nekst>>

vol. 30 no. 2 | winter 2022 | **nekst-online.nl**

Special

Carnival around the World

>> **The Teacher**
Erwin Charlier

>> **Special**
Board Game Theory

>> **Report**
Europe Trip

ASSET Econometrics

Light

It is winter. That means dark nights, cold weather and less energy (at least for a lot of us). In addition, there is still a virus around that messes with a lot of our plans. In these times there is little as important as *light*. For example, someone taught me a more positive view on the lockdown that taunted us during December and January. Of course, it was not ideal, but at least it was during the exams! Also, the winter gives us the opportunity to cozy up under a blanket with some glühwein after going for a walk in the forest. And this Nekst edition, being the winter special, will give you light by having an extended Quatsch section! And when this Nekst arrives, maybe you will even see the light of the upcoming spring season already…

Whether you are in the light of the study rooms of the Cube building, or using a reading light because it is late in the evening, I think you will enjoy reading this edition of Nekst. Next to all the exam stress, the committee has worked hard to provide you with some interesting and entertaining articles. We have two very different but both interesting specials: *Board Game Theory* and *Carnival around the World* for you to read. Professor Erwin Charlier was interviewed for the teacher and Björn Floor tells you everything about his view on student life. As promised, the Europe Trip makes a return, this time with a review of the trip, and Pierre Verhulst has written the Practical Report. Not to forget the two columns, and many more beautiful articles. Hopefully they will bring you some *light* in the dark winter nights.

See you in spring!

Yours sincerely,

Juliëtte Tillie
Editor-In-Chief

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Nekst is the quarterly magazine of Asset | Econometrics ©2022
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Printing
BladNL

Circulation
550

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Dear Members,

The first semester of the academic year 2021-2022 is coming to a close, so now it is a nice moment to look back and reflect. I hope everyone got a chance to experience all that Asset | Econometrics has to offer, during the few weeks last year that all bars and restaurants were open. Especially since I know that many of you have not had the chance to experience what it means to be a student. When we as a board received the news a few weeks ago that we would go into another lockdown it really saddened us, because we really believed we had turned the corner on Covid-19. Let's not get stuck in the negative however, since there is plenty to look back at.

We have had a lot of awesome events in the past year, like the Christmas dinner lunch and the announcement of our two new winter board members: Ikie Leunissen and Nienke Keuning. Both Ikie and Nienke are very excited to start their board year at Asset | Econometrics, and on behalf of the 'old' board I want to congratulate them and wish them a lot of success because they will need it. With the addition of the new board members, I believe the association will improve even further. Both newcomers are already coming up with great ideas, if you want to know more about these ideas, I suggest you read the minutes of the Department members meeting (DMM).

Another highlight of the past half year was of course the incredible Europe trip, where during the span of four days we as an association experienced all that the beautiful city of Prague had to offer. From a boat trip on the river Donau to a pub crawl through the busy city center. Read more about this in the event report! For some of the Europe trip participants the upcoming rail trip that will be organized will come as mustard after the meal, since they already went on an awesome road trip.

Furthermore, I am really proud of our association for raising almost 300 euros for the charity Villa Vivre with an event that gave the term folding another meaning. The good does not stop there, looking forward the Econometricians for society (EfS) committee is also looking to organize a dinner for the homeless, where everyone of you can show that you are capable of more than just cooking pancakes.

In this edition of the dear members, I also want to give a special thanks to the entire editorial team of the Nekst, seeing them work around the clock is a testament to the dedication they have to our beautiful association.

With brighter times ahead I want to end my essay by making a promise to all of our members. When the regulations allow it, we as a board will make sure that all time that was lost due to lockdown will be made up for in the upcoming months. By organizing as many events as we possibly can with the help of our amazing committees. I will no longer keep you from reading this edition of the Nekst.

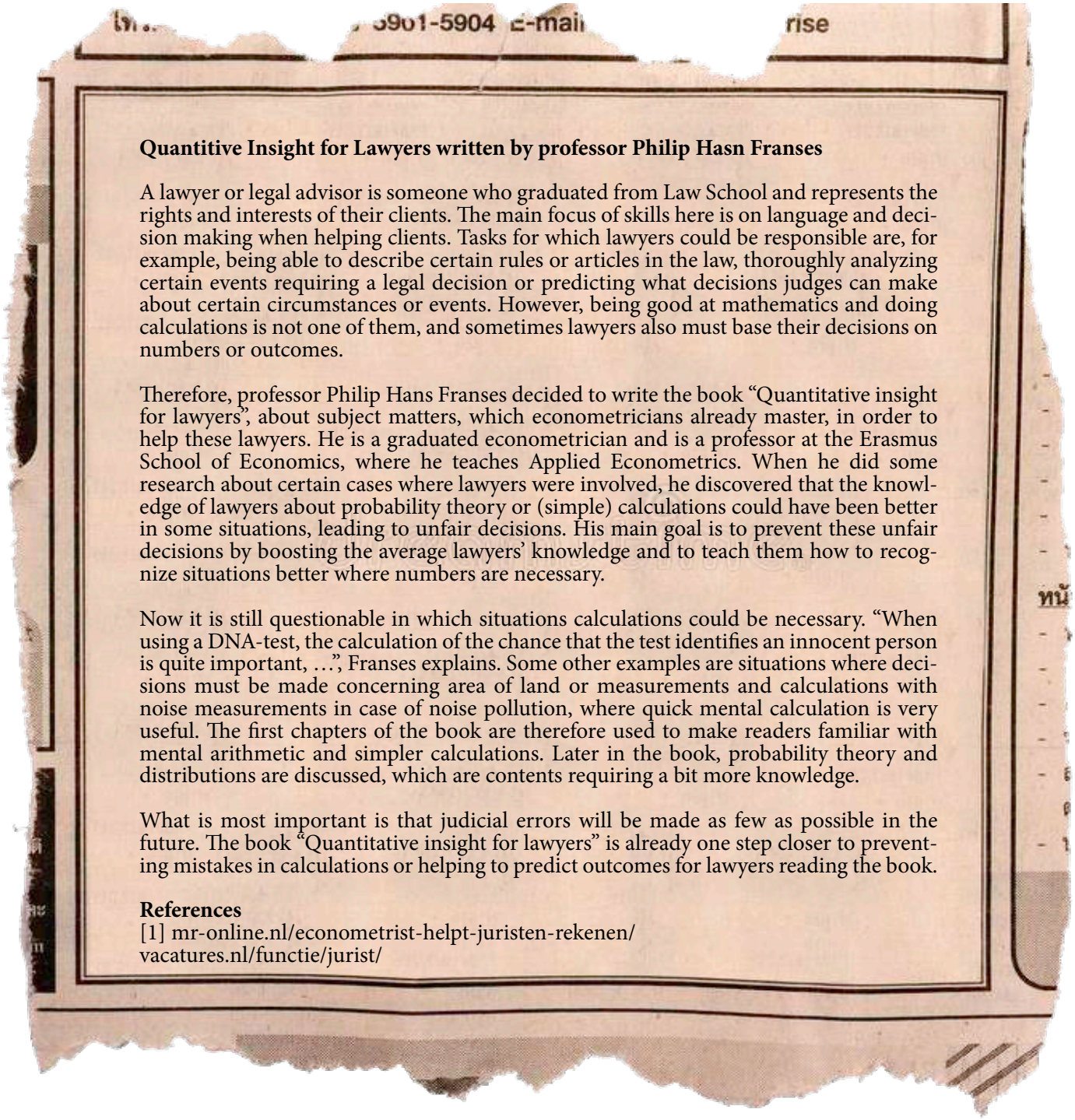
On behalf of the board,

Wout Temmink
Chairman Asset | Econometrics 2021-2022

The Latest

In this Nekst edition, "the Latest" is about a recently published book considering the help of econometricians in a profession where most people probably would not expect it.

written by **Timo van Oorschot**



Quantitive Insight for Lawyers written by professor Philip Hasn Franses

A lawyer or legal advisor is someone who graduated from Law School and represents the rights and interests of their clients. The main focus of skills here is on language and decision making when helping clients. Tasks for which lawyers could be responsible are, for example, being able to describe certain rules or articles in the law, thoroughly analyzing certain events requiring a legal decision or predicting what decisions judges can make about certain circumstances or events. However, being good at mathematics and doing calculations is not one of them, and sometimes lawyers also must base their decisions on numbers or outcomes.

Therefore, professor Philip Hans Franses decided to write the book "Quantitative insight for lawyers", about subject matters, which econometricians already master, in order to help these lawyers. He is a graduated econometrician and is a professor at the Erasmus School of Economics, where he teaches Applied Econometrics. When he did some research about certain cases where lawyers were involved, he discovered that the knowledge of lawyers about probability theory or (simple) calculations could have been better in some situations, leading to unfair decisions. His main goal is to prevent these unfair decisions by boosting the average lawyers' knowledge and to teach them how to recognize situations better where numbers are necessary.

Now it is still questionable in which situations calculations could be necessary. "When using a DNA-test, the calculation of the chance that the test identifies an innocent person is quite important, …", Franses explains. Some other examples are situations where decisions must be made concerning area of land or measurements and calculations with noise measurements in case of noise pollution, where quick mental calculation is very useful. The first chapters of the book are therefore used to make readers familiar with mental arithmetic and simpler calculations. Later in the book, probability theory and distributions are discussed, which are contents requiring a bit more knowledge.

What is most important is that judicial errors will be made as few as possible in the future. The book "Quantitative insight for lawyers" is already one step closer to preventing mistakes in calculations or helping to predict outcomes for lawyers reading the book.

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ENHANCE

In the previous column Hein Fleuren explained how the Zero Hunger Lab uses data science to contribute to one of society's biggest issues: hunger. Working on this problem is complex, as feeding people is often integrated with other big problems such as poverty, war, gender inequalities and climate impact. In this column we elaborate on one of our research projects called "ENHANCE", where we optimize diets that are not only nutritious and affordable, but also have limited environmental impact.

The diet problem is a typical textbook example when you follow a linear programming course. The goal is to minimize the cost of a food basket such that sufficient nutrients (e.g. vitamins, protein, fat, energy) are included. Although this model is fairly simple, it has been of great importance to the history of operations research: it was actually one of the first problems on which the simplex method was tested [1]. It even inspired George Dantzig—the founding father of operations research—to include upper bounds within minimization problems: after trying to model his own diet the model told him to consume 200 stock cubes (broth) a day!

The core model of the diet problem is nowadays often enriched to include palatability, cultural preferences and dietary habits as well. Already for many years the World Food Programme (WFP) makes great use of this augmented model [2] to help local governments. They perform a complete analysis, called "Fill the Nutrient Gap" (FNG), where they analyze the local market, take interviews, bring important stakeholders together and perform a diet problem assessment.

Although healthy diets are constructed, these diets are not dictated to be consumed by the population. Models cannot capture all aspects of the real world, especially regarding the palatability of a diet. Instead, these constructed diets state the minimum earnings an individual should have to afford a healthy diet. For example, in South Sudan 186% of the average daily income is needed to afford a healthy meal [3]. Obviously, in such a case drastic actions need to be taken.

In the end this complete assessment helps to answer questions and model interventions such as (1) Does a household earn enough money to afford a healthy diet? If not, how can we ensure that their nutritional gap is as small as possible?; (2) Which age groups experience problems with consuming sufficient nutrients?; (3) If children consume healthy lunches at school, how much money is saved for the household?; (4) Which food items are important for a healthy diet? We can thus conclude that the current FNG analyses really help to address, form and change local policies!

As food systems contribute to 20-30% of all greenhouse gas emissions [4], it is necessary to incorporate the environmental impact of dietary choices within the model as well. This led to the start of ENHANCE; a collaboration between WFP, John Hopkins University, Capgemini and Zero Hunger Lab. Within ENHANCE we focus on the trade-offs between affordability, sustainability and health. That is, an affordable and healthy diet may not be environmentally friendly as well. In such a case it might be worthwhile to consider a slightly more ex pensive diet, which burdens the environment less. With this, we hope to enhance the current FNG analyzes such that more informed decisions can be made.●

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Marleen Balvert
Marleen Balvert is assistant professor in Operations Research and Machine Learning. Her research focuses on applying these two techniques to solve questions related to zero hunger and in the discovery of disease-causing genes from large databases.

Melissa Koenen
Melissa Koenen is a PhD student in the field of Operations Research at the Zero Hunger Lab. Her research is related to diet optimization. Together with WFP she works on the project ENHANCE to show environmental trade-offs between different nutritious diets.

EfS: Game Night

The Committee's View

Let me start with introducing myself. I am Luuk Reinders, 20 years old and this year I am part of the econometricians for society committee, better known as the EfS committee. In the beginning of December we organized a little event called EfS Game Night. The goal of this event was to raise money for a local charity we reached out to ourselves called Villa Vivre. This is a nursing home in Goirle, for chronically and acutely sick children in the neighborhood. We raised money the same as a casino would raise money: people could purchase "casino coins" with their own money to either play party games or play poker. On top of this we added a twist, more on that later.

We had been planning this event since our first committee meeting. In this meeting lots of ideas for our first event came along, ranging from cooking for the homeless to a sponsored run and from helping disabled youth to organizing a carwash. After careful consideration we ended up choosing to organize a casino night. Now the actual organizing of the event could begin. We thought of a lot of games that people could bet their own "casino coins" on and more importantly, lose their coins on so we could raise more money. We also had to get a venue. However due to scheduling and covid-restrictions we ended up having to find several smaller locations as an alternative. Hence, the EfS Game Night was born (which ended up being in the afternoon). Instead of organizing one big casino night, we would split the group up into several groups. We found some willing students that would let us organize the event at their student home and finally the event could begin.

The event took place on December 2. When I arrived at the address, my group, which was the recreational poker group, consisting of Meike, Juliëtte, Constantijn and Robin were already there, because I was a little late. Finally, we could sit down and after I finished explaining the rules of poker to everyone, we could begin. We were enjoying the game of poker and everything was going fine at first, but then the twist arrived. The doorbell rang and two of our committee members that were biking from location to location in the cold weather (shoutout to Gijs and Annelies) came in, together with a spinning wheel. We could spin the spinning wheel for €2 for cool prizes. On top of that, the person that would spin the wheel the most times that night would get a cinema gift card. Wout ended up spinning the wheel for a total of thirteen times! He won the gift card in the end.

When we carried on playing Poker I kept losing and at one point I lost all my coins so I had to buy some extra coins to stay in the game. After this the afternoon was coming to an end so it became sudden death poker, if you were out you had lost. Robin ended up losing and having to leave the game first. I was right behind him. Even the extra coins I bought couldn't help my poker skills. It seemed Constantijn was going to win but when Constantijn folded one time, both Juliëtte and Meike went all-in. Juliëtte won all the coins of Meike, so she ended up having more coins than Constantijn and therefore won, also winning a cinema gift card.

Luuk Reinders

Bachelor EOR

Age: 20

With this the afternoon came to an end and if I may say so myself, after a lot of doubt the activity still ended up becoming a success. Therefore, we as a committee are happy to report we were able to raise a total of €289 during this event. This beautiful amount of money will go to the deserving children at Villa Vivre, to make their lives a little easier!

Thanks to all the participants who helped raise money!

EFS committee 2021-2022

The Participant's View

written by **Juliëtte Tillie**

I am Juliëtte Tillie, 23 years old and you might have seen me on page one of this Nekst edition, as the editor-in-chief. Nekst to working on this beautiful magazine I like to join events organized by Asset | Econometrics, and so I ended up on the EfS Game Night as well. Let me share with you what it was like as a simple participant.

The EfS Game Night, which ironically took place in the afternoon due to Covid-19 measures, took place on a typical December day. I was happy that the event could continue and we had a chance to (safely) see some other Asset | Econometrics members again. I say safely here because every participant had to have a negative self-test before joining their group. After a successful test, I too ended up being negative and could go to Meike's house to meet the rest of the group. Earlier that day the committee had brought some drinks and snacks to her house, so that we would not miss out on anything during the games. We sat down around Meike's round table, which was perfect for the event. When subscribing for the event you had to choose if you wanted to join the serious poker game, the recreational poker game or the party games. Since we were the recreational poker group, a round table was very fitting.

When I signed in, I did not think I would be good at poker. One of my friends, who plays poker regularly with his mates, had taught me some things about the game but that was already a few months ago and that was also the only experience I had with the game. Nevertheless, I thought it would be fun to subscribe for the recreational poker game (not the serious poker game, since I would stand no chance). Luckily our own Nekst designer had the same thing in mind and joined me. Together with Constantijn, Robin and of course Luuk, we started the first poker round. I was not doing well so I decided to pay better attention to the strategies of the others. However, the committee quickly announced that not only the winner of the team would win a prize, but also the person who spun the wheel the most times out of all the participants. That quickly became my new goal. The committee would visit all the houses twice, giving the people there the opportunity to spin the wheel. On the wheel there were prizes as well, like extra coins (which I won one time!) and hotdogs (which we won a lot of times). After the second visit I was positive that I spun the wheel most times that night and we continued the poker game.

In the end my seven times of spinning the wheel were not enough, as Wout apparently ended up spinning it thirteen times. There went my chance to win a cinema giftcard… or at least that was what I thought. In the last two rounds, the game changed. Meike and I crushed Constantijn (very unexpectedly) and even though Meike already smelled her victory, I stole her crown. I won a cinema gift card after all!

Looking back at the event, we had a very fun night with many plot twists and even more hotdogs. It was exciting to participate and exciting that the committee raised so much money for the children at Villa Vivre. After all, that was what the whole event was about. We hope that it helps!

I want to thank the committee for being so flexible during these unsure times, and for helping the wonderful cause Villa Vivre!

Board Game Theory

It is Friday afternoon, and the weekly game night with the family is about to begin. A set of games - battleship, rock paper scissors, and guess who- are laid out on a table, and the one who wins the most games will be declared the big winner of the night. Your eight year old cousin proclaims proudly that he is going to beat everyone. Fury and fire boil within: rather death than losing to that brat! Maybe there are some optimal strategies to wield when playing these games, where you will always win more games than your direct opponent. Ultimately, this will lead to becoming the big winner of the night - and thereby achieving eternal fame and the undying respect of the entire family. Time to do some research in this pursuit of glory.

written by Matthijs Kroesen and Sara Darwinkel

First, you move to the game of battleship, where your father is impatiently waiting for you. In this game, you imitate a battle at sea with your direct opponent. Each player has to place five ships of different sizes on a 10 by 10 grid. They can be vertically or horizontally placed, however, it is not allowed to place the ships diagonally. These ships can not overlap, but two different ships can be on neighboring coordinates. The respective lengths of the ships are:

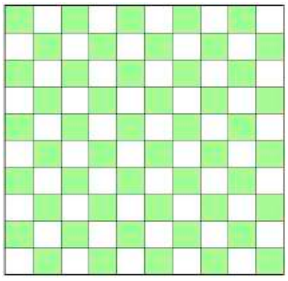
- 5 for the carrier
- 4 for the battleship
- 3 for the cruiser and the submarine
- 2 for the destroyer

After choosing a location for these ships, each player is going to guess alternately at which coordinate their competitor has placed a ship and sends a torpedo to said coordinate. If you guessed correctly, you hit the ship; if you were wrong, you shot an unnecessary torpedo. To remember where you have sent your missiles, you place a red torpedo on your own grid in case of a hit, and a white torpedo otherwise. After hitting all the coordinates of a certain ship, then this ship sinks to the bottom of the ocean. If you sink the entire fleet of your foe before he sinks your fleet, you have won the battle, and one point is added to your resume of the night.

At first, this game seems to be based purely on luck. After all, every choice of coordinate is completely random; since you can not know where your rival has placed his ships. Furthermore, your father always plays without a strategy, thus it is also not possible to predict his behavior, unless by cheating by looking at a reflective surface to see his grid (which is unfortunately not allowed). Maybe, applying some game theory will help here. What are the optimal plays that will help you win the most games?

Firstly, let's discuss the strategy that seems to always be the case: to choose every coordinate at random. This means that you have no strategy whatsoever; every turn, you ignore the results of the previous turn (even if you had hit a ship) and you randomly pick a new coordinate. Let's assume that the random variable $X = 1$ if a ship is hit, and $X = 0$ otherwise. In the first move, you have $P(X = 1) = (2 + 3 + 3{+}4{+}5)/100 = 17/100$. Afterward, you pick new coordinates without replacement, thus $X \sim HYP(n, 17, 100)$, where n is the number of plays necessary to end the game. After running 100 million simulations of games, it becomes clear that an approximate 99% confidence interval for n is $CI = [78, \infty)$, and the median for n is 96 shots (DataGenetics, 2011). Obviously, this is not the desired outcome, and you need fewer plays to win consistently. Let's consider some different strategies.

When hitting a vessel of your enemy, it seems evident that another piece of that vessel must be near. After all, each ship is located on two or more coordinates. Hence we arrive at the 'hunt and target' strategy: first 'hunt' coordinates (shoot torpedoes at random coordinates), and when hitting a ship, start 'targeting' adjacent (up, right, left, or down; unless you have hit a ship that is located on the border of the grid) coordinates. Now, stay in this 'target' mode until you have sunk the ship entirely, and then you go back to the 'hunt' mode. This reduces the mean amount of plays to end a game of battleship significantly: the median for n is now approximately 65 shots when playing 100 million games of battleship (DataGenetics, 2011). It is evident that this is a big improvement of the random strategy, however, wielding this strategy alone is not optimal yet.



To understand the next strategy fully, we first need to introduce some terminology. If we consider the index of the rows $i = 1, 2, ..., 10$ and the index of the columns $j = 1, 2, .., 10$ (in the game itself, the column indexes are $j = A, B, ..., J$, let's assume for simplicity that the columns have a numerical index), then the coordinate that we bomb is (i, j).

Furthermore, we know that a ship has a length of at least two units. This means that if we would 'hunt' in only 50 of the coordinates, namely the coordinates where $i + j = 2n$ where $n \in N$ (the white squares in the picture), we would

still hit all the desired targets eventually in the 'hunt' strategy. With the help of the 'target' strategy, all ships will be sunk. This means that the set of coordinates that can be targeted randomly is reduced by 50 squares. We call this the parity strategy. This strategy, when wielded in combination with the 'hunt and target' strategy, again leads to a small improvement: when playing 100 million games, the approximate median for n is 63 shots (as opposed to the 96 shots we found before) (DataGenetics, 2011). Note that if you get lucky and sink the smallest ship of two units, you can 'hunt' for the coordinates where $i + j = 3n$ where $n \in N$, furthermore improving the required amount of plays to find a different ship. Obviously, this tactic is applicable as well if you have sunken all the ships with length three or fewer units, etcetera. This improved parity strategy is a special case of the next tactic.

This last strategy is called probability assessment, which basically means that you assess whether a certain ship has a high or low probability of being on a certain coordinate. When starting a new game, this strategy is hardly useable yet, since thus far you have not acquired any information about where a vessel could be (the vessels could be everywhere). But as the game progresses, you can use this strategy more often. Let's assume you have sunk all ships of two and three units, and you have a space of three units between two already fired torpedoes. Now there is a probability of zero that a leftover ship is in this space since their lengths are larger than the length of the space. Also, if you have an area where no torpedoes are fired and a different area where a lot of torpedoes are fired, then there is a higher probability that there is a battleship in the area with little torpedoes than the area with lots of torpedoes. Wielding this probability assessment strategy in addition to wielding all the previously mentioned strategies, the approximate median for the number of shots fired n is 43, a serious improvement. When applying these strategies correctly, it is very difficult for your direct opponent to beat you in one game, let alone when using an overall score of multiple games, which is the case this game night.

After playing multiple games of battleship, you have utterly destroyed your father, leaving him with mixed feelings about whether he should have left you at an orphanage all those years ago. You move to the Nekst (pun intended) game.

The next game is rock, paper, scissors. Unfortunately, your sister is sitting at that game. Although she is not that bright, even she can understand this game: the players count down using the verse 'rock, paper, scissors', and at 'scissors', they have to choose between one element in the set rock, paper, scissors, showing the corresponding hand-signs. Scissors beat rock, rock beats scissors, and paper beats rock. If there is a draw, the game is played again, until some player wins.

Maybe some game theory will help us when dealing with the problem of finding an optimal strategy. You are player 1 and your sister is player 2. We denote $\pi_i(x) = 1$ if player i wins, $\pi_i(x) = 0$ if there is a draw, and $\pi_i(x) = -1$ if player i loses, $\forall i \in 1, 2$. The payoff matrix of a game of rock, paper, scissors is:

You \ Your Sister	Rock	Paper	Scissors
Rock	(0,0)	(-1,1)	(1,-1)
Paper	(1,-1)	(0,0)	(-1,1)
Scissors	(-1,1)	(1,-1)	(0,0)

Notice that there is not a Nash equilibrium in pure strategies. If (Rock, Paper) is played, then you have an incentive to play scissors, but then your sister has an incentive to play rock, ad infinitum. Maybe there is a Nash equilibrium in mixed strategies.

Let $p = (p_1, p_2, p_3)$ be the probability vector that you choose rock, paper, and scissors respectively, and let $q = (q_1, q_2, q_3)$ be the probability vector such that your sister chooses rock, paper, and scissors respectively. Now your payoff is $\pi_1(p, q) = p^T Aq$, where A is the payoff matrix of player 1. When optimizing this $\pi_1(p, q)$ with respect to the choice op player 2, one will end up with the probability vectors $p = (1/3, 1/3, 1/3)$ and $q = (1/3, 1/3, 1/3)$. Now the strategy profile (p, q) is the Nash equilibrium in mixed strategies of rock, paper, scissors (Cornell University, 2014).

This means that according to game theory when playing a finite game, the best you can do is play rock, paper, or scissors each with a probability of $1/3$. However, there is one issue: we can not assume our game is finite. A round of game night continues and continues until all games are played multiple times, and a few games of battleship take a whole lot longer than a game of rock, paper, scissors: it is unclear when the game will end, hence we will assume that this game will be repeated infinitely.

Now an entirely different game unfolds. Since players play the game multiple times, the players have the opportunity to react to the actions of their opponent. It has been shown that when playing an infinitely repeated game of rock, paper, scissors, winners tend to repeat winning strategies, and losers tend to switch strategies when they lose a game (Wang et al., 2014). This chosen strategy has the largest probability of being the strategy that would have beaten the strategy their competitor played in the previous game. This is called a conditional response in game theory terminology. For example, player 1 wins a game playing rock, while player 2 played scissors. It is statistically most likely that now player 1 will play rock again, while player 2 will switch strategy to paper.

Hence we arrive at our final strategy you will use to destroy your sister: the so-called conditional strategy. The first game

has to be played at random since we have no information yet of previously played games. It's a $1/3$ probability that you either draw, win or lose. When losing, it is statistically most likely that your opponent plays the previously played strategy again. Your optimal tactic will now be to play the strategy that will beat the strategy that player 1 plays. Conversely, if you win the game, player 2 will most likely play the strategy that would have beaten your strategy next game. This means that you should play the strategy that will beat player 2's future strategy - thus playing the strategy that player 2 played in the previous game will be optimal. When wielding this conditional strategy, your chances of winning rock paper scissors will increase by 10% (Wang et al., 2014), a significant amount.

Note that this strategy is only valid if your opponent does not know that you are using this strategy: he could then play his moves such that he would always respond optimally to the conditional choices. Fortunately, since your sister is not that smart, we can assume that she will not figure out your tactic.

After what felt like an eternity, this round of the game night ends. With a very positive win-loss ratio, you leave, quite satisfied. This round has not been as fun for everyone; your sister has started to scroll her Instagram timeline out of pure frustration. Let's move on to the last game of the night.

It is time for *Guess Who*, and your mother is waiting for you. She is a real master in this game - you know that, even without her having a strategy - she always wins. Your only chance to win is to find the ultimate strategy in order to beat her random skills.

You both flip your cardboards to get all the characters standing and draw your mystery persons. When all is settled, the battle begins. Since you are the youngest (you play with your mother, so I hope you are), you may begin. Alternately you ask closed questions to each other about physical characteristics of the characters such that, when getting the answer, you can eliminate characters and end up with a final question which will be "Is [enter name] your mystery person?". If your guess is right you win, if it is wrong you lose.

As you closely look at your cardboard, you rapidly see that in this $3x8$ grid with 24 characters (yes, I am giving you the math), each character is different and has his own characteristics. And what is remarkable is that, as each characteristic applies to around five characters, this game is made for narrow questions . We can thus assume that your mother will, without thinking about it, play the narrow question strategy. This strategy is also called the naive or optimistic strategy, your mother is hoping that you have a character that is most convenient to her. According to Mark Rober, who thanks to an algorithm played 625 games of guess who, your mother will have to ask around seven questions in order to determine your mystery character. But you are smart enough and know that you can use math in order to win in less turns.

It is already obvious for you that the most important thing is to ask questions that will optimize the amount of people left on your board, which will hopefully each time result in the elimination of half of the characters. The expected number of people left on the board can be easily computed, let's take an example. The expected number of people left when you ask "does your character wear earrings?" is the following:

$$\begin{aligned} E[\text{earrings}] &= \binom{\text{characters}}{\text{earrings}} \cdot P[\text{earrings}] \\ &+ \binom{\text{characters}}{\text{no earrings}} \cdot P[\text{no earrings}] \end{aligned}$$

Giving us:

$$E[\text{earrings}] = 2 \cdot \frac{2}{24} + 22 \cdot \frac{22}{24} = 20.3$$

So if the first question you ask is about the earring, the expected number of people left will be a bit more than twenty compared to a bit more than twelve if you ask about a big mouth.

Your question choice is therefore really important. When you halve the amount of characters left each time you go from 24, to 12, to 6, to 3, to 2 or 1, to finally only one character left on your board. Hence you will win one third of the time in five guesses, two thirds of the time in six guesses. But what questions are best to ask? This matter is all about decision theory.

Even though this seems like cheating, you can ask compound questions. For example, you can ask if the mystery person of your mother has ginger or white hair or if they wear

glasses. This way, you eliminate exactly twelve characters. In the instructions it is only written you must ask yes/no questions. This is just like cheating within the rules ;). Another strategy would be to begin with the question "Does your mystery person's name begin with the letter A-G?". This way you again eliminate half of the characters.

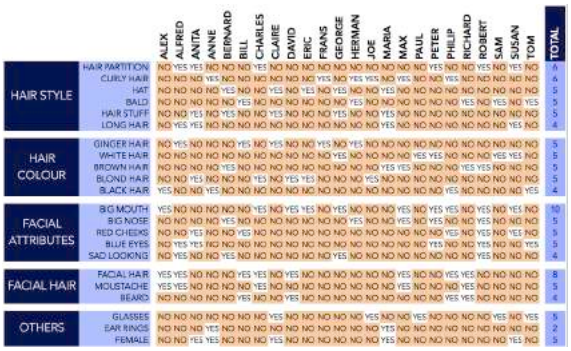
QUESTION ASKED	CHARACTERS WITH THAT ATTRIBUTE	EXPECTED NUMBER OF PEOPLE LEFT
EAR RINGS	2	20.3
LONG HAIR	4	17.3
BLACK HAIR	4	17.3
SAD LOOKING	4	17.3
BEARD	4	17.3
HAT	5	16.1
BALD	5	16.1
HAIR STUFF	5	16.1
GINGER HAIR	5	16.1
WHITE HAIR	5	16.1
BROWN HAIR	5	16.1
BLOND HAIR	5	16.1
BIG NOSE	5	16.1
RED CHEEKS	5	16.1
BLUE EYES	5	16.1
MOUSTACHE	5	16.1
GLASSES	5	16.1
FEMALE	5	16.1
HAIR PARTITION	6	15.0
CURLY HAIR	6	15.0
FACIAL HAIR	8	13.3
BIG MOUTH	10	12.3

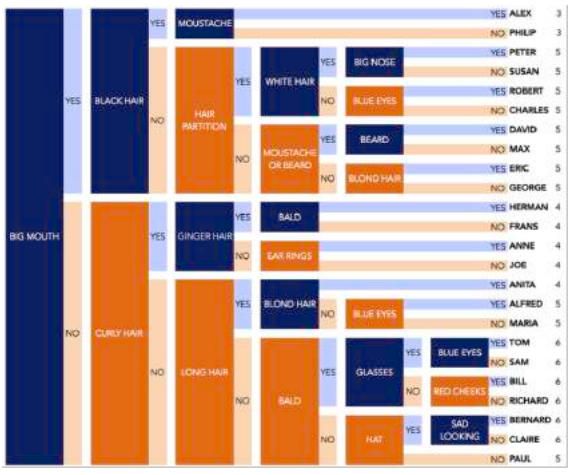
The problem with these two methods would be that they are really obvious. Your mother may not be the smartest, but your intelligence does not come from nobody. If she plays the game with the same strategy, you are back to winning with a chance of 50 percent. So what would be the best question to begin with? Well - according to Rafael Prieto Curiel - you need to take the question which has an expected outcome of characters left as close as possible to half of your characters remaining on your board. For the first question, half of the characters would be twelve. This question would be "Does your mystery person have a big mouth?". This way you concretely ask something about a characteristic without giving your mother doubts about a special strategy.

Looking at the table it seems a logical step to then ask about "facial hair". Yet the problem is that all characteristics are correlated and hence you can use the table only for the first question and must then compute it all again. Playing this game asking broad questions but without thinking about the correlation would be better than using the naive strategy but is far from optimal. It is important to think a few steps ahead because some questions may halve your characters but leave you only with terrible follow up questions.

To wrap this up, the best way to play this game is to ask questions that lead to an expected number of people left as close as possible to half of the characters remaining on your board. By doing this you will win around 80 percent of the time if your mother does not play the same optimal strategy. And to make this better, if you play multiple times, your chances of winning increase according to the law of large numbers and you will, if you play indefinitely, win with 96 percent confidence.

You made it! You are the big winner, the game master of the night, the overlord of the house. But while you are calling all your nerd friends to share your victory, your family is plotting against you. This is the end of the board game nights, it is no fun like this. Nekst time you will have a different game night, namely 'just dance' this way. Your math brain will not get in the way... or will it?





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Is there life …
… after student life?

Some questions you might ask yourself, while you are enjoying your student life, are "What is next after my student life?", "How is it like to work full-time?" and "Do I still have time for my friends and myself?". From my personal experience I can assure you that even after a wonderful student time, working full-time as a graduated econometrician is not bad at all. Currently, I am working as a Management Consultant at Capgemini Invent, where I started almost two and a half years ago. I started with my internship where I wrote my thesis, and continued working as a consultant in the same team. Until this point in time I was a full-time student, probably just like most of you who are reading this right now. During my student life I was an active member at Asset | Econometrics, with the peak during the academic year 2015-2016, where I was part of the board as Internal Affairs. The goal for me in this article is to tell my story of how I decided to become a Management Consultant and what kind of professional life you could possibly have after your time as a student. I am also trying to answer the question what kind of skills I learned as a student that are still useful today.

Before I started at my current job, I had other opportunities to experience what it is like to work (part-time) and have responsibilities that come along with it, apart from the obvious fact of earning some extra money to finance my beers. I started at a small data science start-up, where I had a great time learning "how to bring econometrics into practice" and working in general. After one and a half years I started my Master's and took a break from this part-time job to fully focus on my studies. However, after the first quarter of my Master's I again had some time left. Through a friend I applied at a medium sized company (200 employees) as an internal data scientist. For me this was a nice experience to take a look behind the scenes of another company and gain extra working experience. After these jobs I decided that I only missed out on the professional experience of a 'big' company, so I decided to apply for an internship at Capgemini Invent. After this internship I made the decision to stay since I thought that a bigger company was a better fit for me.

Before I continue explaining what experiences of my studies and Asset | Econometrics still benefit me today, I want to briefly explain what a Management Consultant does in general. The goal and project of a typical Management Consultant is to help your clients improve their performance by improving their processes. These improvements are often achieved by identifying organizational problems, analyzing the root causes of these problems, proposing different kinds of solutions, and potentially helping them with the implementation of the solution. Let's illustrate this by an example of a project I have worked on. The organization in question had a typical problem that I face in my day-to-day work: "an organization could have the desire to improve their data quality". In this case we first need to identify the motivation of the client as to 'why' they want to improve their data quality and in which instances it is especially important. This helps us better understand their problem and 'scope' the project, meaning that we can focus on the most important part first. Together with the scoping phase we can analyze their current situation, by charting their data flows. And

Björn Floor

Graduated Master QFAS

Age: 27

then identify which data quality checks they have in place, which data quality checks are missing, and propose solutions on which checks to implement.

I want to emphasize that this is a very specific example of a project. As a Management Consultant you work on a wide variety of projects.. But in these kinds of projects my expertise as an econometrician can be very convenient. The reason for this is that during this project I worked with a lot of data, and as an econometrician you are trained to think carefully about the characteristics of data. Furthermore, the analytical method of solving problems taught at our studies is very important in typical projects. Besides the gained technical skills, the 'soft skills' I learned when being part of several committees at Asset | Econometrics are priceless as well. During projects it is important to set up frequent formal meetings with the project team, client, and experts within your own organization about this topic. As a starting consultant it is beneficial to have skills in agenda using, making & sending minutes, and chairing a meeting.

Another skill you develop during your time as a student when being part of an association, is 'networking'. I know that this term sometimes has a negative connotation, since it might sound like 'abusing' your relationships for your own gain only. During your studies you probably all have used your network. For example, when you needed to do a difficult assignment, you probably collaborated with your fellow students or asked older students to help you out when you could not solve a difficult question together. Therefore, I see the skill of 'networking' more like building a good relationship with the people you like spending time with. And when you face some difficult challenges you do not have any experience with, you might ask this relation for help. This relationship comes from both directions, where you are also ready to help them out with your expertise.

Before wrapping up this article I want to illustrate the possible applications of econometrics using a project I personally did in the consultancy world. During my time as consultant, I developed a sustainability rater to predict the sustainability of a company together with another colleague. The idea of this project was to use text from companies' websites to make predictions on how "sustainable" a company is. To realize this idea, we first had to gather our own data set, by identifying sustainable and non-sustainable companies. We extracted the data from the websites, processed this data, trained the NLP (Natural Language Processing) model, and eventually gave an individual score to each company in our test set using the programming language Python. In this project, the experience as an econometrician helped me understand and interpret the results of the NLP model and act accordingly.

Hopefully I have clarified the opportunities as a graduated econometrician by sharing my experiences. I hope you know better on how your skills as an econometrician could be applied, but also how your gained skills as an active member of an association could benefit you in your professional (future) career. Nevertheless, I understand that you still might have some questions. You can always contact me to have a cup of coffee in case you have any!

Hard times in Prague

After a long time of waiting, the Europe trip finally took place on November 11 till November 15! We traveled with a group of thirty people to Prague, the capital of the Czech Republic. When the WiFi network let me down when I wanted to subscribe, I was very happy to hear that I was number 29 in the subscription list and could join the trip. In my first year of being a student almost everything was online. So, this trip was also the perfect opportunity to meet some new people.

On the day of departure, we gathered at the central train station of Tilburg to go to Eindhoven Airport. When we arrived at Eindhoven Airport we had to wait for a while before getting on the plain. Then finally the trip started on November 11. As you might know this day is also the beginning of carnaval as most of you know. Even though we could not celebrate it in the pub, we still wanted to do something. ... So, the day before some people came up with the idea to have a toast at 11.11 hours. Unfortunately, we were waiting in line at that time, so we postponed it to 23.11 hours.

When we arrived at our hostel at around 15.30 hours and everybody was done choosing their bed, we went to the beer museum. The highlight of this museum was of course the four craft beers we got afterwards. After the beer museum we went to a cozy restaurant where we could enjoy a delicious meal. When everybody was finished, the pub quiz started and everybody had a lot of fun. Afterwards, we went back to the hostel to get ready for our first night out in Prague. The hostel advertised an evening of 'two hours open bar' for only €4 and we took that chance immediately of course. It is safe to say that our first night was a great success!

The second day started with a city tour. We had an amazing woman as a guide. Even though it was extremely cold and a lot of us had a hangover, she tried to make the best of it. We stopped at different spots where she told us about the meaning and the history of it. I immediately fell in love with the city! When the tour was over, we had some free time where we got some lunch and walked over the Charles Bridge. Afterwards, we played glow golf. In the evening we went to a restaurant where we enjoyed our second dinner in Prague with a glass of wine. After dinner we went back to the hostel to drop off our stuff and get ready for the pub crawl! During the pub crawl, we went to a five floored discotheque, which was the most amazing club I had ever seen! It was amazing.

The third day started with a visit to the St. Vitus Cathedral. After a tough climb which included walking a lot of steps, we finally arrived and could enjoy the beautiful view. Once we arrived, we were free to go wherever we wanted to go. Later that day we met each other again to go on a boat trip. We got the chance to dance and everyone had a really great time. After the boat trip, everybody went their own way to get something to eat and rest a little bit. Later that evening we all went to the karaoke bar where we all sang as good as we could. I lost my voice the day before so I tried my best, but you could not really hear me while I was singing. Luckily you could turn up the volume on each microphone so that made it better. Most people ended the evening at the club with the five floors again.

Our last full day of the trip began by visiting the zoo. Almost everybody joined, but someone overslept, missed the train and therefore missed the zoo unfortunately. After seeing a lot of animals, it was time to go back to the city. One person was not paying attention when we had to enter the bus to the city and was too late to get in. Luckily there were multiple buses driving back so after only 5-10 minutes he could get onto the next one.

On our last night I went to the city with some people and got a souvenir. We also got to see the famous clock that moves every hour. It was not as much f

Eva Schoenmakers

Bachelor EOR

Age: 20

fun as we all hoped but like our guide told us, if you have not seen the clock move, you have not really been to Prague.
We ended the night in a cocktail bar where I first watched the Formula 1 race and after that socialized with everyone. It was a great last night with a lot of different cocktails. We ended with a bucket of mojitos, which was mostly filled with ice cubes. Despite my straw not working, it was still fun to watch everybody fight over a little sip. It was a great last evening!!

On Monday we had to leave very early to fly back to the Netherlands. Sadly, the trip was over. But the good news was that we could all go to sleep on the flight! It was an amazing trip with a lot of great memories!

I want to thank the Europe Trip committee for organizing this amazing trip and the rest of the group for making this a trip we will never forget!

Math, sports and a lot of lecture videos

written by **Tijn Scholten** and **Timo van Oorschot**

This edition's The Teacher is about Erwin Charlier. Some of you may not know him yet, since he teaches a third-year course. Even if you already know Erwin, you may not know anything from his past. That is why we decided to go and interview mr. Charlier and ask him questions about his student life, working life and spare time. Erwin even provided us with some inspiring advice that may help you in your career. So do not hesitate, and continue to read our interview with Erwin Charlier.

Student life

Erwin Charlier started studying mathematics at Eindhoven University of Technology. He particularly enjoyed the part of the study in which he applied his knowledge to real life models, and especially the economic models. During his studies, he had the opportunity to follow an econometrics course, which triggered his interest. So when he found out that there was a partnership with Tilburg University, he started to study at both universities. This gave him the opportunity to follow some additional econometrics courses in Tilburg and write his Master thesis about econometrics. After that, he started his PhD at Tilburg University.

Erwin followed his studies while living at his parents' home, during the first years. Still he liked to be involved with student activities, which is why he got involved with the student futsal association ESZVV TotelLos in Eindhoven. However, due to a physical injury he had to stop with this. When Erwin went to Tilburg University, he decided to move to Tilburg, in which he still enjoyed doing lots of sports at the sports center, and next to that he enjoyed cycling. When Erwin thinks back about his student life, he is overall content about the choices he made during this time.

Half a day at Tilburg University

We were interested in how Erwin ended up teaching for half a day at the university and what he does for a living the rest of the week. He told us that he wanted to continue his academic career after studying, but later he felt like he wanted to put his academic skills to use in the business world. So after defending his Ph.D. thesis, Erwin started a full-time job at APG, the asset management company of the Pension Fund for Public Employees in The Netherlands (ABP). Here he managed the asset and liabilities. However, he also wanted to publish the chapters of his thesis by working on them during his spare time. This didn't seem to be a good idea, and so he decided to go back to work at the university for one day a week. After publishing the chapters of his Ph.D. thesis, he went on to investigate some new topics. However, this also has its problems according to Erwin, as it takes quite a long time between starting research and publishing. That's why he chose to fully dedicate to teaching courses and supervising Master students when writing their thesis. Currently he teaches the Bachelor course Data Analytics for Non-Life Insurance.

After working for APG, Erwin switched from asset management to a job at the ABN-AMRO bank, which he found interesting as it was at that time an international bank. From this he learned a lot, but it had to stop its international activities. After his time at the bank, he worked at the insurance company SNS Reaal, which was interesting as it was a combination of a bank and an insurance company. But this company had to be split as well, and he took a job at the insurance part, the name of which is currently ATHORA Netherlands (with Zwitserleven and Reaal as the main brands). He really enjoys working on the modeling of the liability part of the balance sheet, which mainly consists of life insurance products. Next to that he still works at the university on Friday mornings.

"In my case, this is my passion for mathematics and I got a lot of energy from becoming good at it, but I also broadened my scope",

Way of teaching during COVID

We were also interested in how Erwin approached teaching with the COVID-measures of the last (almost) two years. Whereas some teachers taught their lectures live via a Zoom call at home or at an empty classroom, Erwin decided to do it differently. He made some shorter recordings beforehand in which different parts of the teaching material were discussed. Afterwards, he organized a weekly Q&A session about the discussed material to still have a moment of live contact with the students. This pleased both Erwin and the students quite well as it was a relaxed way of teaching (although it took him quite a lot of time to properly construct these recordings). Another advantage of this was that he could record these videos whenever he wanted. As his lecture was scheduled on Friday mornings at 8:45, when he is "not at his best" (neither are most students probably), this did work out well. However, he prefers classroom teaching: "Teaching in a full classroom is much more pleasant in terms of contact, asking questions and having a chat with the students during the break", he explained. Fortunately, teaching on-campus was possible in September and October last year and he hopes that the situation around COVID will quickly improve. At the moment, if it comes to hybrid teaching, he is well prepared as he can teach his lectures at university and provide students in quarantine with the recordings he made.

Advice for students

After Erwin told us about his career path, we were wondering what his advice would be for students who want to follow a similar path. For example, what skills do they need? The ability to use different kinds of arguments in discussions and empathy with stakeholders are skills that are key to future success, he thinks. But, what he thinks is the most important is that each student follows his passion and becomes very familiar and good at it, which is easier because a passion is something a student really thinks is interesting. "In my case, this is my passion for mathematics and I got a lot of energy from becoming good at it, but I also broadened my scope", he explained. He told us he thinks that once students follow their passion, they can achieve a lot as it keeps their future job challenging and interesting. However, once students lose interest in a certain topic or job, he would advise them to broaden their view and to find another path which is more engaging.

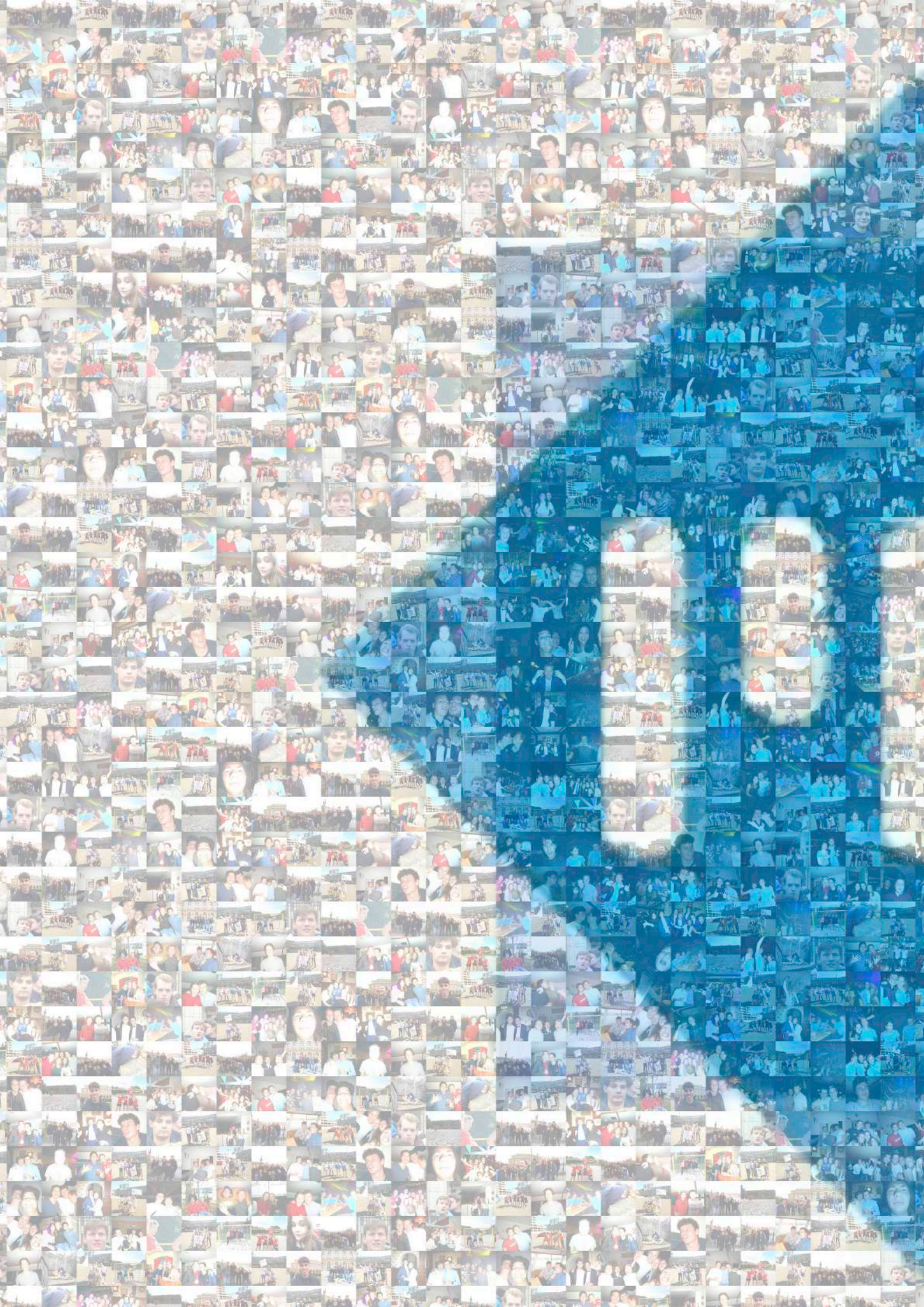
Spare time

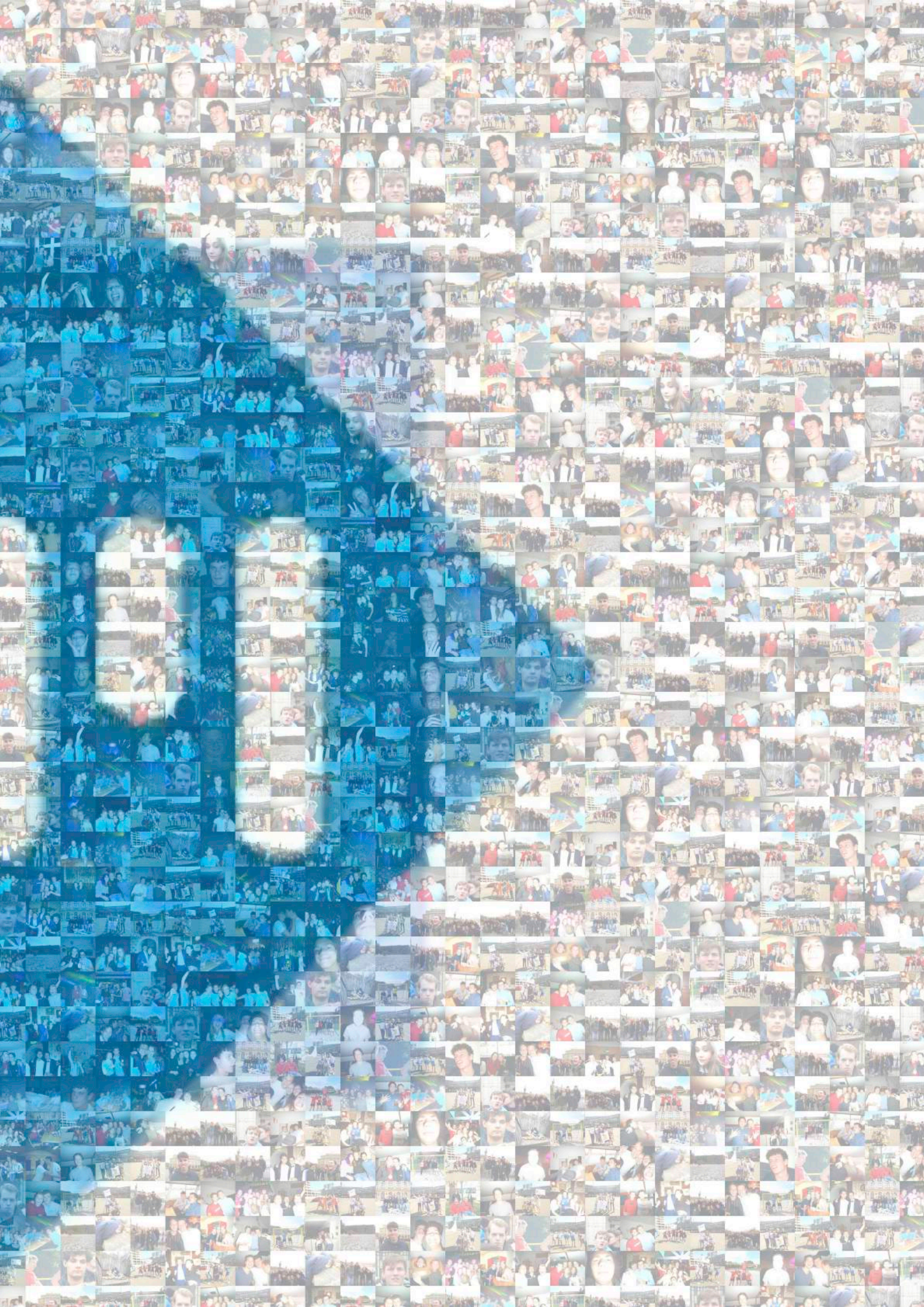
When asked about Erwin's hobbies and leisure activity, we discovered that he is quite into sports, both watching them on TV and doing them himself. When he has some free time, he likes to grab his racing bike for a ride or watch some cycling or football on the TV. He also uses his spare time doing fun activities with his family, like going on a holiday. Ever since the COVID-19 measures were applied, he also goes for walks more and more, as a break from working at home. He is a person that sometimes likes to spend his time alone (when cycling for example), but always has room for a good time with people around him.

Erwin Charlier

Bert & Ernie Questions

Bert or Ernie	**Ernie**
Tilburg or Eindhoven	**'s Hertogenbosch ;)**
Asia or America	**America**
Teaching or research	**Teaching**
Theory or practice	**Practice**
Speaking or listening	**Listening**





... Copenhagen!

written by **Roel Delescen**

The Greetings from... of this Nekst edition is a little bit different from usual. Where normally a student that is on an Exchange shares their experiences, we now did an interview. This interview is with Tom Pfeiffer, a 3rd year bachelor student from Tilburg university who went to Copenhagen, Denmark for the last four months. He is back in the Netherlands since this week, but would like to share his experiences from the last few months.

Hi Tom, how are you doing?
I am doing great, Thank you!

Were there other people you already knew who also went to Copenhagen?
No, I did not know anyone who was going to Copenhagen with me. This made it scary in the beginning but afterwards I'm glad. You noticed that the people who went on Exchange with friends from home were less open to meet new people.

Did you live with other people that were on Exchange and where did they come from?
I shared my kitchen and bathroom with two other students. One from Denmark and one from China. Therefore, I unexpectedly learned a lot about Chinese culture and especially about Chinese food during my stay!

Were the friends you made Dutch students, or were they from other countries?
One of my very good friends came from the Netherlands and studies in Tilburg as well. I didn't know him before my Exchange to Copenhagen. The majority of my non-Dutch friends came from Western Europe. I think it is due to COVID that there are less people coming from outside of Europe.

How were the courses in Copenhagen, were they easier relative to the courses on Tilburg University?

The courses that I followed are almost comparable in level to the courses in our Bachelor's program. You have the freedom to take courses at other faculties. At the faculty of Economics you are even allowed to take Master courses as a Bachelor student, so you have a lot of choice. The majority of courses I picked where about 'time series', which I think is very interesting.

What did you do in your spare time?
From my shortlist of favourite destinations, I chose the place that gave me the most certainty that my exchange would take place and also where I would probably have the least restrictions. There were no COVID-19 restrictions in Denmark for the first 3 months of my stay, life was completely normal. So, in my spare time I enjoyed the many bars and clubs that the city offers, visited theatres, concerts and several football matches. Besides discovering Copenhagen, I have also made trips through Scandinavia. One of the highlights was when we took a boat to some nearby islands of Gothenburg, Sweden, where we caught our own oysters and ate them at a beautiful sunset. Another highlight of my trips was the Norwegian fjords. I took a beautiful picture about two hours north of Bergen, Norway, which you can see here.

How was Copenhagen as city relative to Tilburg? Are there big differences?
Copenhagen really has a mixture of very beautiful old buildings like at the very famous Nyhavn. It however is also well known for its innovative architecture. A very good example of this is CopenHill, a Waste-to-Energy plant which has an artificial ski slope on top of the building.

What did you like the most from Copenhagen?
There is a certain vibe in Copenhagen that is hard to describe, but you have to experience it for yourself. It is a big city, but it is less chaotic than other big cities and even in the most crowded and touristy places, the normal life of the inhabitants takes place, whereas in other cities these places are often avoided. It really is a city that lives, with bars and places everywhere where people enjoy the simple things in life, known in Denmark as 'Hygge'.

Tom Pfeiffer

Bachelor EOR

Age: 21

Would you recommend an Exchange to Copenhagen to other EOR students?
In general, if people are considering an exchange, I would really recommend going on an Exchange and I'm convinced that you will have a great time regardless of the destination. For people that are particularly interested in the Northern countries, in my opinion Copenhagen is the best city to live and still gives you the opportunity to travel around the beautiful nature that Scandinavia has to offer.

Are you happy to be back in Tilburg?
Yes, I am happy to be back and see my friends and family again, taking with me great memories from the past few months. But to be honest, I think I could have stayed in Copenhagen for a few months longer if it was possible. ●

Bipartite Graphs

René Peeters
is dairy farmer and part time assistant professor in mathematics and operations research. He is specialized in disrete mathematics, in particular in algebraic graph theory and combinatorial optimization.

I do not like Christmas very much. I hate Christmas songs on the radio and at the age of 54 I still do not see the point behind the yearly Christmas card terror. And although I like food, I feel a bit anxious as soon as people start to talk about Christmas dinners. Fascinating to see how people can turn a daily habit into an unsolvable scheduling problem. At first I thought this would be a perfect topic for this column, that I write before Christmas and you read after. However, since this is a magazine for econometricians and you expect me to write columns with a mathematical or agricultural twist I decided to concentrate on bipartite graphs.

I was introduced to bipartite graphs in the first trimester of my study (Technical) Mathematics in Eindhoven during the course Discrete Mathematics 1 when we discussed the theorem of König and Hall. I have remembered this theorem ever since because the popular version of it is called the marriage theorem. In this theorem the vertices of the bipartite graph consist of men and women and there is an edge between a man and a woman if they would be willing to marry. The aim is to find the largest possible number of disjoint couples. The theorem states that this maximum number is equal to the minimum number of persons that cover all possible marriages and the proof consists of an algorithm that finds both. For the single young man that I was back then, this was a fascinating result. Since I realized that all persons in this minimal set will marry in case of a maximal matching I determined my strategy to focus on rival-free girls. Of course these girls typically have a lot of imperfections but that means that you do not have to bother about your own either. Furthermore it is a much nicer experience to find out later that behind all these imperfections there is still some unexpected beauty hidden, instead of being confronted with major shortcomings hidden behind beauty.

For the second example of bipartite graphs I first want to look at the (trivial) mathematical part. When for a bipartite graph you want to determine the average degree of the vertices in each of the two co-cliques, you just have to divide the total number of edges by the number of vertices in that co-clique. So if the two co-cliques have (more or less) the same size, also the average degrees should be (more or less) the same. This was what I had in mind when I read about a research by psychologists that determined the average number of sexual partners for men and women. In their research women scored considerably lower than men and although they talked about a double standard and men and women lying in opposite directions, they totally seemed to have missed the fact that these averages should be more or less the same. My point is: I understand that all the kids that scored bad grades for math at school should finally get some position such that they also can contribute to society, but something went wrong here.

I want to end with the Christmas issue I started with. When you finally found your partner with or without my advice you automatically also get his/her family with it, meaning that you are supposed to show up together at two Christmas dinners. At first sight it seems to be enough to have the two Christmas days to plan these dinners but then you forget all other couples that put on similar constraints. What you try to do here is coloring a graph with two colors, however this is only possible if the graph is bipartite and of course not all graphs are. Now try to explain this to your parents in law if these are for instance psychologists.

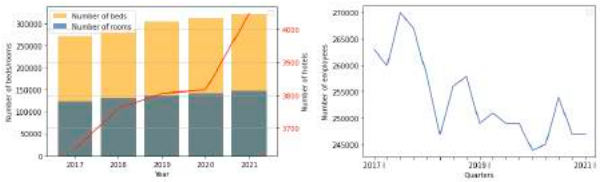
Good luck! ●

Robust optimizing the employee composition within the cleaning branch

In addition to that the facilities in a hotel are important, guests will always find it important that the room and common areas are always clean. As a result, it is important that the cleaning companies contracted enough employees so that everything can be cleaned. However, too many own employees leads to a too large cost. In this article you will find out how the optimum employee composition can be calculated and where each employee has to work.

Background

Since COVID-19 is already two years among us, the cleaning branch has only become more important in the fight against COVID-19. The cleaners also ensure that the risk of transferring the virus is as small as possible. As a result, there are enough cleaners needed. Only now the number of employees in the cleaning industry take off and the number of hotels only rises.



(a) Growth of the hotels in the Netherlands (CBS 2021a)

(b) Number of employees working in the cleaning industry (CBS 2021b)

Figure 1: The increasing workload in the cleaning industry

This only results in crowded market.
This makes it only more important to properly predict and deploy the number of employees required. This is done on the basis of two performance measure:

- The cost
  The total labour cost must be minimized. As a result, fewer temporary workers will be deployed, because they have a higher hourly wage.
- The demand
  Of course, all the necessary cleaning tasks must be done. Due to the shortage on the labour market, sometimes temporary workers have to be hired.

From this we can establish the following problem statement of this article:

- How many hours of labor is needed to meet the expected demand?

Here are the follow-up problems that will be answered given the models in this research:

- Whether it is necessary to invest in a larger workforce.
- Whether it is profitable to deploy more temporary workers.
- Determine in which hotel which employee should work, given the demand.

This is all done, to obtain the optimal employee composition.

Two-stage problem

Since this problem needs to be solved for all hotels in the Netherlands, the problem can be better shred into a two-stage problem. In the first stage, the number of permanent employees is determined what is then used in the second stage where employees are scheduled at hotels.

First stage

As indicated earlier, the optimum employee composition is determined in the first stage. This is therefore considered how many permanent employees must be under contract and consequently how many temporary workers have to be deployed per period. This period (τ) can be a period per day, week or month. It is therefore important that the predicted demand per period is also accurate.
Therefore, nine different distributions are fitted on the total demand per period.

Over all these nine fitted distributions the Chi-Squared test is carried out, all this to see what distribution best predicts the question.

The best distribution with the best score is used to predict the demand per period $\tilde{b}_\tau$. This question is then used in the following model where it is made between how many permanent employees must be used (xp_n) with contract type n and how many hours temporary workers must be used per period (xt_τ).

$$\min_{xp,xt_\tau} \sum_{\tau=1}^{\mathcal{T}} \sum_{n=1}^{N} cp_n \times xp + ct \times xt_\tau$$

$$\text{s.t.} \sum_{n=1}^{N} AP_n \times xp_n + AT \times xt_\tau = \tilde{b}_\tau \qquad \forall \tau \in \mathcal{T}$$

$$xp_n \in Z_+^n \qquad \forall n \in N$$

$$xt_\tau \in Z_+ \qquad \forall \tau \in \mathcal{T}$$

Where cp_n is the periodic cost per employee hired with contract n, ct is the hourly wage of temporary worker, AP_n the availability per period τ per contract type n and finally AT the (minimum) amount of hours a temporary worker must be deployed each time.
Note that this code can be run for different cluster of hotels. For example, it can be carefully considered in which areas people have to be hired and in which areas there are too many people under contract.

Second stage

In the second stage, employees are scheduled at the hotels so that the total costs are minimized and the demand is met per day.
In addition, a number of constraints have been drawn up so that the collective labor agreement is not violated. For example, this states that an employee must work a minimum of four hours a day and a maximum of nine hours.
Another important labor rule is that the employee must be given a base location. The base location is the hotel to which an employee is linked. If an employee works at another hotel a bit further, in distance, than his base location, then the employee is paid for the kilometers that are made more than the kilometers from his home to his base location.

This constraint is very important within the cleaning industry. This is because if another cleaning party takes over a hotel-contract, in terms of cleaning tasks, the new cleaning party must also take over all employees who had that hotel as their base location.
If employees have the wrong hotel as their base location, it is possible that the cleaning company will remain with too many or too few employees after taking over a hotel.
Since this constraint is important, the constraints implemented for calculation the base location B_k of employee k is given by:

$$B_k = \arg\max_j \left\{ \sum_i X_{i,j,k} \right\} \qquad \forall(k) \qquad (1)$$

$$U_{k,j} = \max \left\{ D_{k,j} - D_{k,B_k}, 0 \right\} \qquad \forall\,(k,j) \qquad (2)$$

$$D_{k,B_k} <= 30 \qquad \forall(k) \qquad (3)$$

The first constraint (1) determines for each employee k how many times he has worked on location j. Here, the location where the employee has worked most is taken as the base location. Where,

$$X_{i,j,k} = \begin{cases} 1, & \text{if employee } k \text{ has worked on day } i \text{ at location } j \\ 0, & \text{otherwise} \end{cases}$$

Constraint (2) calculates the difference in distance that has to be paid if the employee works at a hotel which is further away then his base location.
Finally, constraint (3) fixes that the distance from employee k to his base location B_k is no longer than 30 kilometer.

Two-stage solution

Because the second stage problem is still too big to solve in one go, it has been decided to optimize every four weeks. However, in the cleaning sector, an employee is allowed to work more than his contract in one period and less than his contract in another period. Because the model is now optimized every four weeks, we have to introduce an extra parameter for this:

$TVT_{pd,k}$ =How many hours employee k has worked beneath or on top of his contract until period pd

Such that we can introduce the following heuristic:

Algorithm 1 Pseudo code of the minimizing the cost over one year

Result: Minimizing the cost over one year

Start with optimizing the first four weeks period
for *Each optimized period of four weeks* **do**

1. Update $TVT_{pd,k}$, such that we know how much TVT each employee has.
2. Start optimizing the next four weeks separately, with model 3, with this new parameter and raise the period pd with one.

end

With this heuristic we therefore have the option of deploying employees less in one period and more in another period. However, it may still be the case that an employee has worked more than his contract hours at the end of the year. This is due to the fact that a parameter O_k has been introduced for each employee. This parameter means what percentage an employee is maximally allowed to work more than his contract per period. All this to ensure that an employee can also work overtime during the first period. If the balance of $TVT_{pd,k}$ is positive at the end of the year, the employer must pay an additional fee for these hours. Hence, the following heuristic is used to ensure that there is no overtime at the end of the year for any employee.

Algorithm 2 Pseudo code of the minimizing the additional hours w.r.t. the contract hours

Result: Minimizing the additional working hours per employee w.r.t. the contract hours

Start with optimizing each four weeks separately until you optimized one year, with Algorithm 1.
for *Each optimized period of one year* **do**
while *Overtime* $TVT_{pd,k}$ *for an employee* $k > 0$ **do**

1. Lower the parameter O_k, with 0.04 for employee k.
2. Start optimizing each year separately, with Algorithm 1, with this new parameters.

end
end

Results and conclusions

The first stage and the second stage provide different insights for the planner and manager. For example, it can be obtained from the first stage how many temporary workers are expected to be deployed in which period. This can be anticipated and (cheaper) seasonal people can be hired. This is to reduce the total costs even more. From the second stage it can be determined where which employee should be deployed in order to obtain the optimal distribution for the relevant base location. This also results in a saving in costs:

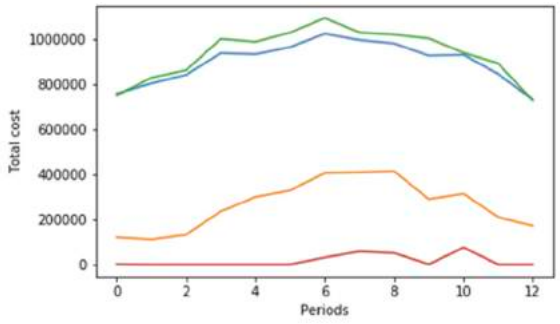


Figure 2: The total employee cost in the old and new situation

Here the blue line is the total costs of the permanent employees in the old situation and the green line in the new situation. The orange line is the total costs of the temporary workers in the old situation and the red line in the new situation.
It cannot be said that all these cost savings are realistic. This is because the data was not available or the employees who worked at a hotel also worked elsewhere (for example at a holiday park). As a result, in the old situation not all employees were deployed their full contract hours, but in the new situation they were. This allows a more optimal scenario to be sketched than in reality. If this data is available, this can be taken into account.
To conclude, in this article we started to investigate whether the optimal employee composition can be determined by introducing a two-stage problem. With this solution it gives planner insights how to plan their personnel such that the total cost will be minimized, all demand is met and all the rules of the collective labor agreement are met.

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– (2021b). *Werkzame beroepsbevolking; beroep*. URL: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82808NED/line?ts=1622573806956&fromstatweb=true.

Pierre Verhulst
Master BOAR Graduate (2021)

Drinks & Activities Committee

We, as the D&A committee, are in charge of organizing different drinks and activities throughout the year. The drinks take place in our favorite pubs: Café de Nachtwacht and De Heuvel Gallery. This year we are in charge of six activities: the Cycling Dinner and Drink, the St. Nicholas Drink, the Male/Female Activity and Drink, the Après Ski Drink, the Beer Games Drink, and the Astrics Beer Cantus. We will tell you more about what the different activities are!

The first activity we organized this year was our famous Cycling Dinner. Every year the committee will come up with a theme and different subthemes. During this activity we enjoyed an amazing three-course meal and different duos to share it with. You could choose your duo yourself or let us choose them for you. After the dinner we all enjoyed a drink at de Nachtwacht and announced the winners for each course. These are the teams that prepared the tastiest or most original meal.

A month later we had our famous St. Nicholas Drink where we, as committee, dressed up as 'Sinterklaas' and 'Pieten'. Every member had the opportunity to anonymously send in a poem about a funny moment or a juicy story and these poems were read by St. Nicholas himself. It was a great way to look back on last year and catch up with everyone.

The next activity we will organize will be the Male and Female Activity, which takes place in February. During this activity the men will be separated from the women and both groups will have an activity of their own. This way you can get to know your fellow, same gender, classmates better. What the different activities will be this year is still a surprise, but it will be fantastic! Afterwards both groups will come together and talk about the fun day they had.

Every year we bring the well known Après-Ski Drink to life where everybody comes in their best après-ski outfit. You should really try to get a great outfit, because there are rewards for best dressed man and best dressed woman. You can also get a special Asset | Econometrics beer mug. Overall, it is always a fun evening, with lederhosen and typical après-ski music.

Another activity we organize is called the Beer Games Drink. As the name makes clear, during this activity we will play multiple games against each other. The games will be fun, fast paced and are all about drinking and having fun.

The Astrics Cantus will be our last organized activity. As most of you know, a cantus is about singing along with songs and doing silly dances with your fellow students. We will not use our phone or go to the toilet, since, as Astrics members, we want to enjoy every second of our time together. The group bounding will be completed by singing "TEV is vet". Maybe not all of you know, but our study association was called TEV (Tilburgse Econometristen Vereniging) from 1979 until 2008. In 2008 the association got the name Asset | Econometrics. Hopefully this activity will be held offline so we can form a human train during the song "Per Spoor" by Guus Meeuwis.

Next to organizing these events we have designed a game which can be played at every event as well. Want to find out what we are talking about? Come to one of our events and you will surely get familiar with it… We hope to see you there!

XOXO the Drinks & Activities Committee

f.l.t.r. Kiki Hengst, Joris te Booij, Roxanne Verriet, Eva Schoenmakers, Laurentien Diepenhorst

Carnival Around the World

written by **Stijn Craenen** and **Roel Delescen**

It is again around that time of the year, Carnival! Originally, Carnival was a Christianized pagan festival. It is a Christian tradition on the Sunday, Monday and Tuesday before the lent of 40 days. In these 40 days the Christians were not allowed to eat any kind of meat. From here, it spread over other parts of Europe and other parts of the world and is now celebrated in many countries. We will take you on a world tour through all different kinds of carnival.

Our fantastic journey will start in Rio de Janeiro in Brazil. This is not the least one to start with, since according to the Guiness book of records this is the biggest carnival of the world. Two million people per day walk the streets during the festival. The most famous phenomenon of the Brazilian carnival is the samba parade. In this parade, 12 samba schools compete every year for the championship title. The costs of the parade can be enormous, some schools spend as much as 4 million dollars on outfits and preparations. As a logical result of these high costs, the samba parade is not available for everyone… a ticket is needed. This is a significantly critical point because the carnival tradition is officially meant for everyone. Fortunately, there are many street festivals that are highly populated by the locals.

For the following location we travel a long way to the north to end up in New Orleans, the United States. The carnival here is called Mardi Gras which is a French expression for Shrove Tuesday. Celebrations take place two weeks before Shrove Tuesday, the day before Ash Wednesday. The original purpose of this carnival was to let go of social relations for a while so that people could mingle with everyone. Nowadays, just like in Rio, there are big parades every day. With these parades, especially on Shrove Tuesday (Mardi Gras) people wear special costumes and masks. On this day even laws against concealing one's identity are suspended. The colors of the costumes and masks are officially green, gold and purple. It is unknown why these specific colors were chosen, but there is a theory that purple stands for justice, green for belief and gold for power.

We have to say goodbye to the relatively warm New Orleans and travel further to Quebec, Canada. Even in this very cold city, carnival is celebrated. It originated when early inhabitants got together before lent from the end of January through the middle of February to celebrate. Nowadays it has become one of the largest winter events in the world. Together with 'Bonhomme Carnaval', the

mascot of the festivities, many activities like ice canoeing where a team tries to push and paddle their boat across the half-frozen landscape. Moreover, the International Snow Sculpture takes place each year with carnival and features artists across the globe. Perhaps the most impressive ice sculpture is the Ice Palace which is the official residence of Bonhomme and exhibitions about the history of the carnival take place. Unfortunately, there is a time of coming and going and we have to leave Quebec to depart for Santa Cruz de Tenerife, Canary Islands.

The carnival of Santa Cruz de Tenerife is considered as the second biggest carnival in the world, after the earlier mentioned carnival in Rio de Janeiro. For fifteen days, the streets of the city come alive with freedom and extravagance. One of the main carnival events is the gala to elect the Carnival Queen which is held on the wednesday before the carnival weekend. This Queen is chosen by a jury composed of members of the municipal corporation and SMS. On Ash Wednesday the carnival ends with "the burial of the sardine". A huge sardine made of paper is buried, followed by wailing widows. After a different farewell in Santa Cruz de Tenerife we travel further to Rijeka, Croatia.

The Rejika Carnival is opened by the mayor handing the keys of the city over to the Master of Carnival (Meštar Toni) which is a symbolic gesture of handing over the rule of the town to the head of the carnival celebrators. On the same day, the traditional Rijeka Carnival Queen Pageant (the election of Queen Carnival) takes place as well. The main event, the Carnival march, is held on the Sunday before Ash Wednesday. This parade attracts over 150,000 spectators and 10,000 participants from all over the world. The Carnival winds down with the burning of the 'pust', which is a satirical puppet usually named after an unpopular politician or other unpopular figure, to say goodbye to everything negative in the previous year.

Now we will have a look at the country where carnival originated, Italy. We will take a look at Venice specifically. In 1268, carnival was celebrated here for the first time. The Venetians celebrate for twelve days long, and this ends at Shrove Tuesday. In the past, it was a tradition to wear masks. This was not only the case during carnival, but with all the traditions, for example when someone wanted to go over the street anonymously. Originally, these masks were used to hide social status. Because social status could not be determined during carnival, everyone could celebrate like they were equal. When Napoleon became the king of Italy, and so of Venice, the wearing of masks was strictly prohibited. Nowadays, the tradition of wearing masks is not like it used to be before Napoleon. Nevertheless, carnival is still celebrated in Venice every year.

We move on to one of the neighboring countries of Italy, which is Austria, taking a look at Vienna especially. Here carnival starts on the eleventh of November at 11.11 hours. The Viennese city center changes into a dance floor. Led by dance teachers, hundreds of people open the ball season near the Stephansdom. The lesson ends traditionally with the quadrille. This ball season ends Ash Wednesday. During the months January and February, every profession has its own ball, from lawyers to bakers. But not only professions have their own ball, also students, refugees, homeless people and a

lot of other groups have their own ball. There is also a ball called 'Life ball', of which the profits are donated to the fight against HIV and AIDS. This last ball however does not take place during the ball season but somewhere in June. In other words, also after the ball season Vienna keeps dancing, but officially the ball season ends at the same time as carnival. This tradition started during the Vienna congress in 1814 and 1815. After the French revolution and the subsequent wars, the victorious countries came together to make agreements about the new national borders. To entertain all the elite who had to be present at the discussions these few months, these balls were organized. This is what the ball season originated from.

One of the countries that were present at these discussions was the United Kingdom, so why not take a look at the carnival traditions in London? The tradition is called "Notting Hill Carnival" here. This is one of the biggest and most exciting street festivals that exists in London. Originally, the Caribbean carnivals started in the 19th century in Trinidad to celebrate the abolition of slavery. Claudia Jones was a Trinidad feministic activist and journalist who is seen as the mother of Notting Hill Carnival. In 1959 she organized an event called Mardi-Gras, which was used to bring Indians and white people together. The event was inside the St. Parcas town hall. The Mardi-Gras event was a small cultural evening in the winter where the yield was used to pay the fines of young people. Because this was a great success, it was organized every year. Nowadays, Notting Hill Carnival is a big street festival.

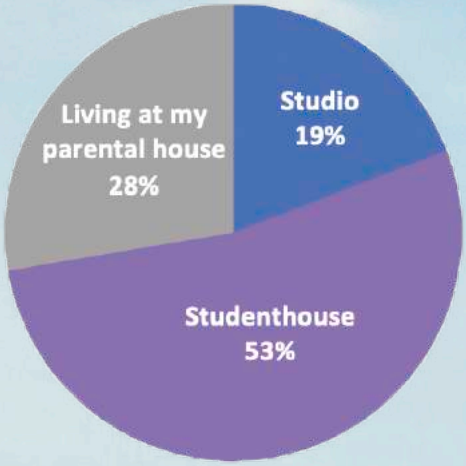
For the last destination, we travel to the most beautiful city of the world which is called Tilburg. In Tilburg, carnival is the biggest tradition of the year. During carnival, Tilburg is called the "Kruikenstad", because in the Netherlands every city has its own carnival name. Eindhoven for example is called "het Lampengat". Kruikenstad is known for some of its traditions. The first one are the colors orange and green, these are the two colors that are originally from the Kruikenstad.
Also the "kruikenmunt" is typically one of the traditions of Tilburg. If you want to order a drink, then you have to pay with this coin. The citizens of Tilburg are called "Kruikenzeikers" during the carnival days.

We can conclude that carnival is celebrated at places spread over the entire globe. Where it started as a Christian tradition in Italy, it spreaded out over the whole world. During this spreading, every place got its own traditions and time of celebration. But there is one important similarity between all the places… carnival brings happiness to the countries and the people!

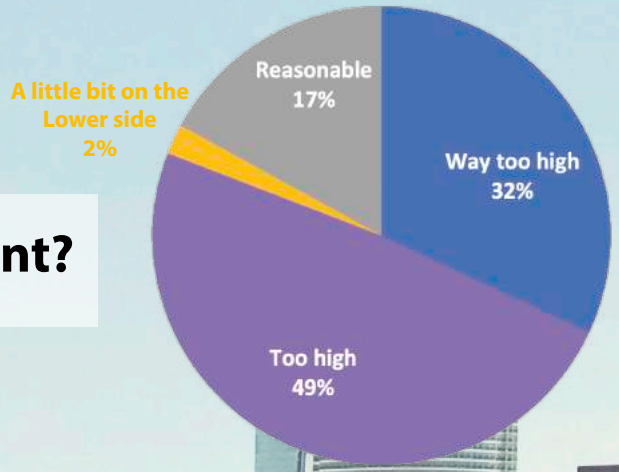
Let's Talk!

The last few years there seems to be a general problem in all Dutch cities, in which students make up a big portion of the population. This is the problem of a shortage of student housing. Next to that the rents are steeply increasing and due to online lectures, due to the COVID-situation, many students wait to move out of their parental house. So, in the upcoming years there will be even more demand for student rooms. But what are the solutions? We've seen that some students had to stay in tents or hostels temporarily. However, this doesn't seem to be a reasonable solution. Therefore, we investigated what fellow Asset|Econometrics members' living situation is and how they think about this problem and if they may have some reasonable solutions for this growing problem.

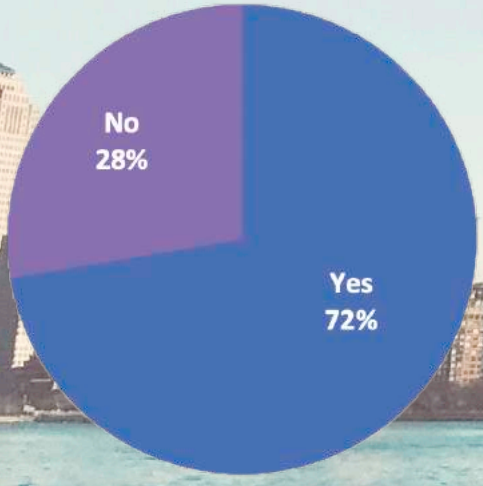
written by **Tijn Scholten**



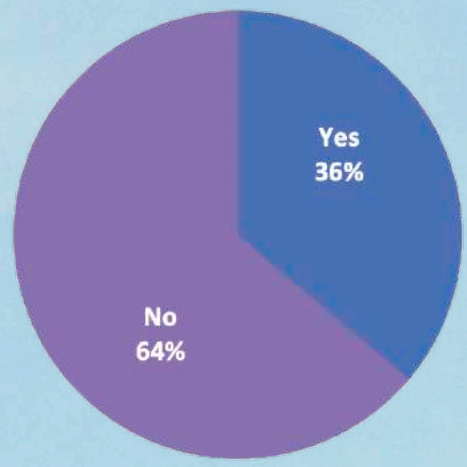
What is you current Living situation?



How do you think about the rent?

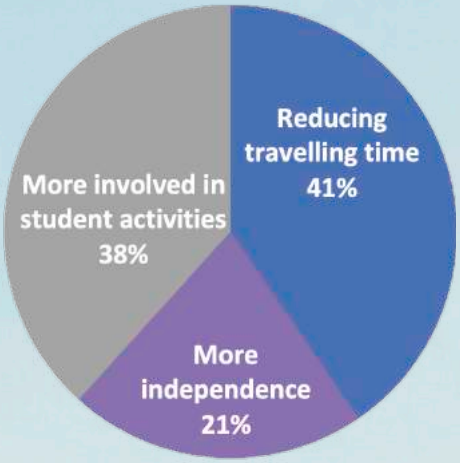


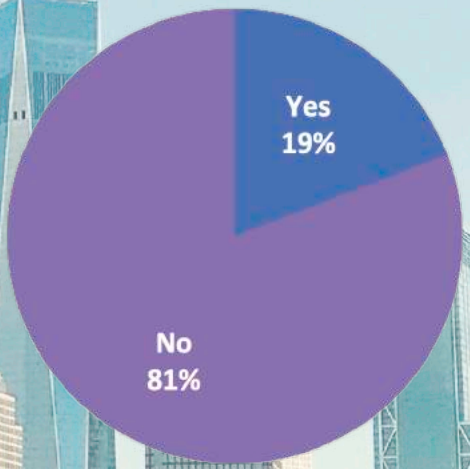
Are you happy with your current living situation?



Did you find problems with finding a room in Tilburg?

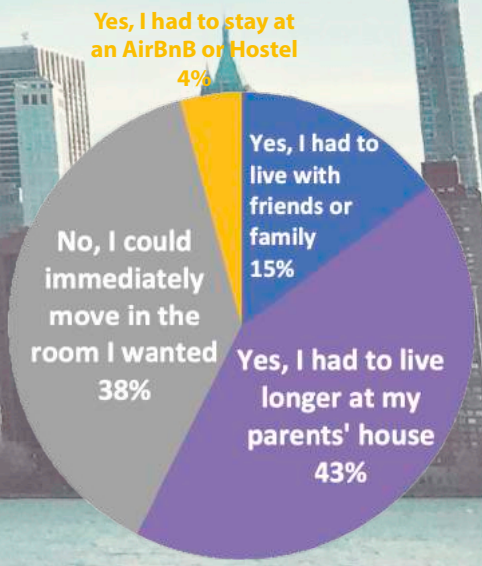
What was your reason of moving out?





Are there enough measures by the government?

Were you forced to improvise a living situation during your studying time?



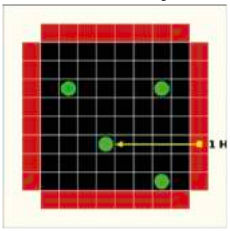
Puzzle Time

Black Box is an abstract board game, which simulates shooting rays into a black box to deduce the locations of "atoms" hidden inside.

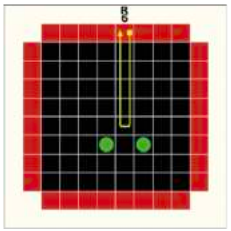
The object of the game is to discover the location of the atoms. A beam is "fired" into one of these positions and the result is used to help deduce the location of a known number of hidden atoms. The result of the beam is to be found in the outer ring of the puzzle and is either a number, an H or an R.

written by **Timo Klabbers**

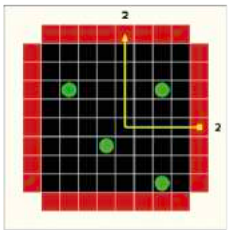
H-> You hit an atom -> A direct impact on an atom by a ray



R-> Reflection -> If a beam comes back at the same place, it's called a reflection. If an atom is at the edge of the grid, any ray which is aimed into the grid directly beside it causes a reflection. In a situation shown the beam gets deflected twice and returns to the base. In this case there is also an R written.



Number-> a beam enters the grid and leaves it at the same number somewhere else on the outer ring. When a beam enters the grid and does not actually hit an atom but passes the atom directly the beam gets deflected. The angle of deflection for this ray/atom interaction is 90 degrees.



	1	2	H	H	3	H	4	H	
3									4
2									H
H									R
H									H
H									R
1									H
H									5
7									6
	7	H	6	H	H	H	5	H	

Can you figure out the puzzle?

Please enter your solutions at www.Nekst-Online.nl/Puzzle. A goodiebag will be waiting for whoever has sent the best (partial) solutions. Please note that, as before, every recipient of this magazine is eligible to send in their solutions, so members of the department are invited to participate as well. Good luck!

Ties Dilling is the winner of the previous puzzle. The solution can be found at www.Nekst-Online.nl.

Extra challenge:
In the 'Dear members' Wout has hidden three words. Can you guess what words he tried to blend flawlessly into his writing?
Let us know and maybe your name will be mentioned in the next edition of Nekst!

Asset | Econometrics congratulates…

Name **Gözde Celik**
Title Network Design Problem of a Third-party Logistics Service Provider
MSc BAOR
Supervisors Dr. Y. Merzifonluoglu, Dr. J.C. Wagenaar

Name **Agustin Basauri**
Title Airline Alliance Revenue Sharing Problems
MSc EME
Supervisors Prof.dr. P.E.M. Borm, Dr. M. Quant

Name **Jialei Xiong**
Title The effect of retirement on health and medical utilization: Evidences from ten European countries
MSc EME
Supervisors Dr. M. Salm, Dr. B.M. Siflinger

Name **Jonas de Boo**
Title The effect of non-financial Twitter sentiment on stock price volatility
MSc QFAS
Supervisors Dr. P. Cizek, MSc. R. Fu

Name **Tristan Surtel**
Title Statistically comparing and clustering origin–destination matrices
MSc BAOR
Supervisors Dr.ir.ing. M.J.P. Peeters, Dr. J.C. Vera Lizcano

Name **Tom Smeets**
Title A new ILP Formulation and Heuristics for the KEP
MSc BAOR
Supervisors Dr. M. Delorme, Dr. J.C. Wagenaar

Name **Ella Du**
Title The Pricing of Equity-linked Insurance Contracts and Longevity Risk Management
MSc QFAS
Supervisors Dr. A.G. Balter, Dr. M. Melenberg

Name **Lucas Konrad**
Title Basically Trapped A General Equilibrium Approach to the Undersupply of Basic Research in Free Markets
MSc EME
Supervisors Dr. C.B.T. Walsh, Dr. C.B.T. Walsh

Name **Maarten de Ree**
Title The validity of backtesting for evaluation of The Road to Personalised Pricing for Commercial Loans: An Application of Value-Based Pricing
MSc EME
Supervisors Dr. C.B.T. Walsh, Dr. D. Kojevnikov

…on obtaining their Master's degree

Quatsch!

¯_(ツ)_/¯

Quatsch?

Over the past few months, the editorial staff of Nekst received many quotes that relate to the study of Econometrics and to the activities organized by Asset | Econometrics.
Hereby, we present to you a selection of some striking and funny quotes!
Please send in your quotes at:
www.Asset-Econometrics.nl/more/nekst/Quatsch

Nienke
"Gingen jouw ouders ook door totdat ze een meisje hadden?"

Pierre
"Als je met twee mensen die je semi kent in de zit. is het niet cool als je daar een ongeluk mee maakt"

Christel
"Hebben jullie leuke ideeen wat we als date kunnen doen?

Floris
"Ik ken wel een leuke app, breeze."

Lotte (over een focaccia)
"Fokakkia"

Joris
"Bestaan rendieren eigenlijk echt?"

Meike
"Bohemian Rhapsody is echt een goede film."

Patrick
"Heel veel film van bands zijn slecht, maar die van Queen is ook goed hoor."

Matthijs
"Als je je kind Floor Oranje noemt, dan doe je gewoon Floris van Oranje na.

Ricardo
"Wie is dat dan?

Matthijs
"Ja, weet ik veel."

Floris
"Hoezo vraag je naar mijn id-kaart? Heb jij soms de andere helft?"

Moet tijdens 30 seconds 'Bali' uitleggen
Patrick
"Niet Nasi, maar ..."

Jasmijn
"Ik heb wel meer eerste dan tweede dates gehad"

Siebe (over Juliette's bagagedrage)
"Ik ga even op jouw onderfiets."

Sara (over een vuilniswagen)
"Prullenbakmachine"

Matthijs
"Is Rinze een Brabntse naam?

Siebe
"Nee, Fries."

Matthijs
"Ja, dat dacht ik al!"

NOTHING BEATS **TRADING**

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FLOW TRADERS

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Agenda

TUE **15** FEB
Econometricians for Society
On this day Asset | Econometrics will collect money by ice skating for charity. Where every particpant is being sponsored by friends and/or family. The money will go to a school at Kenya!

THU **17** FEB
Male/Female Activity
On Thursday February 27, the Male/Female Activity will take place. On this evening, there will be a separate activity for males and females. Both activities will be organized by the Drinks and Activities committee.

TUE **22** FEB
Active Member Meeting
During the active members meeting the board of Asset | Econometrics asks their members their opinion about difficult dilemmas and discussion. So do not hesitate to share your opinion and join!

TUE **23** FEB
Arriva Inhouse Day
On Wednesday February 23, you get the opportunity to visit the offices of Arriva to follow an inhouse day. Arriva is a Britisch transportation organisation and is partly responsible for the public transport in the Netherlands.

THU **24** FEB
Asset Pre-Carnaval
After reading the special about carnaval you could probably not wait until carnaval arrives to celebrate this event. Asset organises a pre-carnaval event as well where everyone dresses up in their most beautifull uniform.

MON **07** MAR – WED **09** MAR
Econometrics Consultancy Tour
From Monday till Wednesday the Econometrics Consultancy Tour takes place during which you will visit a total of four companies. Whether it will be at the companies office, or just on the university campus will yet to be seen. However, this is the ideal event to get in touch with consultancy.

FRI **11** MAR
Vriendjes van Vroeger Dag
Besides a borther and sisterday or partentsday Asset | Econometrics now organises an Old friends day. At this day everyone brings an old friend that does not live in Tilburg. During this day everyone can have a chat with eachother and meet eachothers friends.

TUE **15** MAR
Master Experience Day
From March 14 till March 17 the master experience day takes place in which all masters of TiSEM are being discussed. This is the perfect event to orientate on what master best fits for you. On March 15 all masters related to Econometrics are being discussed.

TUE **15** MAR
Apres-Ski Drink
In the evening an Apres-Ski drink will be held, where everyone dresses up as the theme. During this drink beer mugs are being hand out to all the participant to get into the apres-ski mood even more.

WED **16** MAR
Board Infromation Session
At this day a short information session takes place to give information about how a life as a board is like and what the benefits of doing a board year exactly are. So if you are interest in doing a board year, this is the event to confirm your interest.

THU **17** MAR
COdE
On March 17, the second COdE will take place. Where a total of 400 Asset members are having a cantus together, and will close off the evening with a party at Vidar.

MON **21** MAR
CZ Inhouse Day
On Monday March 21, we will have an interesting inhouse day with CZ together with Asset | Economics and Asset | Accounting & Finance. During this afternoon, CZ will explain the structure of the company and provide all students with a case.

TUE **22** MAR
Freshmen Information Day
On March 22, there will be a Freshmen Information Day. During this day, the Academic Director will explain the possibilities during the Bachelor. An older student will come and tell all about the experiences of an exchange.

TUE **22** MAR
Freshmen Drink
To close off the day for all the freshmen, a drink takes place right after the freshmen information day ended.

WED **23** MAR
Olden Goldies Activity
On March 23, the Olden Goldies Activity for fourthyear students and older will take place. Be ready to make it an unforgettable night!

THU **24** MAR
Optiver Inhouse Day
On March 24, there is an Inhouse Day with Optiver. During this day, students get insight in how Optiver is trading and Optiver will also provide the participants with an interesting case.

Register and find more information about our events at
www.Asset-Econometrics.nl/events


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