



# Per vectum



## FEATURING

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- Thesis Experiences
  - How to Live on a Budget in Maastricht
  - Meet the Professor: Interview with Marc Schröder
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## PerVectum

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# Word of the



# President

## Dear econometrician,

Although we are already a full month into 2023, I want to start off by wishing you all a happy new year. I hope you were able to make the most of the Christmas break and are now ready to take on the second semester of the year.

Firstly, a warm welcome back to all third-year students returning to Maastricht from their exchange. I hope you all had an unforgettable semester abroad, but that you are also excited to be back in Maastricht.

For most of you the next semester will be your most important one yet, with your bachelor's thesis coming up and your graduation on the horizon. However, you are not the only ones taking that final step towards graduation, as most of our master students, me included, have already started working on their thesis. Our second-years are also heading into an exciting period, as they now know their exchange university for the coming fall and can slowly start preparing for their semester abroad.

In period 2 we saw the return of another Vectum classic™, namely ice skating at the Vrijthof, and while not all our members were entirely confident in their sense of balance on the ice, everyone still made the most of it and had a good time in the end. Afterwards we were also rewarded with a hot cocoa and an amazing view from the ferris wheel. Of course, ice skating was not the only activity we did this period; other activities include glowgolf, a painting workshop, and the Sinterklaas activity. More details on these and the other activities can be found in this edition of the Per Vectum. We also had our first career event of the academic year, together with SCOPE: a dinner with Slimstock. After the Christmas break we ended the semester on a high note with the active members' karaoke and Vectum's semi-annual general members' assembly.

There are also plenty of things to look forward to this coming semester. For starters, there is the National Econometricians' Day (LED) in 's-Hertogenbosch on the first Monday of period 4 for those third-years and masters lucky enough to obtain a ticket. Looking further ahead there are several other career events coming up, like case days, in-house days, and the Econometrics Consultancy Tour, but also plenty of social activities, including a dance workshop and an enigma night. After the exam week we will round off the period with our annual ski trip, this year to La Plagne.

## FEBRUARY 2023

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If you don't have a resit I highly encourage you to sign up for it this year, as sadly it might be the last year Vectum can organise the ski trip in its current form due to a policy change of the travel agency. Also, I promise we will make it an unforgettable trip!

As the first semester has drawn to a close, I realise that we are already halfway through our board year. A realisation that gives me mixed feelings. On the one hand, I think I learned a lot during the first half and have grown much as a person and I am excited to see what more we can achieve during the second half. I am also excited to graduate and take the next step in my life. On the other hand, it makes me a bit sad that, after five years (more or less), I might have to leave Maastricht and Vectum behind. Anyways, the time to pass the torch to the next generation comes closer, meaning we will also have to start thinking about who the next bearer will be. If you are interested, definitely be sure to come to the board info session in week 4 of the coming period.

To wrap up this Word of the President, I will leave you this Haiku:

*Late nights at the Preuv,  
Standing shoulder to shoulder,  
See you next Tuesday.*

I wish all members, alumni, and other esteemed relations an exceptional and educational 2023.

Best regards,

*Hugo van Oosterhout*  
28th President of Vectum





## Interview with Joost de Jong Energy Trader at Northpool

# 'THE ENERGY TRANSITION IS THE THEME OF OUR GENERATION'

When Joost de Jong came into contact with Northpool, he was still a student. "I met the company at the career days at Delft University in 2019. I visited the event again one year later and Trisha - one of my colleagues now - recognised me. 'How did your thesis go?' she said and she remembered the topic I told her about a year before. That made me feel really valued and I decided to try it out at Northpool."

### Many opportunities

Since June 2020 Joost has been working as an energy trader. "I get a huge feeling of opportunity and a bit of restlessness too. The energy market is still developing and although more competitors are entering, I expect volatility to remain high. Especially with the amount of renewables we are placing on the grid."

### From junior to independent trader

After learning the basics of the energy market as a junior, Joost was able to quickly sit in on the shifts and see everything in action. "As a junior trader you will train in our own simulation environment just to get you ready for the real deal. You will start out small just with one or two delivery hours per country. From there on, you expand. Step by step you become more independent until you are able to trade all countries and lead your own shifts. It's a steep learning curve but I think you can go from junior trader to independent trader within a year."

It can be stressful, Joost explains. "You are involved with money making decisions all the time and you can constantly ask yourself: 'Could I have seen this move coming, should I have timed the market differently?'. But you have to realize that the most important thing is consistency. You can't win every hour but if you are consistent you will do better in the long run. Tomorrow is another day, another puzzle, so you can try again."

### Working on the future

As a 24/7 trading company Northpool works in shifts. "We want you to be able to do every type of shift so you will need to see them all regularly. By trading the energy markets we stabilize the grid and are a part of the price formation process. We can literally flow surplus wind power from the UK via underseas cables to a cloudy France where there is less solar generation than expected. It avoids them having to turn off wind turbines and burn extra gas. With more renewable energy to be installed it becomes increasingly challenging to keep the European grid stable and efficient. This energy transition is the theme of our generation and we are just a part of that. That's why working at a company like this really feels like working on the future."

We like to share our knowledge and are always looking for talent. So if you have an analytical mind, superb mathematical instincts and you can't rest until you solve the task: apply!

[WWW.NORTHPOOL.NL/VACANCIES](http://WWW.NORTHPOOL.NL/VACANCIES)

# GlowGolf

**By Aashia Chanana**


The Tuesday vibes continue at GlowGolf Maastricht, as we used mini-golf as a way to release all our stress. Although it wasn't regular mini-golf, it was glow-in-the-dark mini-golf. A neon golf club and an amazing evening were promised by Vectum to our beloved members.

The course was set up in a dark room, with each hole and obstacle lit up with neon lights. There were thirteen holes, and each one was inspired by different countries across the globe, featuring monuments like the Taj Mahal, the Statue of Liberty, the Leaning Tower of Pisa, and many more. The glowing balls, neon obstacles, and amazing music created a surreal and magical atmosphere, and our members made it even more interesting by using glow-in-the-dark paint and wearing neon clothing.



One of the most exciting things about playing glow golf was the added challenge of hitting the ball in the dark. It takes a little extra concentration to aim and make the shot, but that's all part of the fun, and you might be able to put your OR skills to the test here;). The obstacles were also designed to be even more challenging, with glow-in-the-dark tunnels and ramps that added to the excitement.

The fun continued with drinks at the Preuv;).



# Casino Night

**By Vamsi Bharadwaja Sunkaranam**

Vectum Members begin to assemble on the first floor of Que Pasa. Most are in sharp suits adhering to the established dress code and others - including me - in regular people's clothes, all with their best poker faces with their eyes on the prize. Five tables have been set, some for blackjack and the others for poker. The organisers begin handing out poker chips to the participants. Chitchat continues in the background; some clarifying the rules, some showing off, and most with casual small talk. The PR committee enthusiastically collects photographic evidence of the ongoing activity (which can be found on Vectum's Facebook group).



As the games began we sprung into action. Most employ various kinds of complicated strategies and others bet on dumb luck. By the end of the night, fortunes were lost and fortunes were made. The declared winner was Leo Aumer. It was a night to remember, like all Vectum Activities, filled with fun, joy, laughter and a couple of drinks.



# Painting Workshop

**By Marie Corillon**

Last period, we got the honour to follow a painting workshop given by our local Monet, Aleksandra Piekarska (member of the activities committee). Once the upstairs room of the Que Pasa turned into an art studio, we were ready to get started on our masterpieces.



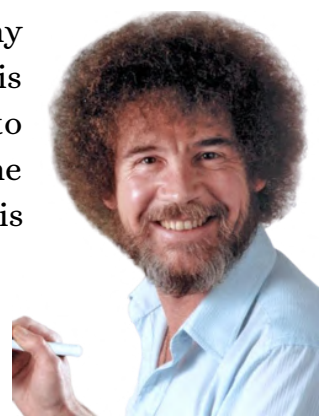
We first followed Aleksandra's recreation of the "Island in the Wilderness" by Bob Ross. She had a big canvas set up in front of us and gave pro tips while guiding us through the different steps of the painting. While some were able to precisely follow the instructions, others let their creative side take over and produced truly unique artworks. I was actually very impressed by how talented our members were and how good everyone's creations looked! Special shout-out to Chiara for winning the best painting of this round!

Once we had our flow going, we moved on to the freestyle part of the activity, during which we could just let our imagination go wild. Some stayed in the Bob Ross style with forest and landscape pictures, some paid homage to Vectum, and some took a more abstract route. The award for the best painting of this second round went to another PR girlie, Aashia! The PR committee clearly detains raw talents 😊



We finished the activity by proudly showing off our art pieces to the other apprentice painters, and hurried home so they wouldn't get wet from Maastricht's typical rainy weather.

This workshop was by far my favourite activity this semester, so thank you to Aleksandra and the rest of the Activities Committee for this activity!





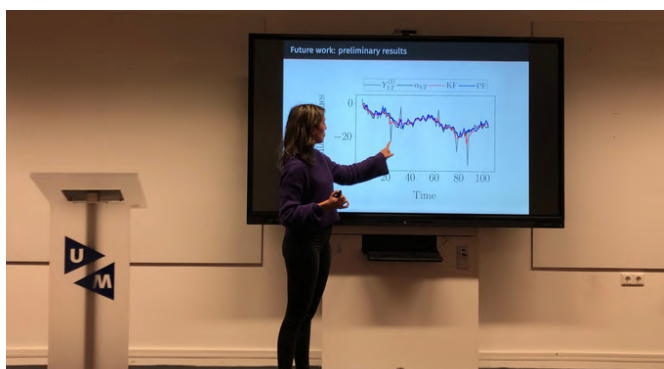
# Research Lecture

By Ngoc Bao Phung

## Road Sensor Traffic flow density estimation using Neural Networks

In period 2, on November 22nd, we welcomed Dewi Peerlings, member of the KE (Quantitative Economics) department since 2018, and currently finishing her PhD, to give us an informative Research lecture about Road Sensor Traffic flow density estimation using Neural Networks.

Explaining traffic flow is essential for planning purposes and for developing intelligent transport systems. The lecture provided us with a more in-depth insight into how we could use Neural Networks to improve this explanation of rather noisy data.



First, Dewi started the lecture by showing us the traffic flow analysis. It could be seen that the numbers recorded by road sensors could be missing and erroneous due to the malfunctioning of these sensors. Given that the obtained data is "noisy", researchers would need to pre-process this data before forecasting.



That is the reason why in her research, Dewi applied the Neural Network approach to estimate the probability density function (pdf) of traffic flow data, and used this density function to clean the data.



Dewi then explained to us the methodology used in her research. In order to estimate the aforementioned pdf, it is important to train empirical cumulative distribution function (cdf) by neural networks. The first step is to design artificial neural networks. An artificial neural network is based on a collection of artificial neurons, and these neurons are aggregated into layers. In this step, researchers would have to perform nonlinear regression to model the neural networks and estimate the cdf.



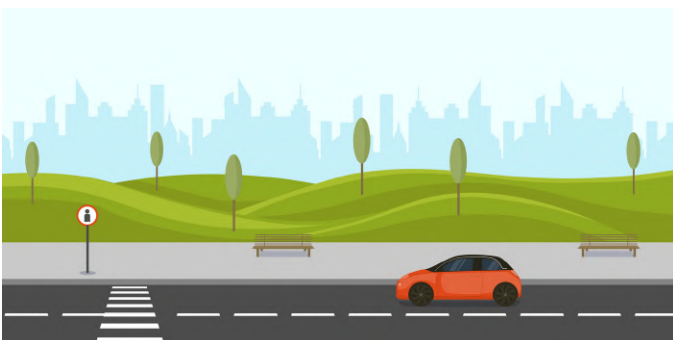
In summary, Dewi showed us that road sensor data is noisy and attains many missing observations; however, removing noises or inputting missing values without accounting for the nature of these data could undermine the analyses. Neural networks are used to avoid such mistakes, and empirical results of this method eventually show that univariate and bivariate cdf estimates resemble empirical pdf, indicating that the model captures properties of data and hence could be used as a pre-processing method. In the end, Dewi also shared with us her future work and some preliminary results.

The second step is to perform differentiation. The estimated cdf from the first step would be a composition of several nested activation functions, so we use Faà di Bruno's formula to differentiate this function several times and obtain an estimated pdf.

Applying this method to empirical data obtained from highways in the Netherlands and measured by different sensors, we could approach the results in 4 different ways: intraday, interday, cross-sectional, and temporal. For intraday approach, we investigate a window of time (E.g: 8:00 am to 8:15am); for interday approach, we investigate a day of the week (E.g: Monday); for cross-sectional approach, we investigate different sensors (E.g: two) to see how correlated they are; for temporal approach, we compare two time windows (E.g: rush hour and another time window) to see how much of a change there is.



**We would like to thank Dewi Peerlings for this engaging research lecture on her field of work.**





# Sinterklaas Party



**By Polina Barinova**

Sinterklaas is a traditional Dutch holiday celebrated annually on December 5th and 6th, preceding the modern-day celebration of Christmas in many Western countries. The holiday involves the exchange of gifts, good food and drink, and the singing of traditional Sinterklaas songs. The legend of Sinterklaas dates back to the 1600s and tells of a bishop who lived in Turkey in the 4th century and was known for his generosity and kindness to children. According to the legend, Sinterklaas travels to the Netherlands every year from Spain and leaves gifts for children in their shoes. Sinterklaas remains an important and beloved part of Dutch culture.

This year, econometricians hosted a Sinterklaas Party on November 29. Five teams gathered on the second floor of the lovely bar Preuverij. In the beginning, the participants played charades, and the winning group was able to choose their first bag of gifts. After the gifts were distributed to all the tables, the next stage came. Each participant took a piece of paper with some person's name on it and showed it to the others. The task was to guess who you were: a celebrity, one of Vectum's boardies, or a university teacher. Whoever guessed first could take the gift. So the gifts were equally distributed among all of us. And then it was time for the most exciting part of the evening. Each participant would roll a die and then follow the action that matched the number on the die. We could give a gift to another person, swap gifts from other teammates, or steal a gift from someone (even from another table). The most coveted gifts were various board games, there was a real fight for them.



This amazing evening ended on a high note with the traditional free drinks at the Preuverij. The variety of gifts was large: from Christmas warm socks, soap bubbles, and metal puzzles to garlands, incredibly interesting board games, and puzzles. Finally, each of us went home with our own gifts and a fantastic mood.



# Ice Skating



**By Chiara Venditti**

Finally, after two long years, Vectum was able to re-organise the long-lasting tradition that usually opens December and gets everyone into Christmas Mode: a trip to Magisch Maastricht at the Vrijthof! If you are wondering what it is, let me fill you up. Every year Maastricht hosts a winter event that spreads the Christmas atmosphere throughout the city with traditional market stalls, attractions, good food and even an ice skating ring. The perfect place to take your mind off exams' anxiety and to experience the real Dutch traditions!



We gathered in front of the theatre to collect our tickets, which included a trip on the Ferris Wheel and two free drinks, as well as the skate rental and entrance to the ring. Then the fun started and before we knew it, two hours flew by while racing against each other, learning new tricks (amazingly shown by Tobias) or just trying to not fall too hard. After all, there is no better way to tighten bonds than falling together on the ice and running after each other! If we felt tired, a nice cup of mulled wine -called bisschopswijn after Saint Nicholas- fixed it and we were ready to skate again!



The magic night ended with some more drinks, chatting, and a beautiful view of Maastricht enlightened by the twinkling Christmas lights from the Ferris Wheel. All in all, I believe we all wished the night could last a bit longer: luckily the tradition is back stronger than ever!



# Semi-Annual GMA



**By Vamsi Bharadwaja Sunkaranam**

The Semi-Annual GMA was scheduled on the 27th of January 2023 at the SBE Aula. The Vectum Board was dressed up in their finest formals. It was their opportunity to convey Vectum's achievements so far and notify their plans for Vectum's future.



Hugo, the president, commenced the evening with a brief overview of Vectum. Who was followed by Filip, the External Affairs Coordinator, regarding the sponsorship situation of Vectum. Marie, the Vice President, Secretary and Head of PR spoke about the changes made on the Vectum website and the quarterly issued Per Vectum. Asem, the Internal Affairs coordinator, spoke about the activities organised this academic year and the activities that are being planned. Valentine, the Treasurer, with the most numbers in his presentation presented the balance sheet and the profit and loss statement for this academic year. The night was concluded at Preuverij as usual over a couple of drinks.



# Happy Hour



## By Aashia Chanana

Econometrics life can be busy and stressful, but every now and then, it's important to take a break and have some fun. What better way to unwind than with a delicious, hand-crafted cocktail? Mixing up a classic easy cocktail is the perfect solution for a party or just a night in with friends.

Not only are they super easy to make, but also budget-friendly, making them a perfect choice for student bartenders. All your friends think you do nothing but study, get ready to impress them with your mad bartending skills and whip up some of these classic cocktails in no time. Cheers to a delicious, stress-free time!



## Strawberry Daiquiri

### Ingredients:

60 ml white rum  
30 ml fresh lime juice  
15 ml simple syrup  
120 ml fresh strawberries  
Ice

### Instructions:

Blend strawberries in a blender until they are pureed. Add the rum, lime juice, simple syrup, and ice to the blender with the strawberries. Blend until the mixture is smooth and the ice is fully crushed. Pour the mixture into a glass and garnish with a lime wedge, if desired. Serve and enjoy!

### Instructions:

Fill a shaker with ice. Add the vodka, gin, rum, tequila, triple sec, and lemon juice to the shaker. Shake well and strain into a glass filled with ice. Top the drink with cola. Stir gently and garnish with a lemon wedge

## Long Island Iced Tea

### Ingredients:

30 ml vodka  
30 ml gin  
30 ml rum  
30 ml tequila  
15 ml triple sec  
30 ml lemon juice  
Cola  
Ice





## Classic Mojito

### Ingredients:

30 ml white rum  
30 ml fresh lime juice  
15 ml simple syrup  
Fresh mint leaves  
Soda water  
Ice

### Instructions:

Fill a glass with ice.  
Add the rum, lime juice, and simple syrup to the glass.  
Add a handful of fresh mint leaves and gently muddle to release the flavours.  
Fill the glass with soda water.  
Stir well and garnish with a lime wedge and fresh mint leaves.  
make it a lil fancy with a fruit juice of your choice



### Instructions:

Fill a shaker with ice.  
Add the gin, triple sec, lemon juice, simple syrup, and grenadine to a long glass or jar.  
Add a handful of fresh strawberries and gently muddle to release the flavour.  
using a long spoon or muddler, stir well making sure not to crush the ice and strain into a glass filled with ice.  
Top the drink with soda water.  
Stir gently and garnish with a lemon wedge and fresh strawberries.

## Pink Gin Cocktail

### Ingredients:

60 ml gin  
15 ml triple sec  
30 ml fresh lemon juice  
15 ml simple syrup  
Dash of grenadine  
Fresh strawberries  
Soda water  
Ice



## Corona Sunrise

### Ingredients:

30 ml tequila  
30 ml orange juice  
30 ml grapefruit juice  
Dash of grenadine  
1 bottle of Corona beer  
Orange wedge for garnish

### Instructions:

Fill a glass with ice.  
Pour in the tequila, orange juice, and grapefruit juice.  
Add a dash of grenadine and stir well.  
Top the drink with a bottle of Corona beer.  
Stir gently and garnish with an orange wedge.

# Thesis Experiences

**By Marie Corillon**

At UM, the bachelor thesis is an inevitable step towards graduation. I have asked four students who submitted their bachelor thesis last June to tell us about their research and experiences. Whether you are curious about what you can achieve at the end of your degree, or whether you're about to start writing yours and are looking for valuable insights, this article is for you.

**Peter van Mill**

**Thesis subject: Quantum approach for finding dept cycles**

**Thesis supervisor: Frank Phillipson**




## Description

My bachelor thesis was about using a quantum annealer to find optimal sets of cycles in graphs. For three related cycle-finding problems I tried to see if a quantum annealer - which essentially performs the minimisation of a certain type of function - could beat normal computers. I could do an actual comparison because it turns out you can quite easily get free computing time on a real quantum annealer. I quickly suspected that the problem was related to the minimum cost flow (MCF) problem, which I knew from a second-year course and for which very efficient algorithms exist. Eventually I proved that (1) if you have an optimal "cycle compound" (a bunch of cycles glued together), this can be easily decomposed into individual cycles, and (2) the cycle compound version of the problem is basically equivalent to the MCF problem. On the quantum annealing side, I formulated the cycle compound version of the problem as a QUBO problem, which is the form taken by the quantum annealer. A bit of a problem here is that a quantum annealer only does unconstrained optimisation, which means you have to incorporate the constraints into the objective function; parameter tweaking is required to make the constraints part of the objective just strong enough to get a valid solution.

Then there was some programming work, essentially translating the problem into the form expected by the chosen MCF solver and the form expected by the quantum annealer, and generating problem instances for testing.



The results were a bit disappointing: the quantum annealer was slower, gave a suboptimal solution for moderately sized problems and for the biggest problems I could not get it to return a valid solution at all. Meanwhile the classical approach solved the instances to optimality in under a second. It was quite clear: no, quantum annealing isn't useful for this particular problem.



One thing that was very helpful for me was to try and write a couple of illustrated pages each week. Another tip I would give is to give priority to those tasks for which you're not really sure how long they will take - I did not and ended up with little time left over for writing the final report, and as a result I'm not completely happy about the document I handed in. On the whole, the thesis project was a strange mix of disappointment and satisfaction, but more importantly I learned a lot from it.

### **Steef Gottenbos**

**Thesis subject: Price sensitivity of demand for prescription drugs: exploiting a regression kink design**

**Thesis supervisor: Martin Schumann**



My bachelor's thesis was in econometrics specifically focusing on regression kinked design (RKD) and how to conduct inference on this. During the class Econometric Methods 2 we had learnt about regression discontinuity design (RDD) where a policy that was enacted has a discontinuous drop or increase depending on some characteristics of individuals or groups. In a similar fashion, my thesis was regarding a discontinuous rate of change of a policy depending on a cut-off. To make it more clear let's use an example. Unemployment benefits in some US states used to depend on earnings before becoming unemployed up to some maximum previous earnings, at which you were getting the same amount of benefits regardless of more earnings. This discontinuous rate of change in the unemployment benefit amount is called a “kink” and RKD allows us to isolate the treatment effect of giving unemployment benefits on for example unemployment rate.

My thesis focused on whether this unemployment data's kink affected the duration of unemployment. The thesis mainly discussed the evaluation of another author's findings with the same data but I implemented a relatively new test called the "permutation test" which assumes that the kink is random and then checks if the actual kink in the data (in this case when the maximum unemployment benefits are reached) has a relatively "extreme" data point compared to the fake kinks. Unfortunately my data did not find a significant effect of the kink on unemployment duration but this may have been due to the relatively strong assumptions required such as the data generating process needing to be properly specified which is difficult to ensure.



In general, I really loved writing my thesis and I loved that it was a follow up to what we did in class. One setback I had was that my original data set was inaccessible so I spent a lot of time making another data set usable for the method I wanted to implement. If I were to give a tip it would be to make sure if you have any doubts discuss with your supervisor so you don't get lost on a path that you really don't need to be on. I will always encourage curiosity but keep in mind your research question and that you only have a limited time. Start sooner rather than later so you have time to make the thesis exactly how you want and so you will still have time to solve any problems you encounter. While the results were disappointing I loved the process and my supervisor was a big help in getting me excited about the research and extending my pre-existing knowledge and I highly recommend a thesis in econometrics!

**Shahrezad Fahmy**

**Thesis subject: The many-visits traveling salesperson problem**

**Thesis supervisor: André Berger**



My bachelor thesis was about the many-visits traveling salesperson problem (MV-TSP), for which André Berger was my supervisor. The MV-TSP is a generalization of the well-known traveling salesperson problem (TSP), namely, we want to find an optimal tour of  $n$  cities, visiting each city  $i$  a prescribed number  $k_i$  of times. As many of you might wonder, this process did not go smoothly from the beginning. Especially as I had a well-known topic, it was quite hard to start. As there was already so much research about the TSP problem, I thought it was hard to develop some (new) ideas for heuristics to solve this problem.

It was not that easy to understand the most recent ideas from researchers, and it took me a lot of time to go through these papers. Therefore, I did not like the thesis that much in the beginning. However, after reading a lot of papers and understanding more about the topic, I started to enjoy the process of the thesis.

The goal of my thesis was to develop a heuristic for the problem, and André Berger really helped me to get some ideas. From this point onwards, the process went very fast, and the thesis period came quickly to an end. To solve the MV-TSP problem, I designed a heuristic that solved the problem in two steps. Initially, a degree-bounded minimum spanning tree is found, such that we start with a connected component. Thereafter, the transportation problem is solved to get the desired number of visits for each city. Since a heuristic does not guarantee the optimal solution, this heuristic was to be compared to an ILP formulation, which does return the optimal solution. From this comparison, I got very promising results, specifically, I found that even though the heuristic does not always lead to the optimal solution, it runs a lot quicker than the ILP formulation. Besides, the solution from the heuristic turned out to be very close to the optimal solution in most scenarios.



My tip for you is do not stress too much in the beginning. It might seem hard to start, but when you start well, the rest of the process can be fun and will be very doable. Besides, make sure to spread the workload well during the periods. For me, I had a pretty nice elective in period 5 that did not require a lot of effort. Therefore, I had plenty of time to work on the thesis during that period and I had no stress at all to finish the thesis on time. Lastly and most importantly, as the thesis is quite flexible, go in a direction that you like such that you do not spend two periods on research that you do not enjoy. All in all, good luck and have fun with the thesis :)



**Süleyman Esener**

**Thesis subject: Boosting for learning graphs from high-dimensional time series**

**Thesis supervisor: Michael Eichler**



### **Description**

Modeling temporal dependence in multivariate time series is a complex task that is the focus of numerous fields such as macroeconomics, finance, biosciences, and neuroscience. The Vector Autoregressive (VAR) model is one of the most effective, adaptable, and straightforward methods for analyzing multivariate time series, but it has its drawbacks. For large (and even moderate) dimensions, the number of AR coefficients can be prohibitively large, resulting in noisy estimates, unstable predictions, and difficult-to-interpret temporal dependence.

Imagine you're a financial analyst trying to predict the stock market. You have data from hundreds of stocks, each of which provides information on different aspects of the economy. Your job is to create a portfolio that minimizes risk, and to do that, you need to understand the covariance matrix of asset returns from hundreds of assets using historical data. However, the VAR model struggles to handle such a high number of dimensions and you find yourself in a situation where your predictions are not accurate enough.

Now imagine that a new method is proposed, called Boosting-VAR. This approach adapts Boosting, a machine learning algorithm, to a VAR model in order to circumvent the limitations of VAR. The method is inspired by Bühlmann's proof that boosting with squared error loss, L2 Boosting, is consistent for very high-dimensional linear models, as well as the approach proposed by Anjum, Doucet, and Holmes.

You decide to give Boosting-VAR a try and you're amazed by the results. The algorithm is able to handle high-dimensional data much better than the VAR model, and it produces more accurate predictions. You're able to create a portfolio that minimizes risk and you're able to make better decisions for your clients. This is just one example of how Boosting-VAR can be applied in the real world. The method has the potential to revolutionize the way we analyze multivariate time series data.

In this research, the performance of the Boosting-VAR approach is evaluated and compared to Lasso-VAR based on results obtained from simulations and based on the visualizations of results from the application of the algorithm on real-life data of cryptocurrencies. The simulation study showed that Boosting-VAR is able to produce more accurate predictions than Lasso-VAR, making it a valuable tool for analysts and researchers.

In conclusion, Boosting-VAR is a powerful method for modeling temporal dependence in multivariate time series that can be applied in a wide range of fields. It offers a solution to the limitations of VAR by adapting Boosting, a machine learning algorithm, to a VAR model, resulting in more accurate predictions and better decision making. This research has shown that Boosting-VAR is a valuable tool that has the potential to revolutionize the way we analyze multivariate time series data.



When I first began working on my thesis, I was filled with a mix of excitement and trepidation. I had chosen a topic that I was deeply passionate about, but I also knew that it would be a significant challenge to research and write about it in a comprehensive and compelling way. As I delved deeper into my topic, I found myself getting lost in the sea of information that was available to me. I spent countless hours reading through academic journals and books, trying to make sense of the complex ideas and theories that were relevant to my research. Despite the difficulties, I was determined to persevere. I knew that my thesis would be an important step in my academic and professional journey, and I was determined to make the most of the opportunity. One of the things that helped me along the way was my supervisor, Michael Eichler. He was supportive and approachable, and our weekly or bi-weekly meetings were always a valuable source of knowledge and guidance.

As I continued to work on my thesis, I found that I had to be incredibly organized in order to keep track of all the different ideas and sources that I was using. I created a detailed outline of my thesis and broke it down into smaller, more manageable sections. After months of hard work, I finally completed my thesis. It was a challenging and rewarding experience, and I felt a great sense of accomplishment when I submitted it to my advisor.

Now that I've shared my own experience with completing a thesis, I'd like to offer some tips and advice to those who will work on theirs. Choose a topic you are passionate about, it will make the process much more enjoyable and you will be more likely to stay motivated. Be organized, make a detailed outline and break it down into smaller sections. Keeping track of your referencing will help you organize your research and keep track of the information you've gathered. Seek feedback from your advisor and peers, it will help you improve your thesis. Stay motivated, it's a challenging process but it's worth it in the end. Take breaks, it's important to take a step back and clear your mind to avoid burnout. Finally, having a supportive supervisor can make the process much more manageable and enjoyable ☺

**A big thank you to Peter, Steef, Shahrezad and Süleyman for sharing their experience and tips with us!**

# How to live on a budget in Maastricht



By Chiara Venditti

Maastricht is a stunningly beautiful small city with medieval buildings, flourishing parks and a young international environment, but living here can easily become very expensive. Thankfully Vectum is here to give you some tips on how to live on a budget in the Netherlands!



Save on groceries!

1


Cooking at home can already save you a some money, but let's take it up a notch!

- Buy your fruit and veggies at the local market on Wednesdays and Fridays on the Market square



- Buy them on the website **EATLY** which also allows you to help the planet by reducing waste (it's always great to be more sustainable where we can – let's help mother nature a bit 😊).
- Join the Facebook group "**Foodbank Maastricht**" which gives up free vegetables every Friday. You never know what you'll get, but that's even more fun because you can put your cooking skills to the challenge!
- Use the app "**Too good to go**". I guess we all have heard of it, but do you know that you can pick it up even at University? Very convenient right? Tapijn Café, the Mensa, the Inner City Library shop and even Randwick (Uns30, Uns50, Uns40) offer "surprise bags" of food at a lower price!

Plants to decorate your room **2**

If you just changed your room and still need to add some personality to it, then buying some plants can really make the difference! 



- Plantenasiel is a Plant shelter: it gives away plants that people don't want anymore to give them a second chance. The price is usually between 1€ and 10€ depending on the size of the plant.

### 3 Clothes and other objects

- **Vinted** is the perfect app to buy second-hand items, like clothes, books, accessories, plates and many more things! By using the app, not only can you find low-priced stuff (yes even that Ralph Lauren sweater you like), you also avoid buying fast fashion.

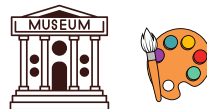


- **Kringloop** is a thrift shop chain which has several locations in Maastricht. Especially Kringloop Zuid has a bit of everything, it's on the other side of the river, not far from UM Sports. There you can find clothes, furniture, bikes, even carnival costumes and a little café. Super cheap – even more during the sales period - usually January and July -!
- For toiletries, head to Kruidvat and get the membership card, which you can build up points to save money.

### 4 Public transportation

Using a bike is the cheapest – and fastest – way to move around Maastricht, but in case of a snow storm or pouring rain you might prefer public transportation.

- Buying an OV-Chipkaart can save you some money. It costs 7,50 € but you can add discounts on it (for example 40% discount during off-peak hours, weekends, public holidays) and you won't have to pay for the full bus fare every time you hop on a bus!
- Otherwise you can buy the ticket on the app Arriva which is still cheaper than buying it directly on the bus.



### Art and culture



- If you love visiting museums around the Netherlands then you may want to consider buying the Museum Card which gives access to over 400 museums across the country – It is not the cheapest but can save you money if you are an art lover! (64.90 for 19+ and 32.45 for 18 years old and under).

Bonnefanten museum in Maastricht

# Meet the Professor

## Interview with Marc Schröder

By Marie Corillon



We know that our members are curious about our tutors and professors: what did their academic journey look like, what work are they the proudest of, but also simply what sort of hobbies do they do? In this edition, professor Marc Schröder, coordinator of the bachelor and master Game Theory courses, kindly accepted to answer our questions.

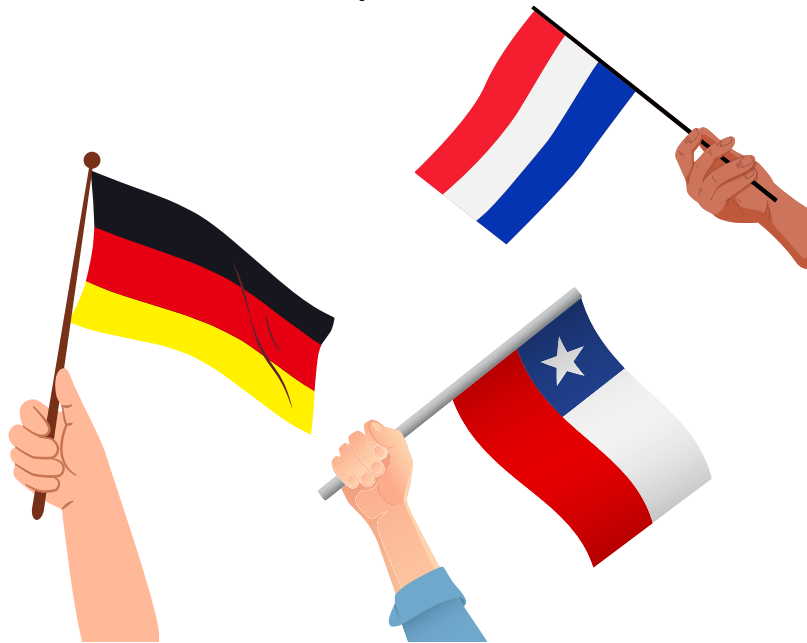
### Could you introduce yourself?

My name is Marc Schröder, I'm 33 years old, and am an assistant professor here at the department of quantitative economics as of November 2020, in the middle of Covid. I'm home-grown so-to say, I studied here, did my PhD here, went abroad for a couple of years for different post-docs and then as of 2020 came back here in Maastricht.

### What did your academic journey look like?

I studied in Maastricht, did the bachelor of E&OR as well as the master programme and continued here because I didn't really know what to do after my study programme, so it was a bit of a coincidence that I was asked by Dries to stay for the PhD. I liked the university and working on problems, so I decided to stay and liked it a lot, which is why I'm still in academia.

I finished my thesis at the end of 2015, stayed an additional year here to finish everything, and then went to Chile for a year to do a post-doc. After Chile, I went to Aachen for three years for another post-doc, and now am an assistant professor at Maastricht University.





## What do you do as a post-doc?

Usually during a post-doc you get to go to other universities to see how it works in different countries and build up your social network, but it's mainly research oriented. For example, in Chile I had no teaching duties whatsoever and was only focusing on research. In Aachen however I was doing some teaching too, so it depends on the university. It's good to see how the academic systems work in different countries and try to bring the best of those back to the system over here.

## Being back in Maastricht, what are your favourite spots around the city? Could you recommend your top spots to our members?

I live very close to the Frontenpark, it's a very beautiful spot to just walk around, spend time in summer, sit and relax. In terms of bars, I like to go to the Koestraat. There is De Kaasbar (cheese bar) and a nice wine bar. You can also get some nice tapas at La Vaca.



## Since you studied in Maastricht, what's your best Vectum memory?

The first thing that pops to mind is the members weekends taking place at the end of June, those were always amazing. I participated in all four of them when I was a student, it was so great to bring everyone together to do those social activities. Another one was winning one of the beer pong tournaments, or the pub crawl we did in The Hague. One year we even did a cantus on the beach. There are a lot of good memories.



## What do you like to do in your free time?

I still play soccer at the same club in the village I'm from. So I go there on Tuesdays and Thursdays for practice, and on Sundays for matches. Last year was the first time ever that I was playing one of the students here. I was shaking hands with the opponents and thought 'Wait I know you right?', that was funny. I guess he also didn't expect to see me there.

## Career-wise, you said that you didn't know what you wanted to do after your studies, and ended up in academia. Did you still have some rough job or career ideas in mind?

Not really. I did attend those career events like the LED, but was never convinced that that was what I really wanted to do. And then I sort of rolled into this, and I like it a lot. On the one hand, you have all these challenges in terms of research,

you're trying to solve problems, trying to get a better and better understanding of how they work. On the other hand, you have the social aspect of teaching, which is what I like about the system here. It's so small-scaled, you get to actually know the students a little bit. I'm really happy with my choice and that's why I never left.

**In your opinion, what are the biggest challenges in game theory at the moment?**

There are still a lot of open problems. When you're a high school student you think that everything is solved in mathematics, that everything has been found and there's nothing left to discover, but there are so many open problems and interesting directions to take. For example, I'm now working a lot on congestion games, in which the idea is to model traffic behaviour. This could be in static models where players make simultaneous choices, or dynamic models where they travel in the network over time. One of the things I intend on doing is trying to see how tolling and road pricing affect behaviour in these models, how equilibria change, and how we can improve the situation for road and traffic users. There are many open questions in that direction, but also in different other areas.



**When students think of game theory, it can be hard for us to see how it is actually used in real life. Could you give us real-life instances in which it could be used?**

I get that. I understand that it can be theoretically challenging because we dive deep into some of these concepts and it can be unclear why they even exist, but I do think it can be used in everyday life. Think of the design of voting mechanisms, or governments that have to decide on how to set up auctions to sell 5G and radio frequencies so as to earn money and give the right incentives to companies to bet well. There are many examples you can think of.



There was [this badminton match](#) at the Olympics a couple of years ago. The group stage consisted of two different groups. In the first group the world number 1 became second, while in the second group one match was left to be played between the numbers 1 and 2 of that group. Basically, both teams knew that whoever won the match would become first in their group, and therefore meet the number 1 in the semi-finals. So both teams had an incentive to lose the match. What started happening is that players started to make as many mistakes as possible, which is of course not how you should play in the Olympics, they should have been incentivised to compete. In the end, trying to maximise their probabilities of winning got them disqualified. I do see that concepts like the equilibria sound abstract, but that's the only way to analyse such strategic behaviour.

### **Are there game theory consultants to solve those kinds of issues then?**

Yes, I do know that a lot of game theorists have been consulted for the design of the auctions for 5G frequencies in other countries.

Another example is from when I was doing my post-doc in Chile, they were having this school choice problem. The richer kids go to the good schools, while the poorer ones have much lower probabilities to get into those schools. So they set up a Gale-Shapley sort of matching to come up with a centralised, fair and incentive-compatible system to assign these kids to schools. The government came to the university for advice on how to do it the right way, and then actually implemented it. It's quite nice that practical problems get to be solved academically, and that governments try to use these ideas.

### **What's the work you're the proudest of so far?**

I always find that difficult. I'm biased because I always have this moment where I'm very happy with something I've recently finished. Right now it's the case about a paper on traffic games in which we try to see how bad are the effects of selfish behaviour versus the effects of directing traffic through alternative routes to prevent congestion. For example, if Google maps instead of sending everyone through the shortest path would tell some people to take detours so as to prevent congestion on specific roads.



We look at how far apart congestion is in those two different instances. We were able to characterise exactly how large this gap can be depending on how many agents participate in these games. We have a randomisation device that determines how many people there are, and based on the level of randomness we can determine if a Nash equilibrium exists in such a situation. We can upper bound this gap between equilibrium, selfish behaviour and social optimal behaviour. We can also give examples to show that all these bounds are tight.



If we come back to practical examples, there's one from when I was still working in Aachen. A master thesis student was organising sports tournaments, badminton in that case, and used the Swiss system: you have two players competing in every game, and you need to set up a tournament so that every player plays an equal amount of rounds, fixing the number of rounds in the beginning. So every player plays another opponent in every round, and based on how well they do in that round, their next opponent is selected such that those who win a lot play each other, and players who lose a lot play each other. That way the losers don't get ejected early in the tournament and get to enjoy the game by playing as much as everyone else.

There was this software being used to organise these tournaments, and at some point the software would stop after a given number of rounds. The problem was that because you assign rounds greedily, you only assign the next round once the previous round has been played. It could be that there does not exist a new round in which everyone plays a new opponent in the next round, and the software didn't know how to deal with that situation. So the goal of the thesis was to try to compute after how many rounds can such a thing happen: given that we have  $n$  players, so there are  $n/2$  matches in every round, after how many rounds can we get stuck in our tournament? And how can we change some rounds earlier on so that more rounds can be played in total? We even put that on [Wikipedia](#), we managed to write a very clear and clean message to give to the outside world for everyone to understand.

### **What are the most rewarding aspects and downsides of being a professor and researcher?**

Teaching-wise, the most rewarding aspect is seeing students' learning curves. From when they first come in on day 1 and have no clue about theorem proving to how they're then able to write really nice research papers, or see where they end up after their bachelor. Research-wise, it's a real challenge. It's like a puzzle and you get to understand more and more of it. The moment of joy once you finally complete a proof is incomparable.

For the downsides, the administrative tasks aren't so nice, like correcting exams for example.

For researching, it can be really frustrating to get stuck on something, for months sometimes, but that's why it's good to have the teaching, you always feel useful doing that.



### **What advice would you give your younger student-self?**

Most importantly, being a student is super exciting. You get so many new experiences, in terms of living by yourself, studying abroad and discovering the world. Intellectually, you learn so many new things, so pick courses that you'd actually like to learn rather than choose the easy courses. Enjoy this time of your life by learning things that interest you!



**We would like to thank Marc for answering our questions and wish him all the best!**

# New Year's Traditions

## By Ngoc Bao Phung

This year, we asked some of our beloved Vectum members how they usually celebrate New Year in their hometown to get to know the diverse cultural celebration of countries. We asked them “What are some New Year's traditions from your region?” and got the following incredibly interesting answers:

### Quinn Cuijpers from Schinnen, Netherlands

For New Year, we always eat Oliebollen and some years even make them ourselves. Furthermore, we just watch the fireworks around us and get together as a neighborhood to wish each other a good new year.



### Matthew Ellis from Johannesburg, South Africa

Big parties are known as Jol's and for new years many go to clubs, raves or outdoor music events, smaller gatherings may opt for a braai (a traditional barbecue) to spend time with people you are close to as you wait for the ball to drop. Pets are kept inside or wrapped in blankets ready for many fireworks to be set off.

### Marie Corillon from Liège, Belgium

I don't think we really have traditions, however something really common is to set off fireworks and eat a raclette. It's a sort of small table grill on which you can melt cheese and grill charcuterie (ham, etc), and then put that on potatoes. It's probably our favorite things about winter.





## **Bao Ngoc from Hanoi, Vietnam**

In Vietnam, we do not do much on New Year Eve but we always throw a big celebration for around 10 days for Lunar New Year. It's the year of the Cat for Vietnamese this year. People will shop for specific plants and flowers to decorate their houses. Children will receive "lucky money" in red envelopes (lì xì) from adults for good luck. There are so many amazing and distinguished dishes that I cannot recreate in Maastricht due to a huge lack of ingredients and utensils. There are many other traditions that I fail to list.

## **Arman Behbood from Maastricht, Netherlands**

Watch fireworks, eat oliebollen and (when it was still legal) set off fireworks. Also just hanging out with the fam/friends and going out. I personally enjoy being on one of the bridges at midnight watching fireworks whilst counting down to the new year.



## **Neive Cosker from Swansea, Wales**



A traditional Welsh New Years tradition is a funny one. Groups get a horse's skull (usually wooden now), covered in white cloth, bells, ribbons and flowers, and go door to door singing a song. At each house, the residents try to outwit the horse, called Mari Lwyd, by telling it to go away, or scratch off in Welsh, but if they don't reply to the song, the group gets to come inside and help themselves to food and beer. Usually this is done in small villages, and since the Mari Lwyd is supposed to bring good luck, people tend to let them in intentionally.

## **Tobias Breuer from Aachen, Germany**

1. Set off fireworks, like rockets, crackers and batteries
2. Watch the sketch "Dinner for One"
3. Molybdomancy
4. Counting down
5. Drinking champagne
6. Wishing people a "good slide into the new year"



# Vectum's 2023 Horoscopes

By Polina Barinova aka Vectum's astrologer

Discover what 2023 has planned for you



## Aries

For Aries, 2023 will be quite an important time. You will need to finally decide on your positions and opinions regarding all spheres. This year will bring a lot of friends and like-minded people with whom you will be united by common interests. Old fears and limitations will be supplanted by your psyche. You will overcome your limitations and strive for personal growth. Self-confidence will present financial opportunities, try to save money. Don't allow yourself to act rashly under the influence of your fiery character.

## Taurus



The changes that Taurus set in motion sometime long ago will finally bear fruit. You will be able to adjust to new circumstances and achieve great success. In relationships with people, firmly control your emotions. The year is better spent on spiritual quests and trying to accumulate inner strength.



## Gemini

You should feel better in 2023. There will be more stability and clarity in all areas of life. There could be more "adult" tasks where you will need to work harder and control those around you. There will be big shifts in communication with the world because of necessity. You will begin to see the world and its values in a new way with an honest outlook on the world.

## Cancer

Cancers are to be congratulated! In 2022 you went a long way in transforming your relationships: you got rid of unnecessary people and made good friends. In 2023 you will feel free and there will be a desire to shake things up and start something new. Do not neglect the safety rules during the year. Be careful when planning trips.

## Leo

Leo will experience a year full of big life changes. You will have a chance to open up and show yourself to the world, but be careful and watch your emotions and mental health. Individuals who aspire to public activity will have a chance to attract the attention of the general public, but the path will be thorny. On a personal level, there may be a desire to stop being good for everyone - learn to stand up for personal boundaries.

## Virgo

For Virgo, the year 2023 will bring many significant events. You could suddenly become a measure of morality and a vector of spirituality. Those around you will see you as a pillar and a leader. Adjust your sleeping, eating, and household routines. Routines can be time-consuming, so reconsider routines imposed by people or circumstances. The stars advise making lifestyle changes and watching your health.

## Libra

Libras in 2023 may feel that everything around you is boring - fight it and color the routine. You'll think someone else is luckier than you are. Work on responsibility and focus. Single Libras will experience a serious love affair in the second half of 2023. It will overwhelm you and leave you with very pleasant memories. Regardless of your love status, the stars advise Libra not to try to forcibly translate the relationship into "all serious" status - a high probability of being disappointed in your illusions. Enjoy the feeling of falling in love, with your partner, and allow yourself a little levity.

## Scorpio

For Scorpions, this is a happy and powerful energy-filled year. There will be profound and lasting changes in your relationship with your parents, where you live, and your inner foundations. Pay great attention to personal space for comfort. The year is good for building a personal life. Single Scorpions may have a life-changing encounter that leads to a comfortable relationship.





### Sagittarius

Sagittarians will be attracted to the thirst for entertainment - they will want a celebration of life. It's time to act on a creative impulse rather than obey someone. Studying or hobbies will consume time and energy, but in return will give the energy of joy. Find time for an outlet. You will have to pay more attention to domestic problems. Superficial acquaintances can become life-changing and change you. Drive cautiously and don't quarrel with your neighbors.

### Capricorn



Capricorns will feel liberated and heavy shackles of responsibility and tension will break down. You'll find a place for joy and pleasure, not just worries and work. Don't expect many contacts, your circle of friends is established - relationships with old friends will deepen and become more serious. There will be a chance to buy something you've wanted for a long time. Learn practical skills rather than theory - they may come in handy unexpectedly for a career opportunity. The stars promise Capricorns a change in personal status. This is a good time to realize the seriousness of a relationship.



### Aquarius

An important year is coming for Aquarius - it will call for feats. In 2023, lay the foundation for change in the future. If you've been waiting a long time for a chance at something, it will present itself this year. Opportunities and strength to start your own business and influence others will arise. Dedicate yourself to an idea and an interest. In the love sphere, the stars advise not to deceive yourself and to discard fears and stereotypes. In 2023, single Aquarians can have a second soulmate who will understand and accept their freedom-loving disposition.

### Pisces



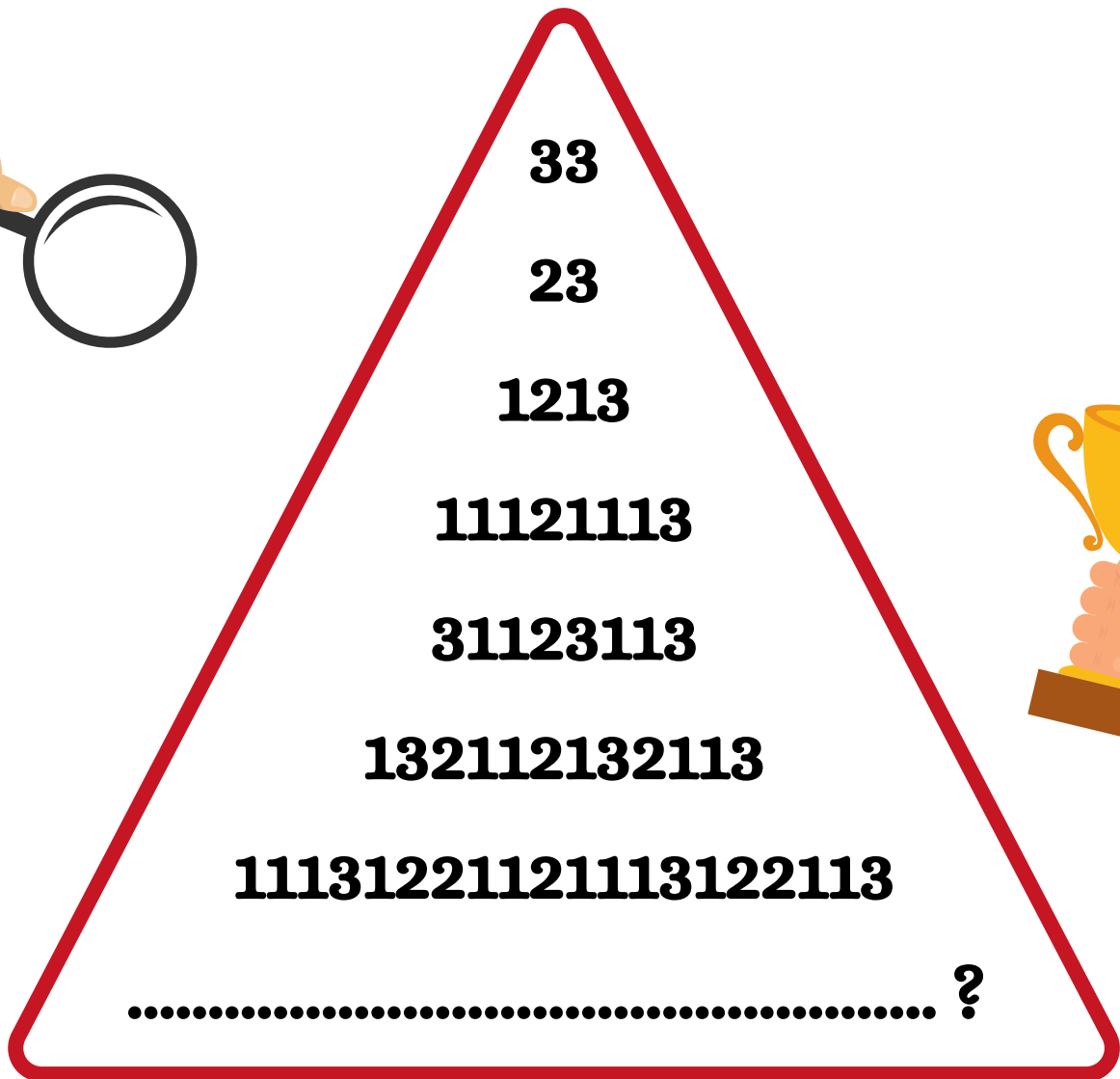
Pisces awaits an unusual year. You will be prone to solitude. It is necessary to be selective in the choice of social circle. Pisces must learn to see the good and good around you. Take time for yourself: rest, get enough sleep, and come to terms with the world around you. The only person you can rely on is yourself. In 2023, Pisces is at risk of falling into the clutches of addictions - watch your health and seek help in time.

# Math Puzzle



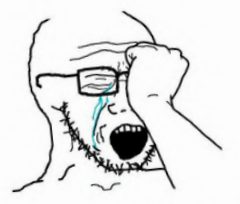
Be the first person to solve this puzzle and win a prize!

#PaidByVectum



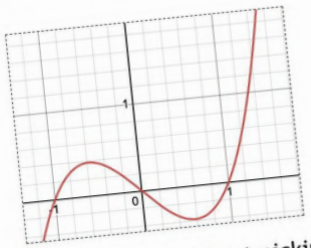
# Memes

Me confidently drawing a square at the end of an incoherent and incorrect proof



Real Analysis Student

YOU NEED THAT FOR  $f: A \rightarrow \mathbb{R}$ ,  $c \in A$ , THE FUNCTION IS CONTINUOUS AT  $c$  IF AND ONLY IF  $\forall \epsilon > 0 \exists \delta > 0 \ni |x-c| < \delta$  and  $x \in A$  implies  $|f(x)-f(c)| < \epsilon$ !!! OTHERWISE IT'S NOT SUFFICIENTLY RIGOROUS!!!!



If I can draw it without picking my pen up, it's continuous.



Precalculus Student

"Every triangle is a love triangle when you love triangles" - Pythagoras

