

Perio Interview: Hildeberto  
Járdon Kojamentov

Recipe: Spica te mbushura

# Periodiek

Recurring Magazine | Issue 2021-1



IMAGE:  
HANS HILLEWAERT

On the biomedical  
applications of jellyfish

*FMF*

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## 8 - On the biomedical applications of jellyfish

“What are the possible biomedical applications of extracts of the *Aurelia aurita* jellyfish?”. In this article, we will read about how these sea creatures might be used in the medical field. Brought to you by our very own Martijn Deinum.



## 12 - Perio interview: Hildeberto

Those who have taken Calculus 1 or Chaos Theory this year might have seen a new face on the other side of the screen: Hildeberto Jardón Kojakhmetov. Originally from Mexico, he moved to the Netherlands in 2011 for his PhD. After spending 2 years at the University of Groningen as a post-doc, he was appointed as an assistant professor in May. We wanted to get to know him a bit more, so we decided to invite him for an interview.

## 17 - Recipe: Speca te mbushura – Stuffed bell peppers

Elda shares a staple of the Mediterranean food hierarchy, stuffed bell peppers. Flavourful, filling, fresh, savoury, and delicious.



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## From the Editor in Chief

It has been a while since you heard of us. The ongoing pandemic and a shift in editors has not been kind on us. Nevertheless, we are happy to bring you a new issue of the Periodiek.

In this issue, we turned to the animal kingdom and brought you some interesting articles about bees and jellyfish that we hope you enjoy!

Do you have any ideas or suggestion for the Periodiek, or would like to become an Editor? Send us a mail at [perio@fmf.nl](mailto:perio@fmf.nl)

*Robert Mol.*

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# From the Board

## Extern

AUTHOR: E. VAN DER MEER

Hi friends!

If you don't know me yet, my name is Esther, and I'm the extern of this wonderful establishment.

I'm 24 years old, and I study International Communication at the Hanze, making me a complete alien in the association. I ended up at the FMF through a good friend of mine, Martijn Deinum, and sort of stuck around when I saw how much fun you all were having! My favourite activities are the room drinks and the bbq, which I sadly only got to attend once so far.

When Covid struck, I was a little lost about what to do. I did find a lot of solace in the FMF WhatsApp chat and later also the Discord, so when I was asked if I'd like to board, I thought "why the hell not?".

Being extern was my first choice from the get-go. I love the idea of talking to companies, showing them the best parts of the FMF, setting up activities, and working out deals that are mutually beneficial.

Talking to companies is nowhere near as formal as I thought it would be. With most of them, you can have a laugh and a friendly conversation in between business.

It's fantastic to see how these companies actually work, and what kind of work these recruiters do.

Doing board during these times is of course a bit different. I don't get to visit these companies and talk face to face like I usually would. I hope that I still get the chance to do this in the future.

Another effect is that even though nearly everything you're working on is somehow related to the FMF, at times I still feel a disconnect from our members. Luckily, we can always rely on our wonderful committees. It is astonishing to me how creative and involved some of the committees are, despite all the constraints that we have to deal with right now. It's good to see that people still find joy in organizing things for each other.



In addition to all the normal board stuff, we are looking into filling the FMF May month! With some luck, we'll have a fun line-up of activities to lift us all up. With the sun starting to show itself more and more often, and vaccination finally picking up, we can start thinking about outside activities. I for one am very happy to leave my room and smell the flowers every once in a while.





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# Will Thorium Save the World?

AUTHOR: N. KALANTAR

In 2017, the energy consumption of the globe amounted to an astonishing 14,069 (increasing to 14,469 in 2018) million ton oil equivalent. This number is, to a very large extent, dominated by fossil fuels (more than 85%; see the figure) and the rest is divided between nuclear (about 5%), hydro and other sustainable sources (about 10%). For the electricity consumption, the share of nuclear increases to about 10%. There are two factors that should make any politician worried about the future of the energy for the whole earth: 1) the population growth, which could go up by 50% in the worst-case scenario by 2050; and 2) the fast industrialization of the developing countries. The speed by which the latter is increasing is even more concerning than the population growth (look at countries like China and India with huge populations).

In 2016, an international agreement was made to reduce the amount of CO<sub>2</sub> substantially, relative to the production of energy. Three years after the agreement, it is now clear that this agreement will most probably not be realized even in many present scenarios. For example, if the new policies include an increase (also in percentage) of the renewable sources of energy from 10% in 2017 to 20% of the total energy consumption in 2040 and keep the nuclear energy at the present level of 5%, one is far from Paris agreement; in fact the CO<sub>2</sub> emission would be even more than the 2017 level. In a more optimistic scenario, in which the renewables are increased to 31% and the nuclear energy to 9%, one would come close to the Paris agreement, reducing the CO<sub>2</sub> levels to slightly more than half of the 2017 level.

solar panels. For the rest, one has to rely on fossil and nuclear fuels. The total amount of reserves that one has at its disposal, based on today's consumption, would be sufficient for another 100 years (total of all different sources). This is assuming that, for nuclear energy, Uranium will be the only energy source for the nuclear power plants. However, as mentioned earlier, the energy consumption is increasing dramatically in the coming decades and this number would be lower, based on realistic situations.

In one of the more optimistic scenarios, an increase of the share of nuclear energy has been considered. This choice is rather intuitive as this mode of energy production is almost CO<sub>2</sub> free meeting the criteria of the Paris agreement. The technical (safety, waste, cost etc.) and social (resistance of western societies) problems with this source of energy should, however, not be ignored but should be handled in a scientific way and a well-balanced discussion should take place putting this source in perspective with the other sources being used.

With the present reserves of Uranium which would last 30 years based on the present share of nuclear power (5%) and the current fuel cycle, this would already pose a problem for resources for this type of energy (and the same holds for the other sources), and one has to consider alternatives, specially if one increases the share of nuclear energy in the total package by almost a factor of two. One has no choice other than employing other technologies in the nuclear sector. The well known production technique is the use of Plutonium breeding reactors

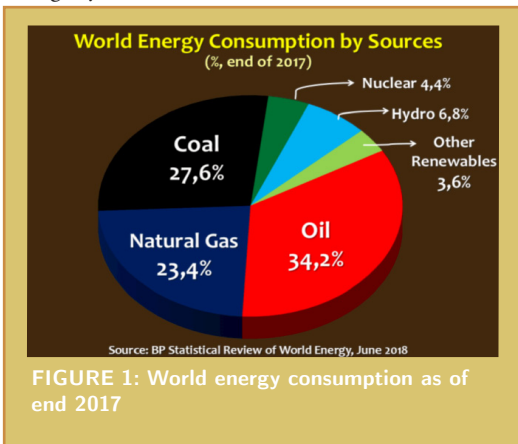


FIGURE 1: World energy consumption as of end 2017

One last issue which one should consider when discussing the energy package of the future is the size of the energy resources. For the renewable energy, one should simply add to the wind mills and the

with a very large amount of reserve (up to 2000 years). This source, like the Uranium reactors has the disadvantage of having very long lifetimes of the waste products, making its management a serious issue. The less known alternative would be the use of thorium instead with the reserves which are 4 to 5 times higher than plutonium making it even more attractive. The thorium option also has the advantage of being immune to proliferation as the source is not radioactive and a breeder reactor is needed to make the fuel ( $^{232}\text{Th}$ ) fissile. Incidentally, one should also mention techniques such as Accelerator Driven System (ADS) which would enhance the safety of the reactor. This will, however, not be discussed in the present contribution.

The problem in increasing the nuclear capacity and in particular making the switch and transfer to Th reactors is partly political and partly economical. Many western countries have stopped any research on reactors and new techniques yielding a setback to this mode of production compared to the other modes which have enjoyed abundant subsidies from the governments in the past 40 years. Because of this and also because of inherent problems of nuclear power (safety and waste management), the production costs of nuclear energy are, presently, higher than the other modes. For companies that are producing nuclear energy, the well-known and established techniques guarantee a successful outcome independent of the other problems mentioned above.

As has been seen in nuclear accidents, a major parameter in the design of any reactor is the cooling system. In the present systems, water, liquid metal or an inert gas like He are used for this purpose. A more recent idea (although this is tested more than 50 years ago) is to use a molten salt that acts as the coolant but a combination can be made with the fuel to make the coolant and the fuel the same. This Molten Salt Reactor (MSR) could form the basis for the Thorium fuel. Once in operation, there would also be no need to transport the fuel for reproduction. This combination would, then, have the maximum safety for operation. In addition, since Thorium waste elements are all short lived, with the lifetime of the fission fragments being the determining time constraint, the problem of waste management is also tremendously simplified (from 100,000 years to a few hundred).

In short, the MSR reactor in combination with thorium has the following advantages:

1. The fuel is much more abundant than the traditional nuclear fuel, U;
2. Thorium fuel cycle is more attractive to produce long-term nuclear energy with low radiotoxicity waste. In addition, the transition to thorium could be done through the incineration of weapons grade plutonium (WPu) or civilian plutonium.
3. Thorium reactor can operate with fast, thermal and epithermal neutrons for the generation of power;
4. Thorium has more favorable physical and chemical properties;
5. Operating temperatures are much lower than the boiling point of the salt (the coolant) leading to no meltdown etc.;
6. The separation between the waste and the material for breeding happen online leading to no transport;
7. Minimum inventory for fuel can be achieved and no major stocks are needed, leading to less proliferation problems;
8. Chance for “burning” transuranics is smaller leading to easier waste management.

Some of these advantages bring with them the disadvantages for the same system. One of the major issues that has to be understood is that the delayed neutrons can be emitted in the heat exchangers due to the fact that the fuel and coolant are the same and moving through the whole system. Another problem is the inertness of  $\text{ThO}_2$  which would require using aggressive materials to dissolve the fuel, which in turn are corrosive and harmful for other components. The problem of separating Th, U and Pu is also not under control. Cross sections for various reactions are also not as widely measured as for Uranium. Such problems need to be resolved soon as the window of opportunity is closing very fast. Many reactors around the world have reached the age at which replacement is becoming a necessity. Some have already been shut down and the discussions to stop operating some others are ongoing. GenIV reactors are conquering a very good position for this source of energy but more R&D for them should be funded by governments to speed up the process of coming to a conclusion regarding the best type of reactor and fuel with its corresponding cycle.

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# On the biomedical applications of jellyfish

AUTHOR: M. DEINUM

## Introduction

Jellyfish (gelatinous zooplankton) are a common appearance in marine ecosystems and most people are familiar with the organism. Though the jellyfish are conspicuous, they have not been the subject of particular interest in research fields. The populations of jellyfish around the globe fluctuate wildly with climate change and are subject to so called 'blooms', an explosive outburst of increase in population. Speculated about increasingly, but little evidence suggests that this increase in blooms is of anthropogenic cause. Whether the cause of this increase in blooms is due to human-made climate change and other factors or not, it has been proven that jellyfish populations and blooms around the world do see a significant increase [1]. The negative effects of sudden outbursts of jellyfish have been described many times in the past, including but not limited to: economic impact on fishing activities, the clogging of powerplants and certainly tourism [2]. There may however also be positive effects regarding these jellyfish blooms. Potential uses for jellyfish include the use as a food source, but also cosmeceutical applications have been described [3]. Perhaps more interesting and impactful to the human species may be the biomedical applications that jellyfish can harness. What are these potential applications, and how can we use them? In this review article several biomedical applications of jellyfish are described, which include anticancer effects of jellyfish venom and the use of jellyfish collagen for a wide range of applications.

## Jellyfish Venom

As jellyfish blooms have increased in several parts of the world, there has also been an increase in interest in the applications of several jellyfish venom. Some examples include the use of *Rhopilema esculentum* venom that has components which can act as an insecticide [4] or *Aurelia aurita* venom which shows anticoagulant effects [5]. Perhaps more interesting is the discovery of venom from *Nemopilema nomurai*, that has anti-cancer effects on liver cancer cells with high selectivity, and no obvious toxicity [6]. The study has shown that the venom from this species

exerts highly selective cytotoxicity in liver-cancer cells via dual inhibition of the Akt and mTOR signaling pathways, but not in normal cells [6]. Thus they have provided the scientific community with new insights in pharmacological intervention of cancer therapy by using *N. nomurai* venom [6].



FIGURE 1: The *Aurelia aurita*.

## Jellyfish Collagen

Collagen has several functions in the human, structural as well as mechanical. For example, they have important applications in tendons, skin and bone. Collagens are therefore widely used in the cosmetic and pharmaceutical industries. Due to safety hazards related with for example bovine collagen, the search for alternatives has begun [7]. Collagen from jellyfish in this case might offer the perfect solution, as from several studies it has been shown that invertebrate fibrillar collagens exhibit similar characteristics than the human collagens [8]. This argument is supported even further by the fact that jellyfish populations have been shown to increase, and they are rich in collagen. Using jellyfish for this purpose also completely avoids the use of mammalian tissues, which have previously caused biohazards [7]. Therefore it can be concluded that jellyfish collagen is very bio-compatible with the human species. *R. esculentum*, the same species as mentioned before, has also been subject to research regarding their collagen. It was discovered that the hydrolyzed form of its collagen can be used to



protect skin lipid and collagen from UV radiation damage. The mechanism through which it does this is mainly dependent on the antioxidative properties and the endogenous collagen synthesis, which could be repaired by the hydrolyzed jellyfish collagen [9]. This research could result in future use in human diet/supplements to protect our skin from UV-radiation. Another study by Zhuang et al. (2012), proved that long term oral use of jellyfish collagen peptides has a antihypertensive effect on renovascular hypertension rats. They showed it was safe to use and that the collagen peptides had an “intense effect” on the blood pressure of these rats, dropping the blood pressure significantly [10]. This discovery could also hold promising future applications in humans.

### Conclusion & Discussion

In this review article we have presented and discussed a multitude of (potential) biomedical applications of extracts of jellyfish, whether that be their collagen, or their venom. We can conclude that there is certainly promising research going on, that could impact human life significantly. It turns out that the increase in jellyfish populations around the globe does not only have negative effects, as the grown interest and research has unveiled several biomedical applications of jellyfish. Collagen could be the most promising over anything else as it has a multitude of applications, it has antihypertensive, anti-arthritic, skin protecting and immunostimulatory effects [2]. Jellyfish are even a subject in other fields of science such as chemistry, where in 2010 jellyfish gel was used to obtain hybrid hydrogels with high mechanical strength [11]. We definitely have not seen the end of this yet, as there are much more jellyfish species to be investigated for their possible applications. Who knows what our gelatinous future holds?•

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# Meet your ASML Campus Promoter David Homan

## Advertorial

You may have seen the ASML logo around the University of Groningen. You may wonder what kind of company ASML is and what potential careers it has to offer. But what you may not know is that there is someone on your campus who can answer all your questions and more – ASML student campus promoter David Homan.

### So, tell us more about David Homan?

Hi, I'm David, I'm 24, I'm in my fifth year, studying for a Bachelor's in Artificial Intelligence. Five years sounds like a long time to be studying, I know. But I started out in two other interesting fields, philosophy and law, before finally ending up at the study I'm most passionate about. I find a lot of things interesting - outside of my studies, I enjoy everything from reading to learning new languages, from playing the drums to kickboxing, from computer games to card games – right now, my new favorite is Texas Holdem poker!

### You're also a member of study and student associations. Is that how you got to know ASML?

That's right. I was on the board of 'Cover', the study association for the Artificial Intelligence and Computer Science. Board members from university associations from across the country get invited to special 'board days' at ASML, and I was lucky enough to go. I was super impressed. It wasn't just how high-tech it was or the jobs on offer. What was most impressive was the feeling of freedom and dynamic creativity. It's an exciting place, and importantly, it's a company that respects its people. When later they were looking for a campus promoter for our university, I was happy to sign up, and proud to represent ASML.

### What can students expect from you as an ASML campus promoter?

First and foremost, I'm here, anytime, for any questions you have about jobs and life at the company, scholarships and internships, and much more. We can arrange a meeting, but equally



(and as I often prefer!) you can chat to me wherever you find me - I'm always enthusiastic to talk about ASML. Beyond that, what I like about the role is the freedom ASML gives me to make it my own – to think of my own ways to reach out to fellow students. But also that the focus is absolutely not on 'headhunting'. I'm not here to recruit you, I'm here to help you understand the company, so you can make more informed choices when it comes to your career after university.

### Finally, what other career advice would you give your fellow students?

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You can get in contact with David via [david@workingatasml.com](mailto:david@workingatasml.com)!

# Interview with Hildeberto Jardón Kojamentov

## Hip-hop, Graffiti, and Maths

AUTHOR: V. SUMBRE, T. TIEMENS

Those who have taken Calculus 1 or Chaos Theory this year might have seen a new face on the other side of the screen: Hildeberto Jardón Kojakhmetov. Originally from Mexico, he moved to the Netherlands in 2011 for his PhD. Having already spent 2 years at the University of Groningen as a post-doc in the past, he was appointed as an assistant professor in May. We wanted to get to know him a bit more, so we decided to invite him for an interview.

### Did you have any particular reason for coming to the Netherlands?

My master thesis was about the Hill equation, related to the Kapitza Pendulum; a pendulum with a vibrating support. It turned out that Professor Henk Broer, at the time a full professor at the uni was one of the experts on the topic, and I wanted to continue looking into it, or at least something related, which I really liked in my masters. Fortunately I got a scholarship for my PhD so I could do whatever I wanted to do, and Henk showed a lot of support. In the end my research was not that much related to what I had in mind, but it all turned out to be fine. But I think that is what usually happens, most of the time there's some deviation. And it was still very nice, I still studied dynamical systems, which is what I wanted to study with Henk.

The Kapitza Pendulum shows a phenomenon called Arnold tongues, with a resonant relation between the frequency of vibration and the natural frequency of the pendulum. This vibrating pendulum is a classical problem nowadays, but it has very nice properties. One can study it from a theoretical perspective, one can study it from a numerical perspective, and it is an easy mechanical system that you can imagine in your head; you just have a pendulum, and you vibrate it. What is very interesting is that you can stabilize the pendulum in the upward position.

You know in a pendulum, the downwards position is stable. You oscillate, and eventually it goes into the resting position down. But if you have the vibrating support, for certain frequencies, you can actually stabilize the upward position.

### What was your most interesting research topic?

When you do maths, you develop a broad set of tools and methodologies that don't depend on applications and then you can apply them in different sciences, which I find very interesting. First you develop a nice set of independent tools and then you exploit them to see if some applications benefit from them. I tend to apply mathematics into control systems, which I really enjoy because it gives you the idea of inducing the behaviour that you want. I like to pursue applications in control systems or control theory<sup>1</sup>.

### Do you like teaching or do you prefer research?

I like teaching a lot, I think it's the second time you learn a topic. The first time is when you study of course, but when you teach it to someone else you realize where your weaknesses are. You have to be really honest with yourself and you need to accept that one is prone to forgetting things and not being dominant in something. I

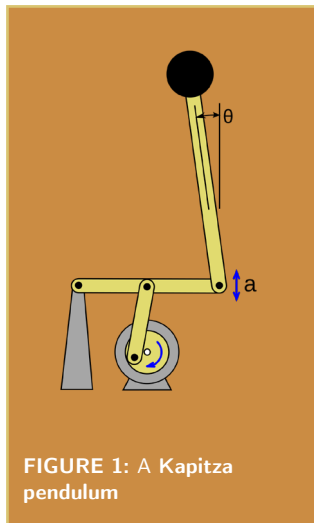


FIGURE 1: A Kapitza pendulum

<sup>1</sup> During the editing of this article he let us know that lately he has been interested in epidemiology - a current hot topic.



also really enjoy the interaction with students. I try to never forget when I was a student, of course this was a long time ago. I do remember what I liked and did not like from my teachers, maybe it's really subjective, but I try to incorporate all the things that I liked and avoid all the things that I didn't like, and this creates a really nice relationship with students, which I really enjoy.

## *“I try to never forget when I was a student”*

### **What is your favorite equation?**

So I thought long about this to be honest, I think especially because I just taught calculus. We know Euler's equation is one of the most beautiful ones, and I guess we already know why. So of course this would be one of them, but probably it's a bit of a cliché. That is perfectly fine though, one needs to realise why it is so beautiful. But to be honest, because I work with differential equations, probably my favourite equation is that of a differential equation ( $x' = f(x)$ ) because this describes a lot of things in nature. One can use it to describe very complicated things, and I work with them every day so in some sense it has become my favourite equation. Of course the way I say it doesn't say much because one needs to specify what  $f$  is. But anyways, I would say differential equations, and an ordinary differential equation would be my favourite one. Then if I had to choose I would say the equation of the pendulum, since it is extremely nice and simple to understand and yet it can lead to very complicated studies. So yes, I guess if I would have to choose a particular one I would go with the equation of a pendulum.

### **Do you have any hobbies, any hidden skills?**

As a hobby, I like to play sports - my favorite sport is squash. I like to cycle as well, I haven't done it much recently because of the weather, but when there is good weather I like it. I used to like basketball quite a lot in the past, but I also don't play that often any more. So my biggest hobby before corona times was playing squash, which I liked quite a lot.

About hidden skills, I don't really know. A long time ago I used to draw a lot, when I was a teenager, I used to do a lot of graffiti, and I think I would have been good at [drawing]. I still do it from time to time. For instance I plan to decorate maybe my house or my office at some point. I liked to do it a lot but I never really pursued a career in design or graphic design which is very creative, but you also need [creativity] for mathematics.

I also like to cook quite a lot. I try to do it, not every day because it takes a lot of time, but I try to take out some time once a week to cook something nice, and try to educate myself a little bit about it - learn new things. I take it really as an experiment, not as an improvement. I like it, and it's quite relaxing and enjoyable.

### **What kind of snacks do you prefer, Dutch or Mexican?**

I think unfortunately I must be honest: I prefer Mexican ones. Of course I like some Dutch ones but there are so many in Mexico, and you grow up with them and the ones with which you grow up are gonna be your favourite always, even if you find some good ones beyond those.

### **What kind of snacks would that be?**

In Mexico most things have chili, so fruit with chili would be one of my favorite snacks. For example, a mango, you peel it and you put powdered chili on it. You have something very fresh and sweet and you put



FIGURE 2: Hildeberto Jardón Kojakhmetov

something acidic and hot on it, which creates a nice contrast, I think that allows you to enjoy it. But I also think it's an acquired taste, so some people would not like it. There are also many many candies that I like, like coco candies, and some other ones. But I also like Bitterballen, I look forward to the time where we can have bitterballen in a nice terrace.

### What kind of stuff do you cook?

Mostly I would try to cook something Mexican, so that we don't miss it. Sometimes when I have traveled - I haven't traveled a lot, but I spent a bit of time in France - I got nice opportunities to visit some people and they taught me a little bit. Well they cooked and I just asked "hey how do you do it?", and then I just tried to replicate it. Sometimes it works, sometimes it doesn't and you still eat it. The important thing is to have fun, I don't plan to ever make it a career, right? So why stress, you know?

### Do you have any pets?

I have a black cat. He is four years old and his name is Benito. Sometimes when I say it in Europe it is associated with Mussolini, but it has nothing to do with that. In Mexico there used to be a very famous cartoon when I was a kid called Top Cat. It was made in the US but it was very very famous in Mexico, I think much more than in the US, and there was a small cat, very cute, called Benito which is the reason our cat is called Benito.

Other than that in Mexico I used to have a dog but he died, I think it was two years ago. His name was Sharik (Шарик) which I think means little balloon in Russian<sup>2</sup>. He was also a character of a cartoon but of that I am not sure<sup>3</sup>.

### Do you listen to a lot of Music?

So I don't listen to a lot of new music, I'm stuck in my past I guess. When I work I like to listen to classical music, even though I don't play any instrument. But, I find it quite good for working. In my free time I listen to hip hop, which is my favourite genre. Maybe sometimes I'll listen to a little bit of rock, but I grew up listening to hip hop.

### Anything in particular?

So I like a band called Delinquent Habits. They used to be three people, and one of their songs appeared in a Nike commercial a long time ago. Anyway, they have a song called 1 Adam 12, which is my favourite song, but I don't think it's well-known at all.

2 It actually means "little ball"

3 The cartoon is Трое из Простоквашино



FIGURE 3: Benito, Hildeberto's cat

### What would a typical day look like for you?

A typical day would be: I wake up around 7, now that it is dark I like to go to breakfast slowly and not be rushed, and start working around 9:30 - except when I was teaching, on Mondays I think that we started at 9, but normally I would start at 9:30, check some emails to see if there is anything urgent. I try to have my work email just on my desk computer and not on my cell phone, so that I don't take work home. I work from home now so I can no longer say that, but that is the idea, and if there is nothing else then I of course have my research projects. It is what I put emphasis on because now I'm not teaching, so I have time to do research. I would work for maybe 2-3 hours before having a break to eat lunch, then maybe work another 4-5 hours in the afternoon and that would be it.

### What is your favorite project?

This is also a difficult question - every project has something interesting and you learn something new out of it. If I had to pick one I would say it was a project during my PhD. The reason is that it was the most challenging personally, it doesn't really matter what the result was, but I had to solve something

almost by myself. With a lot of support from my supervisor and other people, but the original idea and some of the steps of the proofs had to be developed in my own desk, and I had to learn quite difficult stuff in my opinion. At the end I could achieve nice results, so I would consider that one of my favourite projects because of this satisfaction at the end, which is quite important. But I have many different ones in which I've learnt quite a lot, so all of them are quite enjoyable in some way.

Of course sometimes you get frustrated, I don't want to say that everything is, how do you say it, honey over flakes, but yeah, if you get a nice result at the end I think you enjoyed the project.

### What project are you currently working on?

So there are several, but the one I'm dedicating most of my time to is studying dynamical systems on networks. So, you have many nodes, and each of the nodes is a dynamical system and between them you have interrelations - they interact in some way. You can think of it as if each node is an oscillator and these could be regulatory processes in your body

the dynamics better. I am particularly interested in situations where you have dynamics in different time scales, some things move faster than others. This is very relevant for example in neuroscience, and population dynamics, epidemics ... so this is overall the current project I'm mostly concerned with right now.

*"I try to enjoy whatever comes to me, and just go with it"*

### Do you have any regrets?

I don't know, I think it is difficult to think about a serious one, because I think maybe every weekend you regret not doing something in your week or you spend too much time doing something else you shouldn't have or something like that.

But at the end of the day, I think what is important is whether they are serious or not; whether they have serious consequences. When it comes to that I cannot think of something. I try to enjoy whatever comes to me and yeah, just go with it.

### Dilemma: Would you rather have all the questions and no answers or have all the answers and don't know what they answer?

Nice question indeed... Let me think about it. Both options are very interesting on their own. If I had to choose, probably I would prefer to have the questions, it's a bit more natural, but I have to be honest, the other option is also interesting. I think if I would have to decide I would prefer to have the questions and then figure out the answers.



FIGURE 4: More of Benito

or they could be generators of electricity, and other nodes would be machines in your house or something like that. It is very general. What we want to study is a particular set of coordinate transformations in these types of systems that allow you to describe

# Bee-tastic

## Exchange article

AUTHOR: J ZEUBRINK

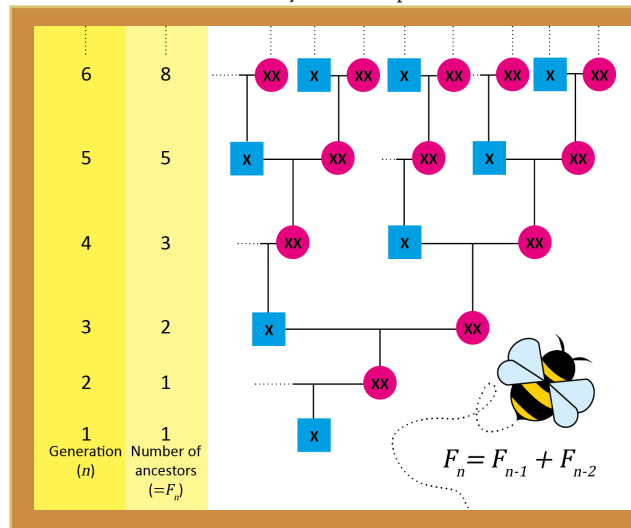
This article is a crossover between the *Periodiek* and the *Lifeline* from GLV Idun, of which one of the editors wrote this piece on bees and Fibonacci numbers.

Biologists love animals. Just like David Attenborough shows in his documentary “Life in the Undergrowth”, we are highly dependent on a certain population of insects: the bees. Bees are a very vital key for maintaining a healthy ecosystem. About 250.000 different flower species are in need of an organism that moves the pollen grains from the stamen (male reproductive organ) to the pistil (female reproductive organ). This process is called pollination, and the “carrying organisms” are called pollinators. Those pollinators are mainly insects, usually flies, wasps, butterflies, beetles, moths, ants, and of course, bees. But only three bee species actually contribute to the flower constancy. The flower constancy is a hypothesis stating that certain insects have innate preferences for certain flowers. As a result, those flowers are disproportionately pollinated and therefore succeed in reproducing. Reproducing is the ultimate life goal for all organisms.

One of these bees is the honeybee, *Apis mellifera*, or more specifically, the western honeybee, which contributes largely to the flower constancy. The western honeybee is the most common of the 7-12 species of honeybees worldwide. And just like their flowering counterparts, the bee reproductive system is only not so straightforward. Specifically, bees have two types of eggs; eggs with a diploid genetic structure (paired chromosomes, like humans) and eggs with a haploid genetic system (unpaired chromosomes, one copy of each chromosome). Diploid eggs become females or workers, and haploid eggs become males or drones. The queen is also a female, but the main difference between workers and the queen is that the queen has a fully developed reproductive tract and is the only member of a hive who procreates.

Here it is where it gets interesting. The determination of gender depends on the number of chromosomes individuals inherit. In this case, males are X, and females are XX. If a female lays an egg, it will contain only an X, and if it remains unfertilized, it will become a male. If the same egg X is fertilized, it will become XX and, therefore, a female. Accordingly, you can state the following:

- A male bee always has one parent.
- A female bee always has two parents.



This means that if you look into the pedigree of any male bee (1 bee), he has one parent (1 bee), 2 grandparents, 3 great-grandparents, 5 great-great-grandparents, etc. Maybe it looks familiar, but this is math. These numbers are similar to Fibonacci numbers. The number of ancestors at each level  $F_n$  is the number of female ancestors  $F_{n-1}$  plus the number of male ancestors  $F_{n-2}$  (this comes with the assumption that the ancestors are not related). And with that, we have the Fibonacci sequence (figure 1).

Now we can state bees are not only good for the ecosystem but can also be a great example for math-sequence.



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# Recipe

## Speciate mbushura – Stuffed bell peppers

AUTHOR: E. PIPA

If there's one thing that was a constant in my life. It was good food, my mother and father and every single generation before them have provided homely and hearty full tables to their close ones and beyond. Their recipes have been carefully (and only verbally) passed down, and as I've been learning to cook this past year, these recipes have made their way to me. Today I share a staple of the Mediterranean food hierarchy, stuffed bell peppers. Flavourful, filling, fresh, savoury, delicious. This recipe feeds 3-4 people.

### Ingredients:

- 500g – 600g Ground beef
- 2-3 onions
- 400g Tomato Sauce
- 150g Rice
- 15g fresh dill, 15g fresh flat leaf parsley
- 15g fresh mint (one AH Box)
- 6 small bell peppers
- Yoghurt to serve with



### Instructions:

1. Dice the onions and pan fry on medium heat and a sizable pan with a splash of olive oil – cook until translucent
2. Add the meat and cook until browned.
3. Add the tomato sauce to the pan, heat until it starts boiling
4. Add salt and pepper to taste
5. Add the rice to the pan. Cook until the rice has absorbed the tomato juice.
6. Clean and add the parsley, mint and dill
7. Add a cup of water, stir well, and let the rice cook and absorb the water as well. This is the filling.
8. In the meanwhile, clean and core the bell peppers. Cut off the tops, so you can use them as fillable cups.
9. Once the filling is done cooking, fill bell peppers and put on a pan. You can put any left over filling on the pan next to the peppers.
10. Preheat the oven to 200 degrees C, and bake for 20-30 minutes, turning the peppers halfway, until the pepper is soft and slightly browned.
11. Serve with yoghurt on the side.

*Ju bëftë mire!*

# Brainwork

## Genius Graphs

AUTHOR: R. MOL

In the 1997 movie “Good Will Hunting” the protagonist, Will Hunting, gets discovered as a mathematical genius by solving a difficult graph problem while working as a janitor at MIT that was said to have two years to prove by MIT’s professors. In this edition’s Brainwork, we will challenge you with a different graph problem.

A graph is a network of nodes, or vertices, and connections, or edges and is denoted  $G = (V, E)$ , where  $V$  is the set of vertices and  $E$  is the set of edges. For this puzzle, consider the graph  $G_n = (V_n, E)$  where  $V_n = \{1, \dots, n\}$  for a natural number  $n$ . For the set of edges, a pair  $(i, j)$  is in  $E$  if and only if  $i$  and  $j$  are both in  $V_n$  and if either  $i$  divides  $j$  or  $j$  divides  $i$ . So if  $n$  is at least 4, then there is a connection between 2 and 4, but not between 2 and 3 or 3 and 4.

Next, we can colour a graph by assigning a colour to each of the vertices, a valid colouring has as its (only) condition that no two connected vertices can have the same colour. Clearly, the maximum amount of colours we can use for a graph is the number of vertices by assigning each vertex its own colour. We are interested in the minimum amount of colours needed, we call this number the colouring number of the graph and is denoted  $\chi G$  for a given graph  $G$ .

For  $G_5$ , the colouring number,  $\chi G_5$ , is equal to 3. We can colour 1 red and 2 blue. Then, we will have to give 4 a new colour, let’s say yellow and then nodes 3 and 4 can be either blue or yellow.

Find  $\chi G_n$  as a function of  $n$ .

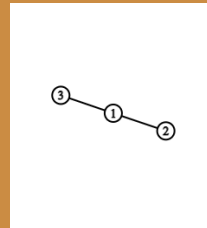


FIGURE 1:  $G_3$

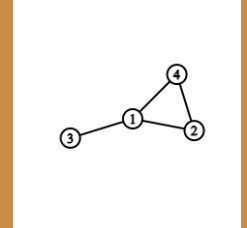


FIGURE 2:  $G_4$

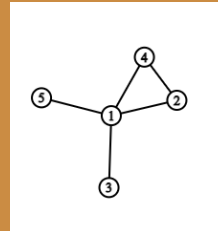


FIGURE 3:  $G_5$

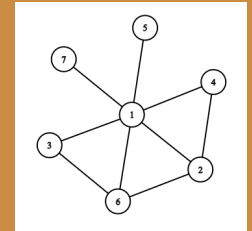


FIGURE 3:  $G_7$

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# Solution to Previous Brainwork

## 36 copies of Schrödinger's cat in a box

AUTHOR: R. MODDERMAN

The Perio redaction was forced to wait a bit with opening the box containing 36 copies of Schrödinger's cat. But last week, we finally managed to open the box. Just as Schrödinger explained in his note earlier, not all cats died. Only 35 of them did (which thus was the worst-case scenario). And the color was ... the most beautiful FMF blue! Schrödinger must have been able to look in the future and see our wonderful study association. Here, I will explain why any opening of the box would always yield at least one blue cat that is alive.

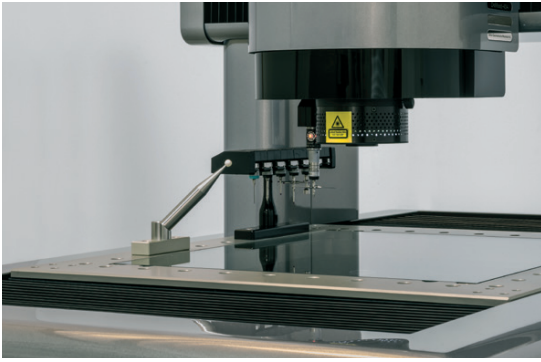
Since the entanglements are uniform and probabilities are phase-independent in Quantum Mechanics, each color can be represented by a list of bitstrings ('1' stands for alive, '0' stands for dead). For example, for yellow we have  $Y = \{00, 11\}$  because this is the only uniform 2-entangled state in which exactly half of the bitstrings contain a '1' in the second spot. Hence we'll show that the bitstring list of B (blue) does not contain the zero bitstring, thus ensuring that there will always be blue cats alive upon opening.

Note that, when a cat is measured, all cats of the same color will be measured along with it (except for gray, as the gray cats were not entangled at all); this is entailed by the Law of Quantum Entanglement. Call any row or column with the property that no three aligned cats in that row or column belong to the same non-gray color a *nice 6-cat alignment* (N6CA). We claim that in any N6CA, when enlisting the six alive probabilities of individual cat-measurements, this list is the same as or a (nontrivial) cyclic permutation of  $(\frac{1}{2}, \frac{1}{2} - a, \frac{1}{2} + a, \frac{1}{2}, \frac{1}{2} - a, \frac{1}{2} + a)$  where  $a$  is in the interval  $[-\frac{1}{2}, \frac{1}{2}]$ . This property you can try to show yourself starting from the observation that in any N6CA the sum of the alive probabilities is precisely 3 (because

of the expected number of alive/dead cats rule for columns and rows) and that in any N6CA the product of three consecutive alive probabilities equals the product of the corresponding dead probabilities.

Applying this knowledge, look at the fourth row (which is a N6CA) and deduce that the alive probabilities are  $(\frac{1}{2}, \frac{3}{4}, \frac{1}{4}, \frac{1}{2}, \frac{3}{4}, \frac{1}{4})$  so the alive probability of the third blue cat is  $\frac{3}{4}$ . Similarly, by looking at the first column which also happens to be a N6CA, we can deduce that the first blue cat has alive probability  $\frac{3}{4}$  as well.

Since the uniform superposition of the eight 3-bit states is not entangled and the denominator of  $\frac{3}{4}$  is 4, it must be that B is represented by a list of exactly four bitstrings of length 3. Now, suppose for a contradiction that the zero bitstring 000 is part of B. Then, all other bitstrings must have a '1' at both the first and third position, in order for the first and third cat to have alive probability  $\frac{3}{4}$ . But there are precisely three of those nonzero bitstrings needed, which is impossible because 101 and 111 are the only nonzero bitstrings of length 3 with a '1' at the first and third position. Hence, 000 is not part of B, and there will always be a blue cat alive when we open the box.



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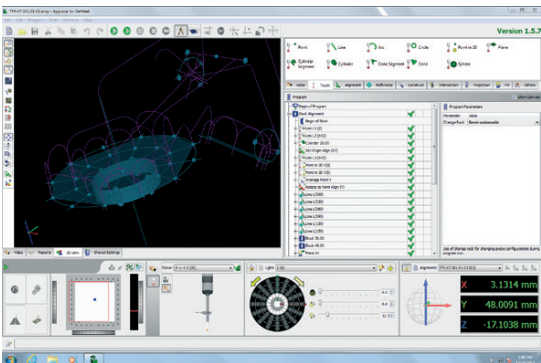
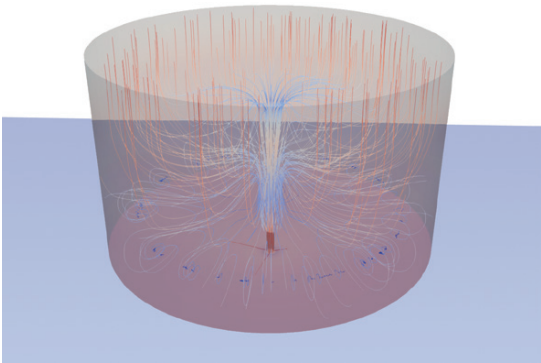
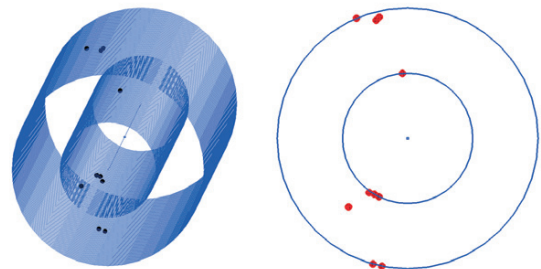
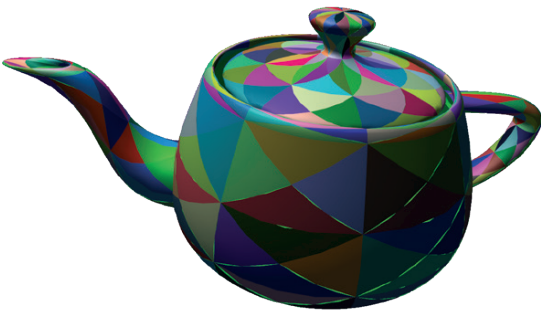
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