filippo and that is to teach him to play klaverjas in Dutch as it is played often in Dutch, before the end of the year.

Well, I guess this will truly be the end of my beautiful passage. I am very much looking forward to making many more beautiful memories with all of you at Francken starting with the upcoming member's weekend. Hopefully, I'll see you then.

Byebye

Koke met Sjoke: Quarktaart

By Sjoukje de Jong

Have you always wanted to eat quarks? Then you must be delighted to hear that everything is made of them! But this is not the quark I meant when writing this recipe, and I also have not been able to find a good translation to English of the dutch word kwark. Although kwark translates to cottage cheese and kwarktaart translates to cheesecake, this is not really what it is. I think we can compare it best to really thick greek yogurt. Anyway, a great type of food to make a cake out of! Off course, I could not leave you Francken members with a recipe without alcohol, but if you wish it to be alcohol-free you can swap the limoncello for the juice of two lemons.

INGREDIENTS

- 9 gelatine leaves
- 200 g cookies (I used bastogne)
- 70 g butter
- 150 ml limoncello
- 1 lemon
- 250 ml (fresh) cream (at least 35% fat)
- 500 g full kwark
- 170 g white sugar

OPTIONAL FOR DRESSING

- 250 ml (fresh) cream (at least 35% fat)
- 2 bags of vanilla sugar

WHAT YOU NEED ADDITIONALLY

- Springform pan of 24 cm
- Electric hand mixer
- Spatula

PREPARATION

1. Let the gelatine leaves soak in enough cold water, for at least 10 minutes. Grease the springform pan with butter.

2. Crumble the cookies, melt the butter in a saucepan and add the cookie crumbles. Add the mixture to the springform pan and press down. You can use a spoon or the bottom of a glass to press the mixture down. Put the springform pan in the fridge to harden.

3. Zest the lemon and juice the lemon. Whip the cream until stiff.

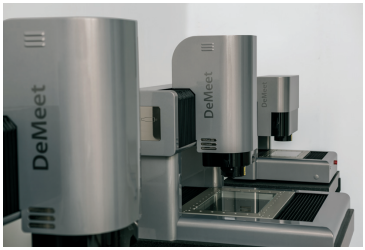
4. Squeeze the gelatine leaves and add them to the lemon juice in a saucepan. Heat it until the gelatine is dissolved, then turn off the stove immediately.

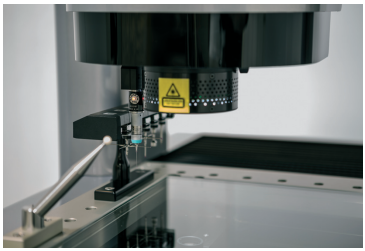
5. Stir the sugar, lemon zest, limoncello, and the gelatine mixture through the kwark. Fold the whipped cream into this mixture.

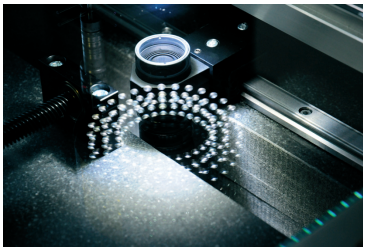
6. Pour the kwark mixture over the cookie bottom and put it in the fridge. Let it set overnight.

7. If you want to you can whip up the extra cream (with vanilla sugar) and pipe it onto the cake as garnish.

Off course you all want to know how it tastes, you can take my not-so-unbiased opinion that it tastes delicious! The cake is nice and fresh and I definitely recommend it. This way you can eat quarks in the form of kwark!







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