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Practical Report

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Tribute to prof. Talman

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Preface

The Nekst Big Thing is already there

Autumn: leaves are falling from the trees and cute summer dresses and sporty t-shirts are - slightly hesitantly – traded for comfortable hoodies and pull-overs while you are counting the days until the first issue of the 27th Nekst Volume falls onto your doorstep.

That moment has finally arrived and, as you may have noticed, our new Lay-out editor Bart Rutten gave it a little make-over. Contemporary, though with tasteful regard towards the legacy of our predecessors.

Good for you, but I never judge a magazine by its cover – I can hear you think. That is why we filled the beautiful body of this edition with some purposeful content: Frank de Meijer takes us through his approach to deal with reload costs, we visited two companies to see what life of an econometrician after studies is like and we introduced a new feature, named Familiar Faces. Of course, classics like Triangle, The Teacher or an impression of the TOP-week from a genuine freshman are present.

This year, the columns are delivered by Bas Dietzenbacher and Theo Nijman. Bas even writes all the way from Russia, with love for our association.

Our editorial staff is large in size and motivated to deliver high quality pieces, of which I am sure you will not get enough. Hence, I invite you to visit nekst-online.nl for more background stories and archive pieces.

Yours cordially,

Dominique Bavelaar
Editor-in-Chief

COLOPHON

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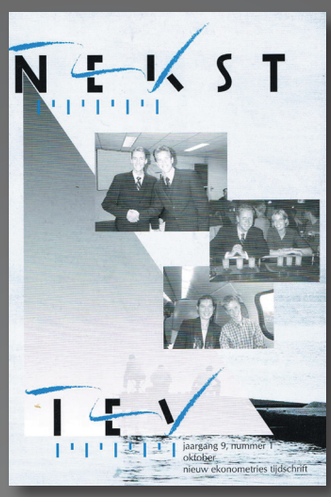

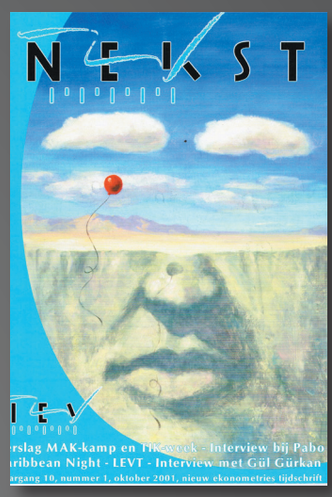

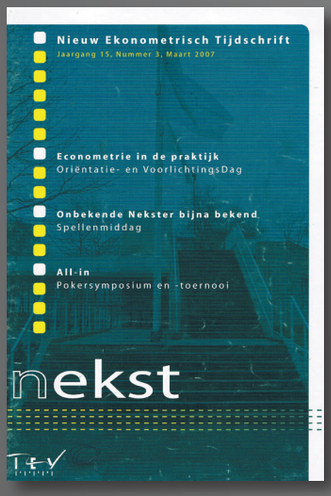

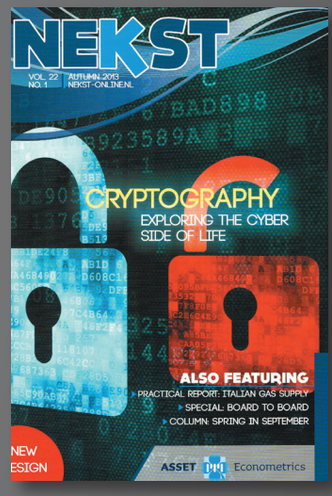

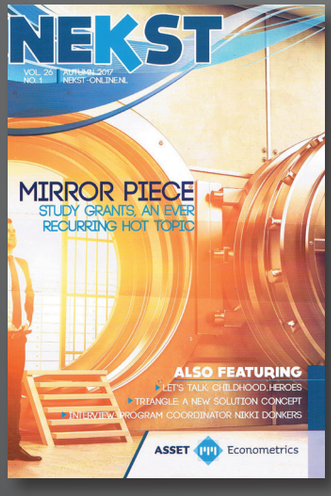

Dear Members,

While writing this article I am contemplating all achievements of this wonderful association. Thinking about all that has been accomplished, I am filled with pride. For many years, Asset | Econometrics has managed to serve econometrics students in the best way possible. This only encourages us to make the best of the upcoming academic year.

Many of you may know me already, but for those who do not know me I will shortly introduce myself. My name is Quirien Raat, I am 24 years old and I already finished one of my Masters, yet I have one more Master thesis to go. I became active last year, serving as chairman of the LED 2018 committee and this was followed by joining the Quantitative Investment Group and Economic Business Diner committee. During my time at these committees I fell deeply in love with our wonderful association. Not only did I feel welcome from the first moment onward, I also made memories and friends every week. When I was announced as the new chairman of Asset | Econometrics I thought I could not be happier as I discovered that my fellow LED committee members Wenxin Lin and Joris Pirée were announced as Secretary and External Affairs, but I was wrong! Because it was the joining of Jelle Sieben and Nina Cuypers, respectively, as our Treasurer and Internal Affairs that made the party complete and filled me with complete happiness. Together we have already experienced many great moments and I am convinced that many more will follow this year.

With the start of the academic year 2018-2019, all of you have returned to our beautiful campus and the start of a new year brings new challenges to all of us. The same goes for my fellow board members and me. While you are getting up to par with the demanding schedule of the courses, we are preparing for the Lustrum of Asset | Econometrics, because as you might know we will celebrate our 40th anniversary on March 15, 2019. Therefore I would like to take a moment to invite you all to join our Lustrum week from April 29 until May 5.

Above all, we are very honored that we are the 40th board of Asset | Econometrics and that we can organize and celebrate our lustrum. We immediately noticed the extra attention that is given to the association and we work very hard to live up to the expectations and desires of our members and related companies. However, we are also very humble as we realize that in the end the strength of the association comes from its members. The better we can serve and support you during your student time, the more we will thrive as an association. Therefore, we want to contribute more as a board towards our members. So do not be surprised when we are interested in your personal goals, how we can support you or how you can make the most out of your time at the association. We want to enable you to reach your full potential and support you along the road. Lastly, we will work to make our career events more accessible for all members by strengthening our collaboration with the university.

All of us are excited for the upcoming year, and we hope to see you soon at one of our events. I hope you are as excited as we are for this year!

On behalf of the board,

Quirien Raat
Chairman Asset | Econometrics 2018-2019

Meet the Crew!

Nekst Committee 2018-2019

written by **Irmgard Oude Alink**

Cas Slootweg

Master

Cas is 21 years old, but already in his fifth study year in Tilburg. He is taking two Master programs at the same time: EME and BAOR. He was born in Zaandam, but he is becoming a real 'Brabander' since he has been living here for 13 years now. Cas started with the Freshmen committee in his second year, after which he joined the AMD committee. This year he is part of the EPD committee as well as the Nekst committee. If this risk-seeking boy would win 10 million euros in the lottery, he would give 1 million to charity, use 1 million as a back-up fund (rather a little risk averse maybe...), but the other 8 million he would put on red in the casino. Cas' guilty pleasure is to play a cover of Dark Horse by Katy Perry: 'Such a terrible song, but so much fun to play'.

Michael Vo

Master

His real name is Hong Phuoc Vo, but we can call him Michael. He comes from Vietnam and is 25-years old by the time you receive this edition of the Nekst. He is doing a Master in Finance, which takes 1 year. He has been in Tilburg, or even the Netherlands, only since August and immediately became active at Asset | Econometrics! Michael is a real science-fiction fan, therefore he would want to travel as far into the future as possible, if he were able to travel in time. He thinks everybody has superhuman abilities and could live forever thanks to biological augmentations by then. In the weekends, he likes to chill out in the park with a Bluetooth speaker and a good audio book. He also likes to play some sports after that. If the weather does not permit this, he just hangs out with friends and complains about how the weather sucks. Welcome to the Netherlands!

Melissa van Wingerden

Bachelor

Melissa is a 20-year old, third-year Bachelor student. She was born in Rijsbergen, but now lives in lodges in Tilburg. She started her active career at Asset | Econometrics with the education committee and last year she joined the AMD and Connection Day committee. Melissa is a real econometrician as she would invest part of her money in derivatives, if she would win 10 million euro in the lottery. The other millions she would set aside for future purposes, spend on travelling certain parts of the world and donate to a charity like "Beat Batten". Her guilty pleasure is about music as she likes Dutch music from artists like Racoon and Bløf.

Charlotte Nijman

Master

Charlotte is 24 years old and was born from her mum's belly in Oisterwijk. She lives in lodges with Wanda (the goldfish) and some other housemates, but these are less important. In the academic year 2016-2017 she was the secretary of Asset | Econometrics. Besides this she joined the Book of Faces, the Promotion committee, the Nekst and the Active Members' Day. If Charlotte would win 10 million euros in the lottery, she would, among other things, bring her niece to Disneyland in a big pink dress! She likes kids, which becomes clearer in her answer to the question in which TV show she would want to participate. Her answer to that namely is K3 zoekt K3: "it would be amazing to sing and dance for kids" or Praatjesmakers. Also she would want to participate in Wie is de Mol and then be the silly one who becomes friends with the Mol. Oh wait...

Bart Rutten

Master

Our Lay-out editor of this year is Bart, 21 years old, raised in Heeze. Bart is living in lodges in Tilburg with three other econometricians. However, in the weekends his lovely mom needs to do his laundry, so Bart is going back home then. He had never done any committee at Asset | Econometrics until this year! When Bart needed to choose a TV show in which he wants to participate he said convincingly: "De rijdende rechter, or even better, the 'tokkie'-variant: Mr. Frank Visser doet uitspraak". He always watches this with his roommates and the silly stuff people can fight about they are really amazed. In the show Bart would want to be the judge or the man from a few houses away who stirs things up during the hearing.

Wenxin Lin

Bachelor

Wenxin is the secretary of Asset | Econometrics of this year. She is 20 years old and grew up in Venlo. Wenxin started her 'career' at Asset | Econometrics with the D&A committee (together with Dominique). Later she joined the faculty-wide committee Food for Thought and the International Business Tour 2018. Wenxin would like to participate in Expeditie Robinson or Wie is de Mol, but she thinks she will not make it very far in either of these shows. Shows like *Lachen om Homevideos* suits her more, for being very clumsy. Wenxin's guilty pleasures are the sweet potato fries of McDonald's. Maybe she needs to try to avoid them more this year, but she likes eating after a night out. Who doesn't?

Ridho Hidayat

Master

Ridho is a 24-year old Master student, who hopes to be graduated by the time you read this! Ridho was born and raised in 's Hertogenbosch. At the start of his second year, Ridho became active at Asset | Econometrics . Last year, he was Nekst's Lay-out editor. Ridho's guilty pleasure is to watch natural disaster movies. He thinks it is fascinating to watch tornados, tsunamis or volcanic eruptions, even though these are terrible things. However, his heart is not only evil, because if he would win 10 million euro in the lottery, he would help his family in Indonesia, as well as some other people he knows that could really use the money. He would also buy a house for his parents and he would donate part of the money, in person, to charity!

Zoë Connell

Master

This 24-year old girl from Uden is already in her sixth year of her studies. She has never joined any other committee of Asset | Econometrics than the Nekst committee. If Zoë would win 10 million euros in the lottery she would give her parents 3 million, such that they can finish their house. She would also give her brothers both 1.5 million. Together with her boyfriend she would buy a house. The last thing Zoë would do with the money is to buy an iPhone PLUS. This is strange, because when she was asked in what time she would like to live if she were able to travel in time, she answered: 'Perhaps the '60s. Any time before mobile phones.'

Irngard Oude Alink

Master

Irmgard is 23 years old and in the first year of the Master EME. She was born and raised in Cadier en Keer, a small village nearby Maastricht, which she claims to be the most beautiful city of the Netherlands. In the past she has been part of the AMD, Trip, OCD and the Yearbook committee. If Irmgard would win 10 million euros in the lottery, she would buy a house in the Netherlands, but she would definitely buy a second house in Greece! The rest of the money she would save to live relaxed without thinking about money and to help people who really need it. Her guilty pleasure is watching unimportant soccer matches. Also Irmgard has a subscription on MVV Maastricht.

Job Hoven
Bachelor

Our Belgian committee member is 19 years old and is in the second year of his Bachelor. Job still lives in Belgium, so he drives to Tilburg every day. Last year, he was part of the Promotion committee and last January he started with the EPD committee, which is almost finished. If Job would participate in a TV show it would be Friends, because he likes the humor in it. If he would win 10 million euros in the lottery he would travel around the world in luxury. Therefore it will be no surprise that Job would want to live in the golden century if he where able to travel through times.

Marieke de Leeuw
Bachelor

Marieke, 20 years old, comes from Eindhoven (de gekste) where she still lives at her parents' house. She just needs to finish one Bachelor course this semester and then she can start with her Master program in February. Before this committee, Marieke only joined the Yearbook committee last year. As a child, she always wanted to be part of Kinderen voor Kinderen, but she never actually did this. Also she really wanted to participate in the Achmea Kennisquiz. Nowadays, Marieke would still like to participate in a TV quiz, for example Weet Ik Veel. Her guilty pleasure is about other TV programs, which she said herself are stupid and many people hate them: Goede Tijden, Slechte Tijden and Boer Zoekt Vrouw.

Guus Vlaskamp
Master

This 21-year old boy from Schaijk lives together with two friends in a house in Tilburg near the Sports Center. Before Guus joined the Nekst, he was part of the Strategy Tour committee. Last year he was the Editor-in-chief of Nekst. If Guus needed to choose a TV show to participate in, he would without no doubt say 'Wie is de Mol?' He was the Mole in the *Wie is de Mol weekend* of Asset | Econometrics last year and he would love to do that again! Guus is perfectly content with the present to be living in. This feeling is so strong that he would stay in the present, even if he would be able to travel through time.

Moving Around the World in Pursuit of the Perfect Academic Career

written by **Zoë Connell**

On the 31st of August, Cas Slootweg and I interviewed dr. Merzifonluoglu to introduce this relatively new professor to her (future) students. dr. Merzifonluoglu is only 39 years old and she has only been living in The Netherlands since August 2017, accompanied by her family. Merzifonluoglu holds the Turkish nationality and was born in Ankara. Her husband is Turkish as well and since she had a job offer from Tilburg University and he could get a job at ASML, they decided to move to Eindhoven.

When Merzifonluoglu was a little girl, she never knew which profession would be suited for her. She had lots of friends that dreamt about becoming an astronaut or a doctor, but for her it was not clear which career was meant for her. After high school, in 1997, she participated in some sort of national exam where general knowledge was tested as a means to assign certain students to different universities. From approximately one million students that took the test at that time, she ended in the top 200 students. Because she scored so well on this test, she was granted a scholarship and 'got paid' to study at Bilkent University in Ankara. This is one of Turkey's top universities. Merzifonluoglu has always known that a medical career was not suited for her and that she enjoyed mathematics. She chose an Industrial Engineering Bachelor, because this was the least practical and most mathematical engineering Bachelor available. Merzifonluoglu: "Optimization and operations research was a big part of this program. At the time there was no such thing as econometrics at Bilkent University."

Towards the end of her Bachelor, she had some friends that were thinking about doing a PhD and she thought that this would be a nice thing to pursue for herself as well. She applied for an Industrial Engineering Master PhD position at the University of Florida in Gainesville and was accepted. Her supervisor was studying a supply chain topic, which is the field she is most interested in. This meant that at the age of 22 she moved to the United States by herself. Merzifonluoglu said that her PhD was quite a shock as she had to start teaching and did not think this part would be so big. Fun fact: the University of Florida is the third largest university of the United States with 55,382 students this academic year (to compare: Tilburg University has 13,153 students this year).

After four years she finished her PhD and started looking for a job in the academic world. She moved to Miami to teach at the Florida International University. Soon she realized that this job was more about teaching than about her research and she wanted to have enough time to work on the latter so she started applying for other jobs and found one at Virginia Tech. Her current husband was also working at Virginia Tech, but they decided that they would rather live closer to their family and decided to move to Cyprus in 2009. In Cyprus she was working at the Middle East Technical University -Cyprus Campus. From Cyprus it was only a one hour flight to visit their families. They were happy there, and had their two daughters (now aged four and seven). Still, they decided that they wanted better opportunities for their two daughters so they both started applying again and, as mentioned before, got accepted in Tilburg and Eindhoven after which they decided to move to the Netherlands.

During Merzifonluoglu's time as a student, she did not participate in any student association like Asset | Econometrics. This is one

of the things she regrets. The main reason why she did not join any association was that she was not aware the benefits of being active in such associations. In addition, due to her scholarship she did not have to work next to studying. "In general," Merzifonluglu explains, "in Turkey students are not expected to have student jobs next to their study: you are either studying or working full-time."

At Tilburg University, Merzifonluoglu is teaching three courses: Inventory and Production Management, Supply Chain Analytics and Simulation. The first is a third year Econometrics and Operations Research Bachelor course and the last two are cluster A Business Analytics and Operations Research Master courses. Her favorite course to teach is Supply Chain Analytics, mainly because this is closest to her research work and she feels most comfortable to teach these subjects. In addition to teaching she supervises Bachelor and Master thesis projects and works on her research. An average week contains two days of teaching and preparing lectures, two days of conducting research and on Friday she plans all her meetings and her other administrative tasks. She said that research takes time and she prefers to be able to work on it for a longer amount of time at once than working on it every day for two hours. She enjoys both research and teaching, but she does not like grading assignments/exams. Any student looking for a job could perhaps offer his or her services in exchange for a guaranteed 8+ grade for their thesis…

> "She likes to read what her students are doing to get to know them a little better (…)"

During weekends, Merzifonluoglu does not work as she spends time with her daughters. Sometimes when something really has to be done outside office hours and her kids are sleeping she might finish it, but that is not often the case. She would want to have more time to work, because the more time you have, the more research you could produce. However, her family prevents her from working around the clock and therefore gives her a good work-life balance at the moment.

We asked Merzifonluoglu if she would recommend her students to do a PhD and she said she would recommend it for people that fit the job. She said it like this, because in general she feels an academic career has great advantages over a business career as you have a lot of freedom as an academic. In addition, in a big organization there are too many meetings that take up valuable time in which something more useful could be done. However, life as an academic is a bit isolated and it requires more responsibilities and discipline. Therefore you have to flourish in this isolation and have the discipline to work. You always need to do something new in research, which makes it a very challenging job and the students keep you young. If she could choose another profession it would be a manager position in a business, but if she would get an offer to change jobs tomorrow, she would definitely not take it.

Merzifonluoglu had heard of Nekst before we had the interview and said that she enjoys reading the magazine. Her favorite pieces are the practical reports and the articles about Asset | Econometrics activities. She likes to read what her students are doing to get to know them a little better and sometimes even recognizes some of the students from her class.

As we always do in an interview with a professor, we asked Merzifonluoglu if she has any advice for her students and she has several tips: "Students should stay positive because you cannot plan your life, so you should just go with the flow and be enthusiastic about what you are doing. If you do not feel like you are going somewhere, maybe you should be doing something different. In addition, if you are doing something that is not challenging you, you should probably move on. " As far as studying goes, students should try to look at the four years as a student as a small portion of your life, where you should merely focus on the end result. So study hard and at the same time take the time to create good memories as a student. Good opportunities will be waiting at the end of the road so be ready to take them and last but not least: always trust yourself.

Bert & Ernie Questions

Bert/**Ernie**
Research/Teaching
Eindhoven/Ankara
Econometrics/**Operations Research**
Fries/Pancakes
America/Asia
Using a calculator/ **Mental calculation**

Bounds on the Minumum Reload Cost Cycle Cover Problem

Networks often consist of different subnetworks that are run by different providers. When operating on such a network, costs arise at points where the underlying provider changes. Such a cost is called a reload cost. In our research we consider an optimization problem incurring these costs: the Minimum Reload Cost Cycle Cover Problem (MinRC3). In this problem we search for a cycle cover in a graph while minimizing the total reload cost. Our goal is to construct strong and efficient lower bounds for the objective value of this problem. We present two new bounding approaches that can be applied to other quadratic binary problems as well.

written by **Frank de Meijer**

Problem Description

A reload cost is a cost that arises in an arc-colored graph when two arcs of different colors are placed in succession on a path, tree or cycle. The concept of reload costs is very natural and has applications in many fields. For instance, transportation networks are often served by different logistic suppliers. When the supplier changes, e.g. from road to maritime transportation, some amount has to be reloaded from truck to ship. This comes at a certain cost, which can be modeled as a reload cost. Moreover, the concept of reload cost has applications in energy networks, telecommunication and robotics.

The Minimum Reload Cost Cycle Cover Problem ($\mathrm{MinRC3}$) is a relatively new optimization problem which is introduced by Galbiati et al. [1]. Given a directed arc-colored graph and a reload cost function, the goal of $\mathrm{MinRC3}$ is to find a minimum cycle cover of the graph with respect to the reload costs. A cycle cover is a set of node-disjoint cycles such that each node is on exactly one cycle. Figure 1 shows a simple example of a feasible cycle cover.

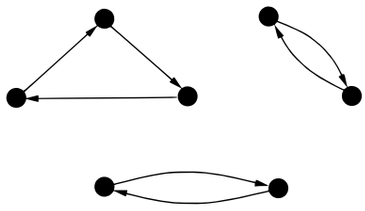

Figure 1: Cycle cover in a directed graph consisting of 7 nodes.

To define the problem mathematically, we consider a directed graph $G = (N, A)$ with node set N and arc set A and an arc-coloring function $c : A \to L$ where L is a set of colors. The color of an arc can be seen as the provider of its corresponding subnetwork. The cost induced by a change of provider is given by a reload cost function $r : L \times L \to \mathbb{Z}^+$. This function has the property that for all colors $l_1, l_2 \in L$ we have $r(l_1, l_2) = 0$ if $l_1 = l_2$ and $r(l_1, l_2) \geq 0$ otherwise. For all arcs $e \in A$ we let c_e denote the color of arc e. Moreover, we define a reload cost matrix $R \in \mathbb{Z}^{m \times m}$ as follows:

$$R_{ef} := \begin{cases} r(c_e, c_f) & \text{if arc } f \text{ is a successor of arc } e, \\ 0 & \text{otherwise.} \end{cases}$$

Let $x \in \{0,1\}^{|A|}$ be a vector for which $x_e = 1$ if arc e belongs to the cycle cover and 0 otherwise. The problem can now be formulated as follows:

$$\min_{x \in \{0,1\}^{|A|}} \left(x^T R x \mid \sum_{e \in \delta^+(i)} x_e = \sum_{e \in \delta^-(i)} x_e = 1 \ \ \forall i \in N \right).$$

Here $\delta^+(i)$ and $\delta^-(i)$ denote the set of outgoing and incoming arcs of node i, respectively.

Bounding Approaches for MinRC3

In our research we prove that the $\mathrm{MinRC3}$ problem is $\mathcal{NP}$-hard by deriving a polynomial time reduction from the Quadratic Assignment Problem (QAP). Consequently, the problem is hard to solve to optimality. For that reason it is of interest to construct strong lower for the optimal value of the problem. Our main focus is on two types of bounds: Gilmore-Lawler type bounds and linearization based bounds.

Gilmore-Lawler type bounds

The Gilmore-Lawler type procedure is a popular approach to construct lower bounds for quadratic binary optimization problems. The main idea is to compute for all arcs $e \in A$ the smallest linear contribution of e to a cycle cover. When X denotes the set of all cycle covers, we calculate:

$$z_e := \min_{x \in X} \left(\sum_{f \text{ succeeds } e} r(c_e, c_f) x_f \mid x_e = 1 \right).$$

In other words, we search for the cycle cover which includes arc e such that the reload cost of arc e and its successor is minimized. After computing z_e for all $e \in A$, the classical GL-type bound can be found by searching for the minimum cycle cover with respect to the linear cost z, i.e. $v_{GL}(R) := \min_{x \in X} \left(\sum_{e \in A} z_e x_e \right)$. In our research we prove that this bound can be found by solving a single linear problem.

We now present two improvements of the classical GL-type approach: a reformulation procedure and the strongest Gilmore-Lawler type bounds based on equivalent representations of the reload cost matrix. By solving $v_{GL}(R)$ we obtain dual variables that can be used to reformulate the objective function. The original objective function can be written as $d_0^T x + x^T R_0 x$ with d equal to the zero vector and $R_0 := R$. By a proper use of the dual variables, we define a new objective function $d_1^T x + x^T R_1 x$. The idea behind this reformulation is that (part of) the quadratic cost in R_0 is shifted towards the linear cost in d_1. This is done in such a way that both objective functions are the same for all cycle covers $x \in X$. This procedure can be performed iteratively such that for all iterations $k \geq 0$ we obtain the objective function $d_k^T x + x^T R_k x$. For all iterations k we introduce the following bound:

$$W^k := \min_{x \in X} \{ d_k^T x \}.$$

In other words, we neglect the quadratic part and optimize with respect to the linear part of the objective function. In this way, a non-decreasing sequence of lower bounds is obtained, i.e. $W^0 \leq W^1 \leq ... \leq OPT(MinRC3)$. If, in addition to the reformulation of the objective function, we rearrange the entries within the reload cost matrix R_k in each step, e.g. by symmetrizing, this sequence can become strictly increasing.

Another improvement can be made by considering equivalent representations of the reload cost matrix R. A matrix Q is called an equivalent representation of R if $x^T Q x = x^T R x$ for all cycle covers $x \in X$. Indeed, each equivalent representation of R results in an equivalent instance of MinRC3. However, it turns out that the use of an equivalent representation of the reload cost matrix can result in a different bound, i.e. $v_{GL}(R)$ depends on the representation of R. We can exploit this fact to derive improved bounds. For this purpose, we introduce two types of equivalent representations:

- **Total rearrangement:** $R^\eta := \eta R + (1 - \eta) R^T$ with $\eta \in [0, 1]$, i.e. R^η equals a convex combination of R and R^T.
  e.g. $R = \begin{pmatrix} 0 & 4 & 3 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$ becomes $R^{\frac{1}{2}} = \begin{pmatrix} 0 & 2 & 2 \\ 2 & 0 & 1 \\ 2 & 1 & 0 \end{pmatrix}$.

- **Entrywise rearrangements:** $R(\Gamma)$ with $R(\Gamma)_{ef} := \eta_{ef} R_{ef} + (1 - \eta_{ef}) R_{fe}$ with $\eta_{ef} \in [0, 1]$ for all $e, f \in A, e \neq f$, and $\Gamma := [\eta_{12}, \eta_{13}, ..., \eta_{(m-1)m}]$. In this case every (e, f)'th entry of $R(\Gamma)$ is a convex combination of R_{ef} and R_{fe}.
  e.g. $R = \begin{pmatrix} 0 & 4 & 3 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$ becomes $R(\Gamma) = \begin{pmatrix} 0 & 4 & 1 \\ 0 & 0 & 1 \\ 3 & 1 & 0 \end{pmatrix}$.

To find the strongest GL-type bounds, we maximize over all equivalent representations of the form R^η and $R(\Gamma)$, i.e.

$$v_{GL}^* := \max_{\eta \in [0,1]} \{ v_{GL}(R^\eta) \},$$
$$v_{GL}^{best} := \max_{\Gamma} \{ v_{GL}(R(\Gamma)) \}.$$

Both bounds can be calculated by solving a single linear programming problem. Since R^η can be seen as a special case of $R(\Gamma)$, it follows that $v_{GL}^* \leq v_{GL}^{best}$. To the best of our knowledge, we are the first who derive these strongest Gilmore-Lawler type bounds. It turns out that this new approach significantly improves the classical GL-type bound. Both the reformulation approach and the calculation of the strongest GL-type bounds improve the classical GL-type bound. If we combine both methods, even stronger bounds are derived.

Linearization Based Bounds

Another type of bound can be obtained by investigating the linearization problem for MinRC3. Recall that the objective function of MinRC3 is quadratic. The corresponding linear problem is called the Cycle Cover Problem (CCP), in which we consider an arc-weighted function $p : A \to \mathbb{R}$. The linear counterpart of MinRC3 reads:

$$\min_{x \in \{0,1\}^{|A|}} \{ p^T x \,|\, x \in X \}.$$

It is well-known that this problem is solvable in polynomial time. We call an instance (G, R) of MinRC3 linearizable if there exists a cost vector p such that $x^T R x = p^T x$ for all $x \in X$.

In our research we derive various sufficient conditions for R to be linearizable. One of them is the incident weak sum property. A cost matrix R is called incident weak sum if there exist $a, b \in \mathbb{R}^m$ such that $R_{ef} = a_e + b_f$ for all e and f that are incident. We can prove that if the reload cost matrix R is an incident weak sum matrix, then R is linearizable with cost vector $p = a + b$. A similar result is proven for four other types of matrices. Each of these sufficient conditions can be used to derive bounds for MinRC3. These bounds are called linearization based bounds. The procedure to construct →

these bounds is as follows: For a given reload cost matrix R we search for a matrix $\hat{R}$ that is (1) linearizable and (2) as 'close' as possible to R. For the first property we use one of the sufficient conditions for linearizability, e.g. $\hat{R}$ being an incident weak sum matrix. To achieve the second property we force $R - \hat{R}$ to be elementwise nonnegative.
Let $\tau(R)$ be a set consisting of cost vectors $\hat{p}$ such that:

1. $\hat{p}$ is a linearization vector of $\hat{R}$ with $\hat{R}$ being an incident weak sum matrix;
2. $R - \hat{R} \geq 0$.

Note that for all $\hat{p} \in \tau(R)$ we have:

$$\min_{x \in X}\{x^T R x\} \geq \min_{x \in X}\{x^T \hat{R} x\} = \min_{x \in X}\{x^T \hat{p}\}$$

Indeed, every $\hat{p} \in \tau(R)$ can be used to construct a lower bound for the optimal value of MinRC3. The strongest linearization based bound (v_{LBB}) can be obtained by maximizing over all cost vectors $\hat{p} \in \tau(R)$:

$$v_{LBB} := \max_{\hat{p} \in \tau(R)} \min_{x \in X}\{x^T \hat{p}\}$$

We can prove that this bound can be calculated by solving a single linear programming problem. Recall that the bound v_{LBB} is calculated under the assumption that $\hat{R}$ should be an incident weak sum matrix. For the other sufficient conditions a similar bound can be obtained. Also these bounds are computable in polynomial time.
In literature only full characterizations of linearizable instances are used to construct bounds. We are the first who only use sufficient conditions for linearizability to construct bounds. This method results in simple and elegant bounding approaches.

Comparison of the bounds

We conclude that the linearization based bounds are often the most efficient. This results from the fact that these bounds can be computed by solving a single linear problem, whereas the GL-type bounds are iteratively computed. In terms of quality, the linearization based bound also perform very well. For graphs with a density of 0.3 and up to 180 arcs, the linearization based bounds are often within 10% of the optimum. If we allow more computation time, the strongest Gilmore-Lawler type bound based on equivalent representations of the form R^η provides even stronger bounds. When considering both quality and efficiency, we conclude that the linearization bound based on incident weak sum matrices (v_{LBB} introduced above) performs best. Experiments show that by using this approach, strong bounds for graphs up to 2000 arcs can be obtained within 20 seconds.

To summarize, two new bounding approaches for quadratic binary problems are introduced. First, we improved the classical GL-type bound by simultaneously searching for the optimal equivalent representation of the quadratic cost matrix. In this way the strongest Gilmore-Lawler type bounds are obtained, which result in a significant gain compared to the classical GL-type bound. This idea can also be applied to other quadratic problems, e.g. the quadratic assignment problem. Moreover, we conclude that the very recent idea of applying the linearization problem to obtain bounds for quadratic problems turns out to be successful for the MinRC3 problem. In our research we only use sufficient conditions to derive these bounds, which results in simple, effective and efficient bounding approaches. For this reason, we are optimistic about applying these methods to other quadratic problems as well.

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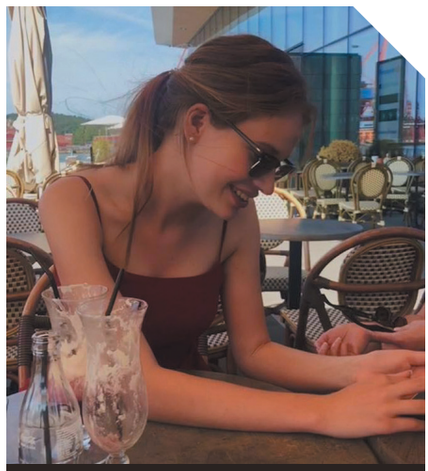
Frank de Meijer
Research Master Student in Operations Research

CSI: Tilburg Crime Scene Introduction



Janne Vos

Bachelor EOR

Age: 18

On Thursday, September 6 the Introduction Activity took place. During this activity, all econometrics freshmen had the chance to get to know each other and the campus in an informal and amusing way.

It started at 16.45 hours. We gathered in the Esplanade building and everyone was divided into small groups to play the game Cluedo. After the group photos were taken everyone shortly introduced themselves and it was time to start the game. The aim of the games we were going to play was to collect as many hints as possible in order to solve Cluedo.

The introduction activity committee did a great job in coming up with games that were slightly to very embarrassing. For instance, in one of the games it was the goal to knock over a bottle filled with water. The challenge in this game was that you could not use your hands, and had to wear a pantyhose with a tennis ball in it on your head. In this way each team member had to knock over a different bottle, which sounds easier than it was. These games were played against the other teams. This competitive way of playing the game was lots of fun, but it of course also created more stress among the team.

This is just one example of a game that seemed very easy, but turned out to be hard. More examples of games like these were putting a cookie on your nose and trying to eat this without using your hands, walking around the fountain with all your group members feet bonded together and transporting a cotton swab with a toothbrush in your mouth.

Luckily, there were some games that were a little less hard. For instance, there was a game in which one team member had to describe words and the other team members had to guess these. Another game that was very doable, was for example to randomly hold the hands of your group members and trying to unfold yourself as soon as possible. Since these games were easier than the others ones, my team and I were lucky enough to gain some hints with these games. The games were a nice way to bond with your group members, since everyone was doing the same crazy things. In the meantime, everyone was still busy in trying to solve Cluedo with the hints that we all received. It was crucial to gain as many hints as possible to solve Cluedo, and therefore some hints were interchanged between the different groups.

During the activity we also got to know the Tilburg University campus a bit better. Each game was behind a different building and was pointed out on a map.

After finishing Cluedo everyone got together at the sports centre for a barbecue. Here the winner was announced. The winning group received a nice prize. During the barbecue everyone was eating the great food while having a few drinks together. Overall, I am glad that I attended this introduction activity. It was a nice way of spending the afternoon and the food was good. Moreover, it was nice to get to know new people.

Ortec Finance: Econometrics, Software and Consultancy

written by **Job Hoven**

Ortec Finance is a Rotterdam-based consultancy company which was founded by a professor of the Erasmus University. They advise their customers by using their knowledge and try to help them to make better decisions. When the company started, all employees were students from Erasmus. Ortec Finance used to be part of Ortec but they have split up and are now functioning as two fully separate companies.

Their HQ is situated in the Netherlands, Rotterdam, but they also have offices abroad, for example in Switzerland, London and Toronto. These offices around the world also help each other. Globally, Ortec Finance employs about 250 people. Joris, 23 years old, has done a Master in Quantitative Finance in Rotterdam and started working at Ortec Finance as Junior Consultant in March. He grew up in the neighborhood of Breda and works now in the Pensions and Insurance department. Most of the time, he is working for Dutch employers. Joris has always been very interested the courses related to Quantitative Finance and consultancy. He does not use his econometric knowledge explicitly all the time at work, like you do at the university. However, the analytical skills you develop as an econometrics student, as well as the model-based way of thinking, do come very much in handy as a consultant at Ortec Finance. Joris receives assignments like making an efficient management policy or modulating the obligations of Dutch

pensions funds. These are long term assignments with lots of councils and calculating. His work is very eclectic: sometimes Joris has to process results into an Excel file, sometimes he needs to prepare a presentation by making a powerpoint, sometimes he is filling in calculations to a model, but of course hardcore programming is involved.

There are also other departments like private client solutions, who are more focused on individual client advisory; a real estate management department, who are doing things like house pricing; a research department, who are trying to keep improving Ortec Finance's technics. Also, there is an investment performance team. Working students and thesis interns are often working in the latter department. You can perform your own research, or you can work on a research line already set out by Ortec Finance.

Joris has good memories of his student life. He advises to enjoy the freedom you have while you still can. He was not part of a study association in his student life, but went on exchange to London in his third year, which he could very much recommend.

> **" (…) they build their own software using advanced models which they use for their consultancy practice. "**

The company was founded by an econometrician and you still notice this throughout the company as everything is built quantitatively on models. Their vision distinguishes them from other companies, as they build their own software using advanced models which they use for their consultancy practice. Ortec Finance is very special because they make software for most of their clients, which they can use themselves after Ortec Finance developed it. Hence, they are actually also a software company. Joris is using a program called Glass. This is a program where you can read the entire financial situations of a pension funds. You can also read the participants of a fund, the investment mix and then by calculations you can create alternatives with this program. You can make a comparison with these alternatives and discuss why this would be better or worse at some points.

Ortec Finance uses its software a lot to produce output for their clients. They get questions from their clients and pass this on to the team who actually programs the software. At first, there were only econometricians working for Ortec Finance. Now, there are more people working with other educations, like Physics or Applied Mathematics. For consultants it is more about the way of thinking that is needed, than the actual applicability of their background knowledge.

Joris works together in his department with a "scrum" team. These are the programmers, people who process everything in terms of software. When they get questions about their software from clients, then these questions are sent to the scrum-team. A department consists approximately for one-third out of support staff and two-third out of consultants. This support staff consists of the programmers in scrum teams and for example teams that work out different scenarios for software implementation.

The hierarchy at Ortec Finance is open and the atmosphere is really relaxed and nice. Sometimes it is of course hectic, but most of the times it is very pleasant. There is some hierarchy at the company, but you do not really notice it on a daily basis. They have every Friday a meeting where all the departments can give a presentation to give everyone an update on field-specific updates. This is always very cosy and helps keeping the relations between the company's employees good. Joris is also planning to go on a ski trip with his colleagues soon.
Ortec Finance is interesting for econometricians because it is very innovative and challenging. They use lots of new techniques.

Currently Joris is really enjoying his job and he thinks that he will keep on working there. He has always been interested in consultancy because of the different aspects it has. He thinks it is difficult to say in which direction he will go in the future. There are some people who try to unfold themselves more in the direction of account management, whereas others try to go more in the commercial direction of the company. Other people specialize themselves in more in depth into specific aspects of the work field. There are many options, but Joris still does not know yet which direction he wants to go to. He is still being challenged in his current job which he really enjoys. The company is also still growing and he would love to be part of this growth in the future too.

Joris Taks
Age: 23
Function: Consultant
Education: Quantitative Finance
Alma Mater: Erasmus University

ORTEC FINANCE

A Remarkable Start to the New Academic Year

written by **Guus Vlaskamp**

The academic year in Tilburg is traditionally opened with a show of gratitude and respect to the two sides of the coin that make Tilburg University. On one hand academia and the scholars of the university, and on the other hand the students and their ever active extracurricular life.

The day started off with the official opening of the academic year, which also marked a special occasion as it also was the first time that this ceremony took place in the newest building: the CUBE. The afternoon filled with tradition as was first displayed by the entrance of the procession. After all attendees were asked to stand up, an impressive number of professors, wearing toga and beret, entered the auditorium. Speaking of traditions: still a prayer marks the character of this event.

The first speech of the afternoon was given by dr. Emile Aarts, Rector Magnificus. Focused mainly on the current state of the university and the vast number of factors that together constitute the 'current state' of the university this speech provided the attendants with an insightful perspective on the university. The responsibility of following up this speech fell to Ingrid van Engelshoven, Minister of Education, Culture and Science. She was welcomed to the university amidst protests against temporary contracts in the academic world, which immediately placed her in a tough spot to present her own view on academia. Her speech revolved around her expressed wish to open up universities and academic education to all groups in society. She also shed light upon the plans of the current administration to lower the allowed BSA for universities to 40 points. All in all, as Aarts was able to provide us with a coherent insight of the view of the university, Van Engelshoven gave us some insight in the governmental side of things.

More speeches were given by both prof. dr. Koen Becking, president of Tilburg University and Lina Segers, former independent chairman of Asset. Becking used this opportunity to present the vision of the university's board on the future, together with some critique on the current administration. This last fact was amplified by the fact that the accountable minister was present. This show of loyalty to the academic workforce by the university's president was often met by applause in the auditorium.

Lina's speech was the kickoff of the student side of this day. She praised the possibilities that students have at Tilburg University to develop themselves, in- and outside the lecture rooms. As chairman of Asset she was the face of our student association and therefor her words definitely gave weight to the student perspective of life in Tilburg. The rest of the day kept the focus on this perspective. It was time for the TUC, the Tilburg University Cantus. This fantastic event is aimed to thank the vast total of 2500 active students for their participation in society, by organizing a both enormous and awesome cantus. As tradition prescribes, a number of beers were drunk, a lot of fun was had, and unforgettable memories were made. ●

Bas Dietzenbacher
is a research fellow within the International Laboratory of Game Theory and Decision Making at HSE University in St. Petersburg, Russia. From 2010 to 2018, he studied at Tilburg University and finished the Bachelor Econometrics and Operations Research, the Master Operations Research and Management Science, and a research Master and PhD program in Business, Operations Research.

Towards the Defense

With the defense of my PhD dissertation on August 31, a period of eight years at Tilburg University came to an end. Although it sounds like a long time, I consider it as a very enjoyable period in my life, especially the last years as a PhD researcher. But what is a PhD? How do you get it and why would you get it? I would like to shed some light on these questions and, more importantly, their answers.

PhD stands for 'Doctor of Philosophy' and is the highest academic degree one can achieve. Since I am neither a doctor in the sense of a medical expert, nor a philosopher, you could be wondering whether I have been manipulating the evaluating committee. However, you should realize that 'doctor' is a Latin word for 'teacher', and 'philosophy' can be translated from Greek into 'love for wisdom'. Hence, I am qualified as a teacher who loves wisdom, could have been worse.

Like any other academic degree, you can achieve it by following a corresponding program, writing a thesis, and defending it. However, contrary to most degrees, you do not follow a PhD program as a student, but as an employee. Some people like to say "een baan krijg ik nie, want ik doe PhD", which is in fact a contradictio in terminis, since doing a PhD is already a job! This also means that you have all rights and duties of an employee, like having a boss and getting a salary.

What does the university want back for this money? Well, in general you are supposed to spend eighty percent of your time on research, and twenty percent on education. This roughly means that you spend one day a week on teaching tutorials, instruction lectures, and computer labs to students of our faculty, and the remaining time on research projects under supervision of one or more professors of our department. This research results in scientific papers which you try to publish in international journals.

Doing research can only be pleasant if you have a strong interest in a specific, often theoretical, research area. For example, there can be a course which you liked very much, or an exciting topic on which you wrote your Bachelor's or Master's thesis. If you would like to acquire more knowledge, even contribute a bit to knowledge, and like to share knowledge, then you should definitely take a PhD program into consideration. Moreover, you need a nice professor who shares your interest and is willing to cooperate with you for several years.

Note that a doctorate degree is necessary for an academic career, but it is also valuable for a business career. If you want to become a professor at a university, a PhD is a basic requirement. Besides, several business employers appreciate job applicants with a PhD, since it is a sign of strong analytical skills and the ability to conduct research independently.

You cannot freely start a PhD program. First, you need to finish the three-years Bachelor's program and a two-years research Master's program. In some cases, it is allowed to continue in the second year of the Research Master when you have finished a regular one-year Master program. During the research Master, you can apply for a three-years PhD position.

All these years you work towards the defense of you PhD dissertation, an official one-hour ceremony in the auditorium of the university. After a laymen speech, the committee members - professors from different universities who are wearing togas - consecutively ask questions which you need to answer in front of the audience. It concludes with the words of the beadle "Hora est!". ●

Blissful Behind the Bar

written by **Ridho Hidayat**

Behind every successful association is a group of dedicated individuals. For Asset | Econometrics, one may think of its active members, and in particular its board members, who all contribute to making the study association an invaluable addition to the student life of econometricians. However, there are some other people that are inextricably connected to the association, but who rarely take a place in the spotlight. In this volume of Nekst, we get to know these individuals better. This way, we give them the recognition they deserve in a newly introduced article: Familiar Faces. For the first edition, Job Hoven and I interviewed a true 'people person', someone who always brings a lot of positive energy and who is an essential part of our unforgettable nights at De Heuvel Gallery: Patricia Villevoye!

If you have ever been to a drink of Asset | Econometrics in the last years, you will undoubtedly have seen Patricia before. Most of you will probably have spoken with her as well, as she loves chit-chatting with other people. Together with her partner, Patricia has been running party venue De Heuvel Gallery, which includes café De Nachtwacht for six years already. Here, Patricia hosts all kinds of parties - including my own graduation party - and the drinks of several associations. She is mainly concerned with making sure that each party is as fun as can be. Her partner, on the other hand, is concerned with the commercial side of the business. He also hosts the larger events, such as techno parties, since Patricia is not in her element when she has to keep track of a large staff and so many guests.

Patricia thoroughly enjoys her work: she loves being among students as it keeps her young. According to her, the students at her drinks are always happy and never cause problems. However, on second thought, 'never' may not be the correct word. She remembers a drink from study association De Smeetskring in café Qwibus. Back then, when she did not own De Heuvel Gallery yet, café Qwibus was the place to be for all the drinks. During this particular drink, two freshmen snuck upstairs, where they found some bean bags. Since they already drank some beers, it obviously seemed like a good idea to jump on these bags. Well, it was all fun and games until one of these bean bags popped and everything was covered in white from the content. When Patricia confronted the students - one of them looking as white as a snowman -said: "I really did not do it Patricia!". It took them forever to clean the place, even with the help of the board members, who were not amused either. However, the two guys apologized to her and gave her some flowers afterwards, so Patricia can laugh about it now.

Born for the job

Interestingly enough, running a party venue was not always Patricia's dream job. In fact, as a child, she always said: "I am not going to work in the hospitality industry." Growing up in Goirle, her parents also owned a café, so she quickly learned that having such a job often means having to work when others are free: in the evenings, during the weekends and even during the holidays. This was not quite the future she had in mind. However, Patricia has always been quite talkative, and she has always enjoyed being around other people. This may also explain why she did not enjoy studying, and why she often skipped classes. In the end, she did not finish her studies to be a social welfare worker. Instead, she started working as a receptionist at the social services office, after having done an internship there, because she loved the interaction with all the people. Altogeth-

er, she worked there for about twenty years. However, everything changed when she fell in love with her current partner.

When she met him, her partner already owned café Qwibus, which was named differently then. However, he then started a new company, which took so much time that he was not able to run the bar by himself anymore. That is when Patricia quit her job and stepped in to take over a part of the work at Qwibus. It turned out that she was born for the job. She hosted the drinks of Asset | Accounting & Finance and De Smeetskring with great success and Patricia quickly became popular among students. Later on, Asset | Econometrics came into play when former board member Fang Qi approached Patricia for a constitution drink. Since then, Patricia has been indispensable for our association as well.

Patricia's pastimes

Although Patricia loves her job and often works long hours ("forty hours is nothing"), she also has an enjoyable personal life. Most importantly, together with her partner she has two sons, aged fifteen and thirteen. This family of four - or five if you include their blue-eyed white cat Snoopy - likes to spend time together. During the weekends, Patricia can often be found along the sidelines of the football pitch, cheering for her sons. Actually, she is more concerned with chatting with other parents than watching the game, so she may not notice every goal. However, if she does see them score, she is extra proud.

Her sons are quite sporty, but Patricia is quite adventurous herself too: for instance, skydiving is still on her bucket list. During their last holiday to France, they also did various sportive activities, such as canoeing and zip lining. However, her favorite holidays are still those in which she can fully relax: going to an all-inclusive resort in Turkey or Egypt and just lying in the sun until all her muscles hurt from being immobile the entire day. That is the perfect way for her to clear her mind. Another hobby that helps her relax, is being creative with all kinds of arts and crafts activities, such as decorating plates with porcelain. She loves pottering around, not having to think.

Passion on the podium

Perhaps the hobby that Patricia is most passionate about, is singing. Ever since she was a child, she has enjoyed taking the microphone and singing her favorite songs. Patricia likes a wide variety of music, anything from top 100 songs to disco and dance classics, and from ACDC to Robbie Williams. Her favorite song though, which you may have heard her sing occasionally during the drinks, is 'Why Tell Me Why' from Anita Meyer.

Patricia has not only sung in front of the mirror or from behind the bar her entire life though. Together with a colleague from the social services office, she started her own cover band. They found two other musicians on Marktplaats and soon after they gathered the rest of the band. They had everything they needed: three singers, a drummer, a guitar player, a bass player, and even their own soundman. Together, they covered all their favorite songs, and played on weddings and other parties, which they did for ten years.

She loved performing on stage. However, her life changed when she started working in café Qwibus. Unfortunately, what she saw from her parents during her childhood also applied to her own life. Working in the hospitality industry means you often have to work when others are free. As a result, it became impossible to combine the band with the bar. Her band practiced hard every week, but Patricia simply did not have the time to learn the lyrics and be prepared all the time. In the end, she decided that her work came first, so Patricia and the band each went their separate ways.

Looking forward

Looking at the future, we asked whether Patricia and her partner have any ambitions to grow, perhaps expanding with extra venues. While her partner can sometimes be full of new ideas, Patricia likes it just the way it is now. They already sold café Qwibus because they were competing with themselves, and now they can fully focus on De Heuvel Gallery. It is a great location with enough room for new concepts, such as their own indoor barbecue restaurant Smikken & Smullen. Patricia also thinks she will continue to host drinks and parties for many years to come, since that is what she loves the most.

We would like to thank Patricia for the time she took to give us a nice insight behind the bar and into her life. Let's hope that she continues to be a familiar face in the future, because I think we can all agree that she is a very important asset to our association.

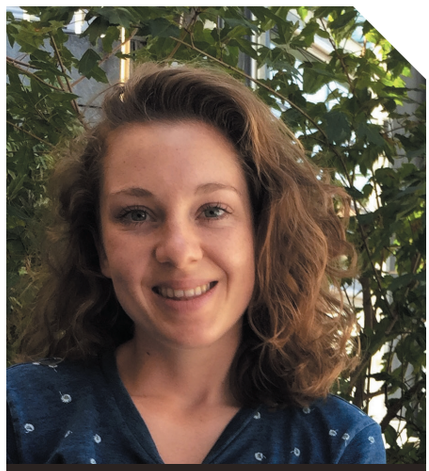
Patricia Villevoye
49 years old
Hospitality entrepeneur

Bert & Ernie Questions

Beer/Wine
Tilburg/Goirle
Fries/Pancakes
America/Asia
Using a calculator/Mental calculation
Singing/**Working in the hospitality industry**

Actuarial Science in Practice

Actuary Day? Boring? Dull profession? What even is an actuary? I can hear you thinking.



Puck Vlaskamp

Master QFAS

Age: 23

Wednesday September 19th Asset | Econometrics hosted the Actuarial Day at Phil in Tilburg. Several companies, as well as the Actuarial Institute and the Executive Master of Actuarial Science (EMAS) represented the profession of an actuary for the students who were interested in either the Master, post-Master or entire career in the field of actuarial science.

The day was certainly not boring at all. As we were pampered with a great 26 degrees hot sunny day and some luxurious coffee, drinks and meals, the atmosphere between students and the professionals stayed fun and enthusiastic until the late end of the day.

With a large attendance of 25 Bachelor's and Master's students, the members of Asset | Econometrics started off the well praised organized event. Corné van Iersel from the Actuarial Institute held a rather interesting speech with the message how actuarial science evolved into a multidisciplinary field, just what econometrics entails. Like the typical actuary by profession will tell that they accidentally rolled into the career because they enjoyed biology, physics or mathematics and found the job of an actuary leading the rankings for job placement back in the days. And like the typical actuary of age will tell how they started with a calculator simply calculating present values of insurance premiums, which quickly evolved to using financial models with constantly new computer programs adhering to enormous and detailed regulation.

As data scientist has now taken over the title of sexiest job and nr. 1 job placement, actuarial science is still in the run for a challenging and diverse career prospective. Not only needs an actuary knowledge of the math behind insurance by itself, one also needs to apply data science, risk management, banking, asset liability management, and create financial models. The econometrics Bachelor's at Tilburg is a perfect building block for the entire toolbox you need to enjoy working with as an actuary. However, the Master of Quantitative Finance and Actuarial Science thereafter is not enough to become a certified actuary we learned. The university also provides the Post-Master in Utrecht to complete the entire track. A long way to go; an exciting one we experienced!

Our first encounter with actuarial science was through a case-study given by Milliman. The two actuaries were Tilburg alumni in both the Bachelor's and Master's, and fully certified. The debates to sell or buy a merging insurance company were a challenging start.

After the lunch, Koos Gubbels who works for the Volksbank and is in charge of the EMAS provided us background knowledge of the post-Master. Back to a hands-on experience with actuarial science, Triple A provided another highly competitive case where all groups had a lot of fun participating in. My group saved a pension fund with a really high funding ratio, however, we took advantage of learning the model first. Or in other words, we cheated to get the best feeling of the investment game. Karma we did not deserve to win.

The Actuarial Institute and EY joined for the delicious dinner where we could not stop talking about the profession and how the consultants enjoy the social gatherings alongside their work. I hope it was not just me to conclude the successful day got us motivated to be working in the financial world as an actuary and complete the educational path to get there!

Perfect Start to a New Academic Year

Jochem Bruijninckx

Bachelor EOR

Age: 21

The most recent Departement Members' Meeting of September 11, 2018 was an exceptional moment for our new board as Asset | Econometrics' members unanimously voted in favor of their appointment. Given that for Loes, Anne, Rachel and myself this also meant the definitive closure of our year as board it was of course a memorable evening for us as well. Still, apart from being an emotional experience for past and current board members, there is much more to the DMM that makes it such a valuable event for all attendees, about which I would love to tell you more!

Every academic year, Asset | Econometrics holds two regular Department Members' Meetings which are open for all its members to join. The main contents of their respective agendas are quite similar. The policy for the current academic year and the progress on its points of focus are discussed, the budget and financial state of the association is presented by the association's Treasurer and during both meetings the board updates the members on any new and important developments within Asset | Econometrics and any parties it collaborates with. What sets both of these sessions apart is that the first DMM of the academic year puts focus on the transition to a new board, policy and budget whereas the second one, which is held midway through the year, mostly serves to update members on how the policy and budget have fared so far.

What really helped me to appreciate these meetings is the chance they give you to get our members involved in what it is you do as board. Over the year, we have spent countless hours confined in our lovely rooms in the Esplanade building and (nearly) every single one was spent working - but if you were to ask me on what, you would definitely not be the first and I would still not be able to give you a concrete answer. The DMM is therefore always a great opportunity to thoroughly walk through all important proceedings within the association and discuss them step by step. Often, you will find that when given the chance to look behind the scenes, our members will give valuable insights or simply provide a fresh perspective on things you have spent months working on. In the end, every bit of effort done by the board is carried out to improve what the association can do for its members and there simply is no one better to advise them on where and how that effort should be put to truly achieve this than the members themselves.

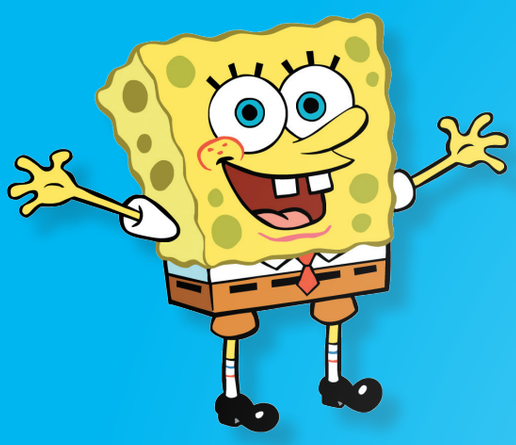
Even though I did promise you to focus on aspects of the DMM besides its emotional value to myself, I do want to briefly touch on it. Looking back on everything we have spent the last year working on, on everything our members have worked to create and organize during that time. And - most importantly- on all the fun we have had while doing so was a great experience.
In writing my last 'Dear Members' for the previous edition of Nekst, I was very glad to have a chance to convey the sincere feeling of gratitude we have for all members that made our year so great but, as old-fashioned as it may seem, nothing beats thanking our members and concluding our year in a setting as tradition-packed as the DMM. Where we sit in the cosy atmosphere of De Heuvel Gallery's meeting room, wearing our board suits for their intended purpose for the very last time and being accompanied by our members made watching that decades-old hammer go down for a definitive closure ever so special.

If you would like to learn more about the inner workings of the association or if you have some great ideas to share about the course Asset | Econometrics should follow, then make sure to join the next DMM on January 15. If such an extensive meeting might seem a bit exhausting to you, then do not worry: they are always followed by a great party to replenish your energy! I would like to thank everyone who was present during the last DMM for their involvement and the members of the new board for organizing a Constitution Drink afterwards that was so great that I unfortunately do not remember too much about it - it was the perfect start to a new academic year. ●

Board 2018-2019

ASSET Econometrics
The Eighth Wonder of the World

f.l.t.r: Joris Pirée (External Affairs), Wenxin Lin (Secretary), Quirien Raat (Chairman), Jelle Sieben (Treasurer), Nina Cuypers (Internal Affairs)



Ohhhh! Who lives in a pineapple in building E?

SpongeBoard Squarepants!

When asking a former boardie about their board year, they will probably say it was the best year of their lives and a year never to forget. Being brand-new boardies, we, the fourtiest board of Asset | Econometrics, were of course very curious about the trueness of this statement and whether we may expect to feel the same after the upcoming year. Luckily, we had the chance to interview Loes, Jochem, Anne and Rachel about all of their experiences and discuss the good memories of their board year. Let's look back on the year of board number 39 or, as they called themselves, the *Kanjer Kwartet*!

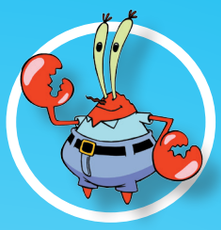
written by **Wenxin Lin**

What was the best moment in your year as a board member of Asset | Econometrics?
Anne: "This interview, since we get the chance to look back on last year and retrieve all good memories."
Loes: "The moment when we had just become a boardies, since at that moment we were still full of ideas and plans for the next year."
Jochem: "The last DMM when we could close this year and look back on everything we have achieved. I think we can be really proud of ourselves and I am really looking forward to it. Of the past year, I think that the best moment was the LED, since we got the chance to show what we are capable of as an association."
Rachel: "The moment when we resign and we get to see how our ideas and everything we have organized will work out."
Anne: "There are so many nice moments, that it is very difficult to pick one."

During a board year, you achieve lots of things for the association and for yourselves. What are you most proud of?
Anne (pointing at her fellow boardies): "Of you guys! Even though things did not always go according to plan and there was a lot of work, we always managed to push through this chaotic year."
Rachel: "I'm proud of Anne for her answer."
Loes: "On my cartoons in Nekst and how the four of us were always very enthusiastic and gave 200% when things did not go as planned."
Jochem: "On behalf of my board, I'm proud that we were never afraid to change things in the association even though there were lots of traditions. Personally, I am very proud of the Career Platform Tilburg."
Rachel: "I am already proud of this board interview! I am also proud of more than 40 events in the past year and participating in the Alpe d'HuZes."

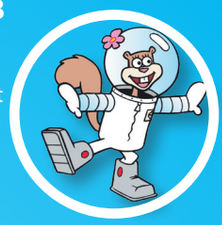
And what are the most important lessons that you learned during this year?
Anne: "Zero-six, no stress. Haha, this rhimes (in Dutch it does, red.). Sleep is for the weak… and I am very weak. The fact that it is not possible to always be a perfectionist."
Rachel: "Taking initiatives, otherwise nothing will happen. I need at least 2.5 hours of sleep."
Jochem: "Be realistic in what you are capable of and be realistic in the goals that you set for yourself."
Loes: "To use your time functionally."

What was your favorite event of the past year?
Loes: "At the start of the year, we wanted to organize a ski trip, but unfortunately this was not very doable for ourselves. Luckily, the Asset ski trip was a huge success and lots of our members got to come along."
Jochem: "The Europe Trip and the International Business Tour (IBT) were very nice."
Anne: "The Apres-Ski drink was very nice as



Jochem - Treasurer 2017-2018

With his very dry sense of humor and his random reader always being nearby, Jochem obviously was the Treasurer of last year's board. Even though he liked being able to spend large amounts of money, don't ask him for money again this year, because Mr. Krabs is very careful with his money!



Rachel - Internal Affairs 2017-2018

Characterised by her bubbly personality full of positive energy, Rachel is what you would call the perfect Internal Affairs. With her many quatsches, maybe Rachel actually is a bit more like Patrick, but her goals for this year are to become a fit girl like Sandy!

Loes - Secretary 2017-2018

Her creativity and her love for the Nekst committee are of course what made Loes the ideal Secretary, but her fellow boardies will also remember her by her great love for food and her happy socks. Don't be scared when you hear some weird noises coming out from under the table, this may just be Garry! Hatsjieee

Anne - External Affairs 2017-2018

As External Affairs it is important that you like to chat and keep calm under pressure. Luckily, Anne's motto last year was '06 geen stress' and her Limburgs accent did not keep her from her love for talking. Together with her cheerful character and her crazy moments, there is no way to tell Anne apart from Spongebob anymore!

well!"
Rachel: "I think that the Active Members Weekend (AMW) was my favorite. During the weekend itself, it sometimes was really hard, but afterwards it was great to see that we were able to entertain 70 econometrics students for a whole weekend long."

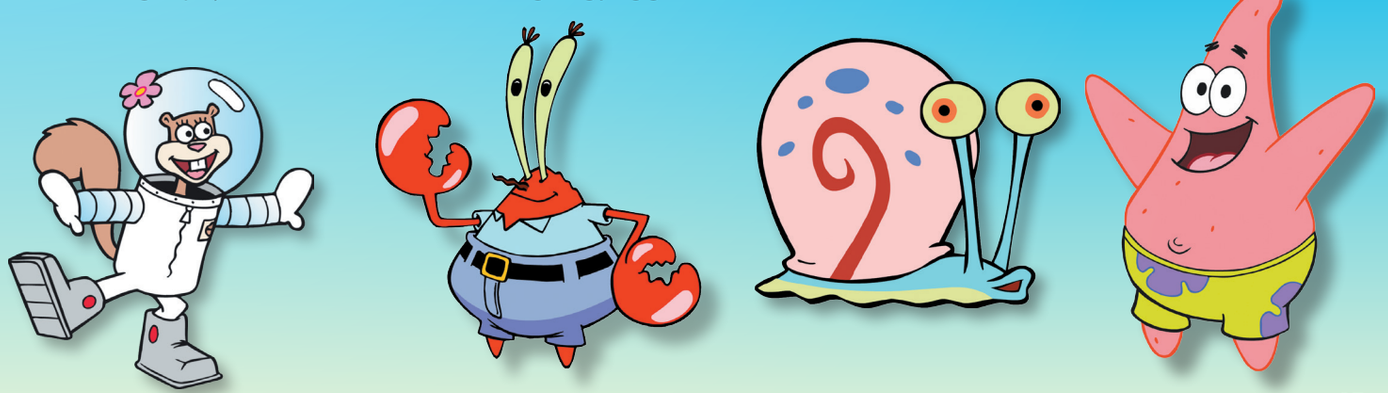
As a board member, you do not only experience one or maybe two committees, you get to know almost all of them! What was your favorite committee?
Rachel: "The AMW and Education committee. The AMW committee was just fantastic! They wanted to do lots of things, of which also a lot of stupid ideas that were impossible in practice. It was a really fun event to organize."
Loes: "The Nekst committee, because of the hard-working members and their enthusiastic ideas. And the Freshmen committee, because theys were always very fun even outside of committee stuff.'
Jochem: 'The Drinks & Activities committee, because they were always very relaxed, but they still did their work well. I think our events and drinks were always very nice!"
Anne: "I think the IBT and Sports committees were always very fun with nice people! I think I will choose the FinEx committee as my favorite in the end, since it was a very different from the other committees and it had different group dynamics."

You also dined with all of the committees during the past year. Which committee dinner was your favorite?
Jochem: "The dinner with the Freshmen committee, because we played a great game of 'stiften'."
Loes: "The FinEx committee dinner, because we didn't know all of the committee members yet. Oh, and they had an amazing grilled cheese with spinach! Ooh and the IBT committee dinner, because of the delicious food."
Loes drools some more whilst thinking about the amazing food at the IBT committee dinner.
Anne: "The AMW committee dinner (who were also the winners of the committee dinner!), because of the delicious food and the special game of rage cagen that we played."
Rachel: "The Sports committee, because of the food and the Taylor Swift and High School Musical karaoke that we did afterwards."

What was your best quatsch of last year?
Jochem to Loes: "Nies gewoon als een volwassene, downie"
Anne: "Ik ga naar de oostkust van Frankrijk op vakantie"
Rachel: "Hij komt echt niet uit 1994, want hij is onlangs nog jarig geweest." and "Ik heb zin om iets gezonds te eten. Zullen we Burger Business bestellen?"
Loes: "Ik vind eigenlijk niks mis met het golddigger concept." and "Ben ik nou zo incapabel of lukt het echt niet?"

What was the most awkward thing you did last year?
Anne: "Doing body shots with Max during the IBT committee dinner."
Loes: "When Jochem had to imitate an intimate moment during our conveyance weekend. Also, I attended the presentation of a company I had to guide during the EBT, where I sat on the front row. Suddenly, I had to sneeze and I sneezed towards the inside of my elbow. But when I looked up, there was a gigantic blob of snot on my jacket. I had no time to go and clean myself up, but I tried to solve this to the best of my ability."

What is the most useless thing you have done in building E in the past year?
Rachel about watching a Disney movie at the rooms: "But I had never seen it before!"
Jochem after thinking very hard about what activity is actually really useless: "I practiced for hours and hours to do an 'omhaal' with foosball. It was very hard and I was very proud when I succeeded." Jochem explained that for a 'omhaal' he managed to push the ball up against the edge such that the ball landed on the feet



of the little puppet and he was able to shoot the ball through the air.
Anne: "Waiting for the very very slow computers at the rooms."

What are your plans for when you finish your board year?
Anne: "Catch up on sleep and go on holiday. I am going to finish my Bachelor and start sporting again."
Loes: "Studying and I am going on holiday at the end of every month this half year. I also want to start sporting."
Jochem: "Studying and catch up on eating."
Rachel: "Studying, working and I will remain in the Almanac committee. I will also go to Seoul during the IBT. Ooh and I will become a fit girl again together with Anne."

What are you going to miss most next year?
Loes, Anne and Rachel: "We always found it very nice to have so many people around you at the rooms. Even though they often made it hard for us to focus on work, this is really what made days at the rooms more fun."
Rachel: "And you guys! During the christmas holidays, which only lasted two weeks, I already started to miss you. It really is true!"
Jochem: "I am going to miss being able to do things that really have a big impact. For example, as treasurer, it is nice to make spendings of 1000 euros, but next week the largest amount I spend will be 5 euros. It is cool that when the four of us decide to organise an event, we really get the opportunity to actually set up such an event a few months later."
Rachel: "Being productive in the morning and being able to discover the association."

Do you have any last wise words for us?
Loes: "It is smart to connect a lot with the other Asset boardies, since you will have to work together very often."
Anne: "Take the time to step back every once in a while and enjoy all the great stuff you are doing."
Jochem: "Failing is better than not trying, and be realistic of your capabilities."
Rachel: "Realize that Asset|Econometrics is not everything in the end, so make sure not to set certain things aside because of your obligations at the association. You will regret this at the end of the year."

During a board year, you will not only learn a lot about yourself, but you will also get to know your fellow boardies on a whole nother level.

What did you all like most..

...about Loes?
Jochem: "I like the creative side of Loes."
Anne: "I like the socks that Loes wears."
Rachel: "Loes is always very helpful. When you ask her for something, she always does it and often almost immediately."

.....about Anne?
Loes: "When Anne suddenly gets very enthusiastic."
Rachel: "I just think Anne is a sweetheart."
Jochem: "I think Anne is a very nice person to brainstorm and discuss with."

...about Rachel?
Anne: "The many adventures that Rachel and I went on this year like hitting the road together and climbing the Alpe d'Huez. Rachel is very sweet."
Jochem: "Rachel is never grumpy or anything like that. She is always very positive. Even when she is frustrated, it is in a positive way."
Loes: "The fact that Rachel can be enthusiastic about literally anything."

...about Jochem?
Loes: "His feedback on my creativity."
Anne and Rachel: "His very dry sense of humor."

And what is the craziest/weirdest thing you have learned...

...about Loes?
Anne and Rachel: "Her cursing."
Rachel: "The sneeze."
Jochem: "The fact that Loes would rather go and lay under a table during a hangover."

....about Anne?
Loes: "Her Limburgs accent, especially the way she pronounces pizza and 'raar.'"
Rachel: "When you have your crazy moments."

...about Jochem?
Anne: "The fact that you can forget to eat."
Rachel: "That your sense of humor doesn't drive you nuts."

...about Rachel?
Anne: "Her look as if she is watching water burn."
Loes: "Forgetting that you kept stuff at the rooms and then blaming your sisters for taking it."

Where do you think everyone of your board will be in ten years?

Rachel will have many children and Anne believes that Rachel will even have triplets. She will meet her future husband because of handball or at the printing machine according to Loes.

Loes will live in Eindhoven in the neighborhood of her parents in law together with her husband and her two children. This is very convenient, since they can easily watch the children this way. She will be working at a cool marketing office for a maximum of 32 hours per week.

Anne will have a great career, maybe even internationally. She and her possible partner will be settled and trying to have children. Her fellow boardies have the fullest trust that Anne will be a great mom.

Jochem will either start an IT company on a freelance basis where he can take on his own projects or his band will have a break through and Jochem will become a rockstar with long hair.

	Loes	Jochem	Anne	Rachel
Favorite drink	Iced coffee from the McDonald's	Apple Bandit from Patricia	Double espresso (5-0-0)	Cranberry juice, Vivit or Optimel
Favorite 50ct candy shop item	Skittles	Cassis	Fuze Tea Mango Camomile	Cassis
Favorite promotional item	Notebooks	Cotton bags	Bath robes	Well then there is nothing left for me :)
First to arrive or last to leave?	First to arrive	First to arrive	Last to leave	Last to leave
My board year in one word	Hectic	Revealing	Vegetable garden	Sleep deprivation

We would like to thank the former board for all their hard work. We hope the board of 2017-2018 will never forget this amazing year and we wish them all the best in the future. Loes, Jochem, Anne and Rachel, thank you for everything!

Five Awesome Days

Gitte Snoeren

Bachelor 1st year

Age: 18

From August 20 till 24, the famous TOP Week took place. It was an amazing week to start the new academic year. In this week we got a lot of opportunities to get to know the city, the university and most importantly, our fellow students. All the new econometrics students were divided into several groups consisting of approximately 20 students. Thanks to such big groups, we can make more friends and now always see at least a few familiar faces in class.

On the first day, Monday, we had to gather very early at 8.30 hours for the long day ahead of us. At the beginning, we mainly focused on getting to know one another. A big challenge was remembering names of everybody. Then we started our first game: you had to solve puzzles in order to get a clue where to find the next one. Our group was the fastest to solve all the puzzles so we won a party package. What a great way to start the week! Afterwards, we had lunch together to get some new energy for upcoming and more exciting things, namely the Asset Introduction activity with some very funny games, such as a survival track or a very big ball on which you had to sit and your team had to push you to the other side. Not only are these games fun, they also require a great amount of teamwork, which made sure we got to know each other better. At the end of this introduction activity, we thought it was time for the first get-together with some nice beers and games. We all went to the house of our Intro Papa and had a nice afternoon there. In the evening we had a BBQ and the TOP-ON festival at the Spoorzone. This festival was only until 11:00 hours so afterwards we went to some bars to have some more drinks on a very successful first day.

We started our second day with breakfast at a café and then went to the Decathlon Sports Day at the Leijpark. There were many stands with fun games, organized by all the different student groups, study or sport associations. During this day, we could get to know all the different associations in a very interactive and lively way. For example, Vidar had some rowing machines with them and organized a competition for the fastest rowers so many people could try and see whether rowing is something they would like. There were also many things with water, such as a big sliding track which was really fun and also very nice to cool down from the hot weather. After the sport day, we went to the house of our Intro Papa again to play some games and have some cold beers. In the evening we went to Vidar for a tour around the accommodation and ate

delicious lasagna. The second day also ended with our group going together to some bars.

The third day, in my opinion, was the best day of the week. We started the day with breakfast at a café again. However, many people missed this because it was quite early after a night out. Around lunch time, we had the 'recharge lunch' on campus. There were many food trucks where you could have some delicious food and healthy drinks. Then the best part of the day started: the cantus! In the Spoorzone, the enormous hall was filled with long tables, benches and a great many people were all singing along to the exciting and catchy songs. The cantus was really a lot of fun! After the cantus are the evening program and the international student association I*ESN.

On Thursday, we had the TOP Festival at the Muzentuin, which was set up really nice. There was a big stage with a DJ, food trucks, places to chill out, and even a secret party spot behind the toilets. What a wonderful afternoon. After the festival, we went to Olof and had a cool party there and ate pizza.

There was also a beer estafette where the different groups had to battle each other. This was really entertaining, and our group did very well and even managed to make it to the finals. In the evening you could go to an outside cinema in the Willem II Stadium; unfortunately, we did not go so I cannot tell you how that was. Instead we chilled at our Intro Papa's home again and similar to all the other days, we went to some bars, which, again, was a lot of fun.

Then the last day came. Although swimming at Stappegoor was on the program, I was not able to be there on time so I can not tell you how it was. However, from what others told me, it was a really refreshing afternoon. In the evening program today, we went to check out Plato, which got really delicious spaghetti and the party over there was, again, awesome. After this, the TOP Off party took place so that we could end the week in the same way as we started it, with the TOP On party. Finally and unsurprisingly, we went to some bars again to end this wonderful week.

To sum up, five days of TOP Week program were awesome. They really gave us a great start of our university life. We got to know the city, the nightlife, the university and our fellow students. Therefore, we want to thank the organization for making this all possible and our Intro Papa's and Mama's for accompanying us all week long, showing us the city and making sure we all had one of the best week of our lives. ●

> **"To sum up, five days of TOP Week program were awesome."**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Nobel Prize in Tilburg

Theo Nijman
is professor of Financial Econometrics in the EOR and Finance departments. Theo is Scientific Director of Netspar, a knowledge network with eight universities and many private partners from the pension industry. Besides his academic work, he is heavily involved in pension regulation and reform in the Netherlands.

In recent years the Nobel prize has been assigned twice to great econometricians with clear links to Tilburg. A fantastic opportunity arises to honor one of them and learn from his most recent insights. On November 15th, the Dies Natalis (birthday) of Tilburg University, Lars Hansen will get an honorary doctorate from Tilburg University. I vividly remember the first time we met. It must have been in the late nineties when he visited Tilburg for a week or so. A soft knock on my door, and a friendly modest person, eager to meet senior as well as junior researchers in Tilburg.

Interaction with top-researchers is highly stimulating if not vital for young researchers. I have been so fortunate already in 1987 to visit Rob Engle in San Diego. Rob was by then exploring models of the conditional heteroskedasticity, which is very much present (e.g. in daily stock returns). These GARCH (Generalized Autoregressive Conditional Heteroskedsticity) models are now in the toolkit of Bachelor students in econometrics, but fully new and fascinating at the time. These GARCH models were among the important contributions to the literature that motivated the prize committee to award the Nobel prize to Rob in 2003. In 1987 Rob invited me for dinner in his four bathroom villa overlooking the Pacific where I also interacted with his wife and children. Such contacts are highly stimulating and have probably also helped in later years to get my own papers on GARCH (often with Feico Drost) published in top-journals. I remember the first time we presented the paper on change of frequency in GARCH models for an international audience in Paris where it was very well received and where we got lots of useful feed-back from Rob. Likewise I remember having dinner with Feico that evening on the Place du Tertre to celebrate our success. As you see, academic life is tough sometimes… Rob Engle once also visited Tilburg and attended a conference in the first days of December where we treated all visitors on Dutch Sinterklaas sweets, which was often referred to in later years.

Nowadays, history repeats itself. Anne Balter, a young assistant professor in the department, visited the University of Chicago last fall and was invited by Lars Hansen to come over to his cottage in the country side to spend the week-end with Lars and his family. This contact is likely to be extremely fruitful for Anne and for econometrics in Tilburg more generally. Anne not only met Lars Hansen but also Tom Sargent, another Nobel prize winner. And was already invited to return to Chicago for a specialized mini-conference on robust modelling initiated by the two Nobel prize winners.

Lars returns to Tilburg on November 15th. Bas Werker has excellent contacts with Lars in his (very prestigious) capacity of associate editor of Econometrica, where Lars is the editor. Bas will be the honorary promotor explaining why Tilburg University chose to "bestow Lars with the dignity of the honorary doctorate" as the formal reading states. Students are welcome to attend, and also be inspired. Note that professorship in Chicago is not impossible for Tilburg students. Ralph Koijen, one of the best Tilburg econometrics students ever, even returned to Chicago recently after having worked there initially as a tenure track assistant professor.

Research is not only about academic values. Research, and research in econometrics in particular, also plays a vital role in many policy discussions. The award ceremony for the honorary doctorate will therefore be preceeded by an event with Lars Hansen, but also the CEO of APG as well as Wouter Koolmees, the Dutch Minister of Social Affairs (and pensions) will attend. •

Many Thanks to our Professor, Colleague and Friend

On September 21, a VAET-day was organized to honor prof. dr. Talman one last time, as he retired last academic year. During that day, a symposium especially for Dolf Talman was organized and after that, he held his farewell speech. In that speech, he named among others his close colleagues prof. dr. Kort, prof. dr. Borm and dr. Hendrickx, whom Melissa and I interviewed afterwards.

written by **Marieke de Leeuw**

The majority of all (former) Econometrics and Operations Research (EOR) students at Tilburg University probably know prof. dr. Talman as a teacher and must have noticed that last year was his final year working at our university. Moreover, Talman has been teaching at our university since 1981 and subjects he recently taught include Auction Theory within the course Auctions, Bargaining and Networks and the course Microeconomics.

Above that, last year each edition of Nekst contained a column written by Dolf Talman himself, containing information and anecdotes about his academic life. This year, the first edition includes once more an article devoted to prof. dr. Talman, about his farewell speech and stories about him from a few of his many former colleagues at the EOR department.

Given the fact that Talman started teaching at Tilburg University back in 1981, he was the person that had been working for the longest time at the Econometrics and Operations Research department at our university until he retired last September. According to his colleague prof. dr. Kort, Talman felt like the 'nestor' of the department. This feeling of responsibility was mainly due to character traits and only in part because of his experience. Peter Kort, for example, now being the 'nestor' in terms of years at the department, does not have this feeling of responsibility (at all).

Besides having the feeling of being responsible for the EOR department's meetings, Talman has also actually been head of the EOR department during the nineties. He prepared for example the agenda for the meetings very well. This characterizes him, as he is described by his former colleagues as precise man that pays great attention to detail. If prof. dr. Borm would have to describe him with a single word, this would be 'carefulness'.
He quitted being head of the department quite early, as it is a task that rotates frequently between different professors and is very time-consuming. This is mainly because sometimes hard decisions need to be made and of course, there are many other obligations one has as a professor. This includes giving lectures, doing research and guiding students writing their theses on Bachelor, Master's, or PhD level.

One may be wondering which aspect of working at the university Dolf Talman liked the most According to his colleagues, it seemed like he was indifferent between them and liked everything very much, as he always was enthusiastic, happy and optimistic. This agrees with the fact that Kort names 'uniformity' as the word describing Talman the best, in its most positive sense.
However, Dolf Talman did have something that he liked just somewhat more than the other aspects of being a professor. This can also be read in his last column in the previous edition of Nekst, where he describes that contact with students and guiding them with their theses was his favorite activity as a prof. This epsecially concerned guiding PhD students towards their promotion, since the contact with a PhD student is much more intense than with students writing their Bachelor thesis.

He promoted a PhD student many times, 23 to be precise , while the new 'nestor' of the EOR department, Peter Kort, only promoted around 15 students. In one case , they did it together. Talman , cordial as he is, went out for dinner with his PhD student to make them feel more comfortable and less lonely if they were foreign. Or he made kale (boerenkool) for them at least once, not only because Talman likes that, but also to let them literally 'taste' the Dutch culture.
In contrast, Kort did not do these things with his PhD students at all, not because he is an unpleasant man but it is just not in his character. Moreover, prof. dr. Borm talks about this as 'dat moet je maar doen', that is far from self-evident. This confirms that Dolf Talman was very involved with the students.
To give an example , Peter Kort quotes Talman : 'Onderzoek is het belangrijkst, maar

prof. dr. P.E.M. Borm

prof. dr. P.M. Kort

dr. R.L.P. Hendrickx

onderwijs heeft de hoogste prioriteit', which translastes to 'research is the most important but education has the highest priority'.

Above that, Talman was involved with his colleagues as well. As Kort tells us, when there was a problem, not necessarily on the work font but also on a personal level, Talman was there for him. A story that illustrates their amicable relationship is the following: when Talman had his 25th anniversary at the department, he got two tickets for a soccer game of Heerenveen. The one he chose to go with him was Peter Kort, who will never forget this. He felt and still feels very honored.

Not only did Talman teach us various things about microeconomics and auction theory, he also taught his colleagues a number of lessons in life. For example, dr. Hendrickx, who by the way as a student took microeconomics taught by Talman, learned from him that it is very important to pay great attention to making things understandable and being precise. Not only in mathematical terms, but also in textual matter. Borm adds to this the importance of being involved and enthusiastic towards students when teaching a course. Moreover, he emphasizes that one needs to enjoy teaching and needs to be engaged with the subject. Furthermore, regarding to teaching, Kort learned from Talman that when giving a lecture, one should write everything on the blackboard. This immediately sets the lecture's pace. In social respect, he learned that everyone is important and that your door should always be open.

Talman will be remembered for always knowing the weatherforecast of the coming days and knowing weather records in incredible detail. , without having a computer or internet connection at his house. . He will be missed for his random talks on a regular working day as he stopped at every open door at the department one by one to tell his story. This could be about the weather and weather records, like 'today is the hottest day since the year x', but also stories about his cycling hobby or actual fun facts about Friesland. The past few months, these talks were also about applications for September 21st, who cancelled and who applied. He had a nice story of about everyone to tell his colleagues. Sometimes, he even did not notice that he already dropped by at Peter Borm's office, which had been next to Talman's one for almost his entire employment at Tilburg university. In the end, a great number of people were attending his speech, a lot more than is usual for a professor's farewell speech. This was not surprising, as Dolf Talman had been working for 37 years at our university and was a man receiving great appreciation from colleagues, students and peers.

Finally, being retired might open up new world for Talman, as he does not to go to work anymore and has more time to spend to one of his biggest hobbies: cycling. According to his colleagues Kort and Borm Talman talked about buying a house in Friesland a few years ago, as he was born there. The plan was to never (or rarely) come back to Tilburg again. Later on, this strong position changed to keeping his apartment in Tilburg but also having one in Friesland. Just before his retirement, he never spoke about moving to Friesland anymore. Some observant readers must have seen Talman come by at our university frequently after his retirement. This is because he still needed to finish some papers. Ruud Hendrickx does not expect this to change in the near future, as he will keep his own room in building P for the remainder of this of the calendar year and maybe even longer. After this, Talman will have access to the special room for emeriti (retired professors) where an office desk is waiting for him.

Even though Dolf Talman and his former colleagues will certainly see each other frequently in the near future, they want to say some kind words to him once more. Peter Borm and Ruud Hendrickx will be missing Talman very much at the EOR department. He was a natural factor who has silently, but certainly had much influence on the developments of the university and the department, shaping them in the way they are now. It will take some time getting used to not being able to walk along the hallway and just ask Dolf. Peter Kort adds to this that he wants to thank Talman for all the support that he gave him during the years, not only as a colleague but also as a friend.
As Melissa and I walk out the door, asking Peter Kort whether he likes us to leave the door open or closed, he answers 'please leave it open, because that is what Dolf taught me'.

Data Science Makes the Difference

Wouter Ludwig on how econometrics can combat tax fraud

written by **Dominique Bavelaar**

Is there anything an econometrician cannot do?, I was thinking to myself while Bart Rutten and I were travelling back from De Belastingdienst's[1] office, located right in the center of our beautiful country near Utrecht central station. Dr. Marcel Das dedicated his column exactly one year ago to the statement that the answer to my question is negative[2]. Reading about the impact Wouter and his team make within De Belastingdienst will certainly strengthen your belief that dr. Das is right.

Wouter started working at De Belastingdienst in the summer of 2014 as a Data Scientist. The data science department was extremely new back then and Wouter was one of the first employees. Wouter: "We started off with 15 people and we worked on a lot of different projects. The idea was that we wanted to perform tasks that are done all over De Belastingdienst in a much quicker and much more efficient way. We encountered quick big successes: we earned back our budget for three years within nine months!". Wouter and his team make software tools and applications which make it easier for employees of other departments all over De Belastingdienst to actually use the huge amount of data efficiently and effectively. Fun fact: De Belastingdienst has the biggest structured database in the Netherlands!

Given that the workload and the number of projects increased, the department grew to 240 people at the moment I am writing this. However, not all of them are data scientists: there are also a lot of programmers occupied with maintenance of the software code. This growth went much quicker than Wouter expected when he started working here: "Two years ago, when I gave a similar interview to Nekst[3], we were still with 40 people!".

Well, that is good for them - I hear you think -, but how can an econometrician earn big money for De Belastingdienst? That works as follows: a tax authority aims to collect the money from citizens and firms, which these are obliged to pay by law. However, not everyone is as able - in case someone lost their job all of a sudden - or as willing - in case you have just opened a Guernsey-based bank account - to fulfill their fiscal obligations. De Belastingdienst has always had a team of analysts, whose expertise is to recognize all kind of tricks individuals or companies frequently use to evade tax or launder money. However, since there are a lot of registered companies and even more registered citizens in the Netherlands, it is impossible to track down everything. And even when you are on the right track of catching someone, it still takes a lot of time to acquire all the information and power you need to actually get the money. Data scientists can speed up things: "A project I have been working on recently was on *Carousel fraud* (NL: carrouselfraude). This means, simply put, that two firms make an

Belastingdienst

agreement in which one of them builds up a considerable tax debt, whereas the other acts such, that they are granted a tax credit. Then the debtor vanishes all of a sudden, costing De Belastingdienst a lot of money.", Wouter explains," In such a situation, our analysts recognize all kind of patterns, for example when a board member switches between two companies who had tax debts in the past, indicating a possible Carousel fraud. We ordered the team of analysts to explain us all these tricks they recognize, which we translated into decision rules in computer code. That way, networks of firms that are trading with or linked with each other are given a 'suspiciousness-score', after which action can be taken by executive business units". What is nice to note is that this project had a big impact: within the first month after this program was introduced, De Belastingdienst managed to lay their hands on as much fraud cases as during the entire year before!

Even though Wouter has only been working at De Belastingdienst for four years, he is one of the most experienced members of his team. That is why he has also some management responsibilities now: Wouter is currently one of the lead data scientists at his department. However, this does not mean that he is the boss or something: "There is no real hierarchy and the whole team cooperates with each other.", Wouter explains, "It really is teamwork: you work on the same project and you and your colleagues try to make the most out of it. ". The kind of projects Wouter is involved in is really diverse: "A lot of projects is initiated by political decisions. For example, a team in our department is currently trying to find out how to use personal data effectively, while still in line with the new privacy legislation GDPR (Dutch: AVG)".

Also, when *Den Haag* want something to be done real quickly, people from all kind of different projects are asked to solve this problem before returning to their own project. For example, recently there has been a lot of political attention to inheritance tax legislation. The implementation of these new political wishes gets priority over the projects that employees are working on normally. Wouter: " In case you want to work here, you really should be aware that situations like this might happen. On one hand it is nice that you see so many different problems you can solve and make a big impact everywhere across the organization, but I feel sometimes a little unsatisfied that there is not always time to completely optimize a solution before we move on to the next project".

Wouter Ludwig
Age: *32*
Function: *Data Scientist*
Alma Mater: *Tilburg University*

Concerning the atmosphere at work, Wouter notes that he has not experienced a company in his career in which colleagues have so much fun together after and on the job. Almost every week, they have a drink and/or activity together. For example, at the moment your beloved Editor-in-Chief is writing this article, Wouter and his colleagues are racing on a karting track. Wouter also organizes a Hackathon four times a year, in which people from the data science department participate. From this, all kind of interesting stuff arises: from apps to improve social cohesion till real estate valuation software. The latter is actually used in practice right now!

In case you want to work at De Belastingdienst or if you want to write your thesis here, you first have to go through a screening which should ensure that you can handle the available data consciously. On the job, you have to take the initiative yourself in terms of thesis subjects or personal development. However, since De Belastingdienst is huge, almost everything is possible! For example, right now someone in Wouter's department is writing a PhD thesis on how to apply machine learning models in the tax collecting process.

When asked which project Wouter liked most, he answered – after a quick contemplation – the following: "It was actually the first project that I carried out. *Dynamisch monitoren*, it is called. This comes down to the following: people with a tax debt, but without any savings or high valued private property cannot be forced to pay without falling into complete poverty. That is why these people are monitored in the sense that as soon as they have savings again, they can partially offset their tax debt. By using the data we have about these people, we are able to come up with a model that can predict how much savings they will have. This turned out to be quite accurate.". But the best is yet to come: "As a nice bycatch", Wouter continues, "this model also happened to identify unwilling debtors with lots of money at hand. On them it was really easy to take more coercive measures to collect the money. After implementation, we just sat there and watched how the money poured in." •

Career Platform Tilburg

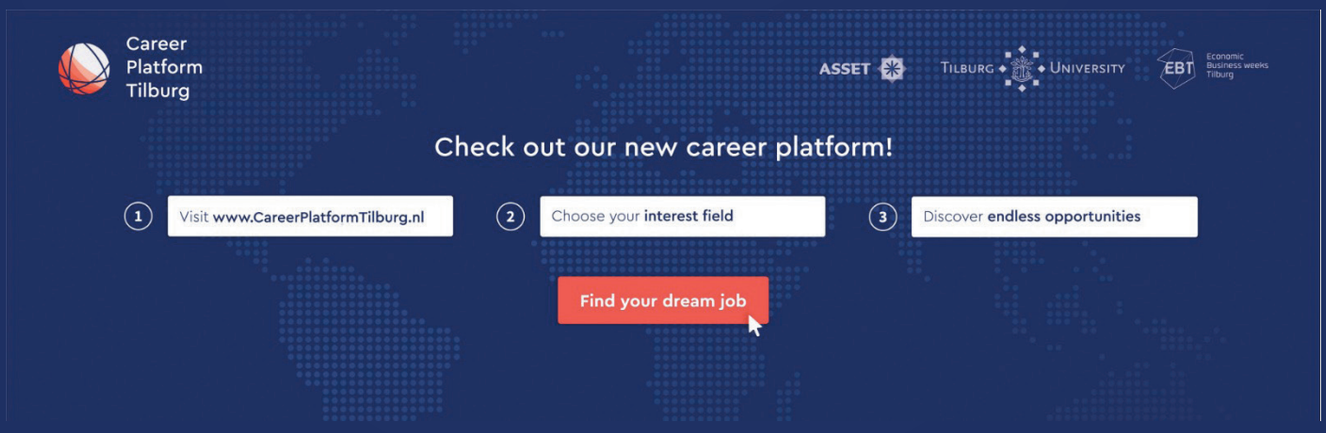
written by **Cas Slootweg**

It might have missed your attention, but Asset has a brand new career platform! The website careerplatform-tilburg.nl went live on August 8 and it was developed by our own Jochem Bruijninckx and his sister Lotte. It was time to meet up with Jochem and discuss the new features of the site.

Before the launch of the new career platform, every department of Asset had its own career portal. This portal was just a tab on the website of every department. The design was rather old-fashioned and the portals did not get many page views. When the websites of Asset and its seven associations were renewed, it was natural to have a look at the career platforms as well. "Career development is one of the key goals of our study association, so our platform deserved a better design." Asset | Econometrics initiated a new platform and almost immediately all other departments agreed. It was decided that all departments would work together on the same website.

"One of the biggest challenges we faced was how to preserve the independence of each department, whilst combining the career opportunities on one website." Every department has its own communication style towards companies and they did not want to change this. After a lot of meetings and discussions, there was agreement on a suitable design for the platform. If you visit careerplatformtilburg.nl, you can choose your field of interest. Once you have selected "Econometrics", you will go to the environment of Asset | Econometrics within the platform. The website changes colors to astrics blue and only the companies are shown which are relevant for econometrics' students. In this way, students can find companies of their interest. Furthermore, some new features were added. Besides the internships and vacancies that were already present in the old portal, tabs with career events and company profiles were added. On the career events tab you can find both InHouse days of companies and formal activities of Asset | Econometrics like the Econometrics in Practice Days. The page of company profiles shows descriptions of the companies Asset | Econometrics works with so students can really get to know these firms. The career opportunities tab has a slicker design, with on the side some key aspects of each vacancy, like the location of the company and the starting date. This enables students to quickly browse through the career opportunities and find the best fit. Finally, students can now filter the opportunities on several aspects. For example, if you are a QFAS student, you can apply a filter such that you only see QFAS related jobs. This also helps students who did not choose their Master yet, since in this way they can explore what kind of vacancies relate to a particular Master. "The Master is really helpful when choosing your Master."

How did Jochem and Lotte get involved in this project? Lotte is doing her Master's in New Media Design and likes to design all sorts of things, like logos and websites. She came up with layouts for websites before and Jochem built those websites afterwards. This was going so well that they started their own company, named "De Stijlfabriek", about two years ago. Their company is still growing and it is getting larger and more challenging orders. Since Jochem was a board member last year, he was involved in the developments of the new career portal



from the start. He knew he wanted to build the website with Lotte, but he was not sure how to accomplish that. When it was decided that the website would be called careerplatformtilburg.nl, he bought the domain name, so that Asset had no option but hiring "De Stijlfabriek". Besides that, as a board member, Jochem exactly knew the structure and goals of Asset, which is quite hard to explain to external website developers. After hiring the "De Stijlfabriek", a special taskforce was initiated by Asset that discussed the features of the new site. After a lot of discussions, the ideal set up of the site was clear within the taskforce. Lotte designed the website accordingly and the only thing left was for Jochem to build the platform. However, he was in his board year, and that is not exactly the most relaxing year in which you have a lot of spare time. Therefore, as the launch approached, he was losing more and more sleep. In the last week before it went live, he was working through the night. "My roommates were going to bed and I said I had to finish something. When they woke up the next morning, I was still sitting in the same spot developing the website." The website had to be finished on time. The old career portals would not be integrated on the new Asset websites and a delay would cause broken contracts between Asset and several companies. Jochem and Lotte succeeded and the new platform went live on August 8, together with the new Asset sites.

Although the new career portal is launched, Jochem and Lotte are not done yet. The name careerplatformtilburg.nl leaves the door open for other associations to join the platform. The design also allows other fields of study to work together with Asset on this platform, as creating new environments is rather easy. Therefore, they hope that the website will grow further in the future. Furthermore, Jochem and Lotte are working on a feature that allows companies to add vacancies themselves. Nowadays firms send their content to the external affairs of each association, which in their turn put it on the website. By doing so, companies will be more involved into the platform and it will save a lot of time.

During the development of the career platform of Asset, Asset encountered another possible problem. Tilburg University also got the idea to launch a new career portal and contacted Asset on this matter. The career platform is essential for Asset and it would not benefit from a competing portal. Asset and the university solved this problem in great harmony by linking the vacancies on the university's portal to Asset's platform. Every career opportunity on Asset's platform has a three sentence teaser on the university's and clicking on it will direct you to careerplatformtilburg.nl. Further, on the portal of the university you have to create an account and login every time you visit. This is quite cumbersome compared to careerplatformtilburg.nl, where this is not required.

Jochem and Lotte are really proud of the end result. As the website went live, the external affairs started adding all the content to the website and Jochem en Lotte could watch the platform grow. Of course, Jochem tested the website with some fake vacancies, but it looks rather different when there are real vacancies instead of "koffiejuffrouw " over and over again. They got a lot of positive feedback from both the board members of all departments and from different companies. The association hopes that this fresher look will encourage students to make use of the platform and convince more firms to cooperate with Asset. Became curious about the new website? Check it out yourself on www.careerplatformtilburg.nl •

Spectral Determination of Digraphs

The connection between graph theoretical properties of a graph and its collection of eigenvalues (also called 'spectrum') has kept many researchers busy for a long time, and quite succesfully so. However, when one wonders about similar principles in the context of *directed* graphs (abbreviated *digraphs*), the list of known results is rather short. In my thesis, we venture into these mostly uncharted waters and attempt to find a foothold in this complex field.

written by **Pepijn Wissing**

Introduction

For a given graph, verifying whether or not it satisfies some property is not always as easy as it may sound. Take, for instance, bipartiteness[1]; for a given partition of the vertex set of said graph, it is easily verified whether or not there are edges between the nodes that belong to the same set, i.e., whether this particular partition shows that the graph is bipartite. But especially when graphs grow larger, finding such a partition is not always trivial. Recall that in order for a graph to be bipartite, it may contain no cycle of odd length, and that a graph may contain exponentially many maximum cycles. Hence, checking all off them is a rather time consuming way to check for bipartiteness. To illustrate the problem, we consider the graph in Figure 1; whether or not it is bipartite is not immediately clear.

One way to tackle this problem, is to look at the spectrum of the graph we are considering. A known property of the graph spectrum is that the spectrum is symmetric around 0, that is, invariant under multiplication by -1, if and only if the graph is bipartite. Thus, the problem that was time consuming just a second ago, has now boiled down to comparing two collections of numbers. In fact, for the graph in Figure 1, we find the spectrum (numeric approximation)

$$\Sigma = \{-2.7, -1.6,\ -1.4,\ -0.9,\ 0,\ 0,\ 0.9,\ 1.4,\ 1.6,\ 2.7\},$$

which is indeed symmetric around 0, and thus gives us all of the necessary evidence.

The graph spectrum holds much more information than just an easy argument for bipartiteness. From a given spectrum, one can derive a number of properties of the corresponding graph. The number of vertices in the graph is quite trivially equal to the number of eigenvalues in the spectrum (including multiplicities), but in addition, one can, for example, derive of the number of edges that are contained in the graph, the number of closed walks of a certain length, and whether or not the graph satisfies the regularity property.

[1] A graph is called bipartite if its node set can be partitioned in two sets such that no two nodes that belong to the same set are connected by an edge.

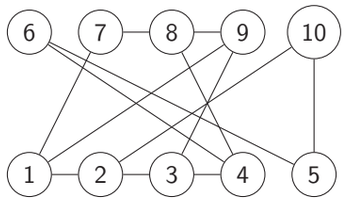


Figure 1: What can we say about this graph?

Moreover, for some families of graphs, the spectrum holds all the necessary information one needs to construct the unique graph that has this spectrum. Examples of such families of graphs are the paths, complete graphs and regular graphs. Such a graph, for which the spectrum holds all of the necessary information, is said to be *determined by its spectrum*. (abbreviated DS hereafter.) There are numerous families of graphs that have been shown to be DS, as well as infinite families of graphs that have been shown *not* to be DS. However, it has been conjectured (Van Dam and Haemers, 2003, 2009) that the families of graphs that are not DS are the exceptions; that is, that the fraction of graphs that is DS converges to one, as the number of vertices grows.

Well, what about digraphs then? In a digraph, not all of the edges are symmetric; a digraph may contain an edge (i, j), but that does not in general imply that the edge (j, i) also exists in said digraph. In other words, the adjacency matrix of a digraph is in general not symmetric. In terms of immediate consequences for the spectrum, this means that the eigenvalues need not all be real numbers and that many widely used techniques may not be applied.

Relevance

That all sounds awfully complicated, so why would you even want to try it? In addition to some historic motivations, an important motivation comes from complexity theory. To this day, it is still undecided whether the graph isomorphism prob-

lem[2] is easy or hard. (See, e.g. Kobler et al. (2012)). As of the time of writing, the best known algorithm to test the isomorphism of two graphs on n vertices runs in quasipolynomial $\exp\left((\log(n))^{O(1)}\right)$ time. (Babai, 2015).
However, we do know that computing the eigenvalues of binary matrices is easy, in terms of complexity. Indeed, we know from Pan and Chen (1999) that the arithmetic complexity of the approximation of the eigenvalues of an arbitrary $n \times n$ matrix A is bounded by $O(n^3) + t(n, b)$, where t is defined as

$$t(n, b) = O\left((n \log^2(n))(\log(b) + \log^2(n))\right), \qquad (1)$$

and b is an input parameter set such that $2^{-b}\|A\|$ is the required upper bound for the absolute output error. As such, the arithmetic complexity is polynomial in n as well as in the required precision. This means that, if we know that two graphs are determined by their spectra, checking whether they are isomorphic becomes as easy as comparing their collections of eigenvalues. This principle is just as valid for digraphs.

Enumeration

The first thing that one could do to get some intuition as to which digraphs are DS is to simply enumerate all of them, compute their spectra and find out which ones occur uniquely. That brings us to an important choice: how do we characterize these digraphs? For now, it suffices to say that we investigate the adjacency matrix A, the Laplacian L, the Normalized Laplacian $\mathcal{L}$ and the Hermitian matrix H. These matrices may define the same digraphs in a different way, and their spectra might (and likely will) behave differently.
By full enumeration of all digraphs on six or less nodes, we observe the results shown in Table 1. Clearly, the fractions

n	A	H	L	$\mathcal{L}$
3	1.000	0.125	0.375	0.600
4	0.277	0.014	0.179	0.783
5	0.033	0.001	0.048	0.935
6	0.002	0.000	0.018	0.983

Table 1: Fractions of digraphs that are DS.

of digraphs that are respectively A, H and L-DS plummet to zero rather quickly. That said, the fraction of $\mathcal{L}$-DS digraphs is climbing at a remarkable rate as well. Thus, it stands to reason that $\mathcal{L}$ has the most potential by far to determine a (very) large fraction of all digraphs. However, since this matrix is rather complicated, we choose to leave $\mathcal{L}$ be for the moment, and instead focus on the digraphs whose A and H-spectra do occur uniquely.

[2]The graph isomorphism problem can informally be stated as: given two graphs, can the vertices of one of them be relabeled such that the two graphs are equal.

The directed cycle

A necessary property for A-DS-ness is called *strongly connectedness*. If a digraph D is strongly connected, then there is a path from any node in D to any other node in D. The sparsest such graph on n nodes is the directed cycle.

Definition 1. Define $\overrightarrow{C}_n = (V, E)$ to be the directed cycle of order n, i.e. $V = [n]$ and $E = \{(v_i, v_{i+1}) \mid i \in [n-1]\} \cup (v_n, v_1)$. This construction is illustrated in Figure 2.

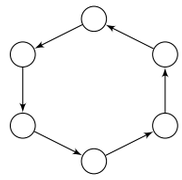


Figure 2: The directed cycle $\overrightarrow{C_6}$

We have been able to show that this family is A-DS. For this proof, we need the following two elementary results. Recall that the spectral radius ρ of a matrix A is the largest eigenvalue in absolute value, i.e. $\rho(A) = \max\{|\lambda| : A\lambda = v\lambda\}$.

Lemma 1. *Let D be a digraph of order n. Then $\rho(D) = 0$ if and only if D is a directed forest.*

Lemma 2. *Let D be a digraph of order n. If D is strongly connected and D has spectral radius 1, then $D = \overrightarrow{C_n}$.*

We are now ready to prove the following proposition.

Proposition 3. *$\overrightarrow{C}_n$ is A-DS.*

Proof. $\overrightarrow{C_n}$ has the eigenvalues λ_j, given by

$$\lambda_j = \cos\left(2\pi\frac{j}{n}\right) + \sin\left(2\pi\frac{j}{n}\right) i, \text{ for } j \in [n]. \qquad (2)$$

We observe that each of the eigenvalues has multiplicity one and that $|\lambda_j| = 1$ for all $j \in [n]$. Recall that the spectrum of $\overrightarrow{C}_n$ is denoted $\Sigma_{\overrightarrow{C_n}}$ and let D be a digraph of order n with spectrum $\Sigma_{\overrightarrow{C_n}}$.
Let n_1 be the size of the largest strongly connected induced subdigraph D_1 of D. Moreover, let D_2 be the induced subdigraph of D that is obtained by removing D_1 and all adjacent edges from D, and let $n_2 = n - n_1$. We distinguish three cases: (i) $n_1 = n$, (ii) $n_1 < n$.

(i) D is strongly connected with $\rho(D) = 1$ and thus by Lemma 2, it holds that $D = \overrightarrow{C_n}$.

(ii) Let A_1 and A_2 be the adjacency matrices of D_1 and D_2, respectively. Since $n_1 < n$, D is not strongly connected,

→

which implies that there exists a permutation matrix P such that

$$PAP^\top = \begin{bmatrix} A_1 & \mathbf{0} \\ X & A_2 \end{bmatrix},$$

for some $n_2 \times n_1$ $\{0,1\}$-matrix X. This means that the spectrum Σ_D can be obtained as $\Sigma_D = \Sigma_{A_1} \cup \Sigma_{A_2}$. Note that since D_1 is strongly connected by assumption and $\rho(D_1) = 1$, $D_1 = \overrightarrow{C_{n_1}}$ by Lemma 2, and thus $1 \in \Sigma_{A_1}$. This means that if $1 \in \Sigma_{A_2}$, Σ_D contains the eigenvalue 1 with algebraic multiplicity 2, which violates the assumption that $\Sigma_D = \Sigma_{\overrightarrow{C_n}}$.

Now, let $n_3 \leq n_2$ be the size of the largest strongly connected induced subdigraph of D_2. Suppose that $n_3 > 1$. Then, by Lemma 2, such an induced subdigraph must be exactly $\overrightarrow{C_{n_3}}$, and thus $1 \in \Sigma_{A_2}$, which implies $\Sigma_D \neq \Sigma_{\overrightarrow{C_n}}$. Hence, the only remaining possibility that does not lead to a contradiction is that $n_3 = 1$. This implies that D_2 is a directed forest, and thus by Lemma 1 we know that $\rho(A_2) = 0$. This implies $0 \in \Sigma_{A_2}$, which is again a contradiction.

To summarize: out of the considered cases, the only one to admit a situation that did not contradict the assumption that $\Sigma_D = \Sigma_{\overrightarrow{C_n}}$ was case (i), and thus the proof is complete. □

This gives us a first infinite family of digraphs that has shown to be determined by its adjacency spectrum.

Adjacency spectra under regularity

If a digraph is regular, i.e. if every vertex has the same in- and outdegree, we are able to show a relation between the spectrum of a digraph and that of its complement.

Proposition 4. *Let D be a regular digraph of order n with constant degree k, and let $\bar{D}$ be its complement. Furthermore, let A and $\bar{A}$ be the adjacency matrices of D and $\bar{D}$, respectively. Then, for their characteristic polynomials χ, the following holds:*

$$\chi_{\bar{A}}(\lambda) = (-1)^n \frac{n-k+\mu}{\mu-k} \chi_A(\mu), \tag{3}$$

where $\mu = -\lambda - 1$.

Proof. Note that since D is regular, we have $AJ = k\mathbf{j}$ and $JA = k\mathbf{j}$, where $\mathbf{j}$ denotes the all ones vector of appropriate length. Using some clever matrix algebra (yes, this is all taught in your Advanced Linear Algebra course!) we obtain

$$\det(J + \mu I - A) = \frac{n-k+\mu}{\mu-k} \det(\mu I - A). \tag{4}$$

Then, writing $\bar{A} = J - I - A$ and $\mu = -\lambda - 1$, we have

$$\begin{aligned} \chi_{\bar{A}}(\lambda) &= \det(\lambda I - \bar{A}) \\ &= \det(-1 \cdot (J + (-\lambda - 1)I - A)) \\ &= (-1)^n \det(J + \mu I - A) \\ &= (-1)^n \frac{n-k+\mu}{\mu-k} \det(\mu I - A) \\ &= (-1)^n \frac{n-k+\mu}{\mu-k} \chi_A(\mu), \end{aligned}$$

where the penultimate equality holds by plugging in (4). □

Now, we would have liked to use the relation above to show that, given a family of regular, A-DS digraphs, the family of digraphs that is obtained by taking their complements is again determined by its A-spectrum. Such a claim, however, is readily disproved by considering the complete graph of order n and its complement. The former can easily be shown to be H-DS, while the latter is H-cospectral to any directed tree. That said, the next result follows fairly straightforwardly from Proposition 4, and gives us in some sense a restricted version of A-DS-ness under regularity.

Proposition 5. *Suppose that D is a regular, DS digraph. Furthermore, let $\bar{D}$ be the complement of D and let X be a regular digraph. If $\Sigma_X = \Sigma_{\bar{D}}$ then X is isomorphic to $\bar{D}$.*

Finally, I would like to touch on the conjecture by Van Dam and Haemers (2003) that I mentioned earlier. While it seems reasonable to claim that almost all graphs are DS, the same does not apply in digraph context. In fact, by using evaluating counting polynomials (Harary and Palmer, 1966), we have sufficient evidence to make the following claim.

Conjecture 1. *The fraction of A-DS digraphs on n nodes goes to zero as $n \to \infty$.*

Conclusion

Of course, all of this has been just the tip of the iceberg; we have researched many more digraph structures and found new lines to follow up on. In fact, I am working on one of these lines, regarding a digraph structure that contains an extreme amount of negative triangles as node-induced subdigraphs, at the time of writing. However, since my pages are running out, that is a story that I will save for another time.

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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. Therefore, we present to you a selection of some striking and funny quotes!
Please mail all remarkable quotes you have heard to Nekst@Asset-Econometrics.nl!

Bernard van den Broek
Jongens, ik doe niet aan groepsdruk
10 seconden later...
Bernard adt een kan

Lotte Gerrits
Beyonce, heeft die een achternaam?

Ruud Hendrickx
Je kent ze wel, de pepernootstudenten: eind augustus komen ze en begin december zijn ze weer weg

Job Hoven
(...) toen ik nog een onwetende eerstejaars was
Wenxin Lin
Wat ben je nu dan, Job?
Job Hoven
Een onwetende tweedejaars

Jeffrey Buijk (tijdens Mario Kart)
Ik vlieg steeds uit de binnenbocht

Lieke Derison
Zijn het alleen Nederlandse BN'ers?

(...) zonder Jelle hebben we niks aan de pinpas
Joris Pirée
En zonder de pinpas hebben we niks aan Jelle

Puzzle

Mister J.J. Hoven and Mister J.J. Boske are two notorious pirates. Both have found a big treasure full of golden coins and they both like to gamble! They meet at a sunny, but mysterious cave located in an island in the Caribbean Sea. In this cave, J.J. Hoven found an ancient wooden, but somehow perfectly square shaped table! He challenges J.J. Boske for a challenge and the latter gladly accepts this, after which they take a seat at this precious table.

J.J. Hoven places a coin on the table and after him, J.J. Boske does this too. Both players keep on doing this with one restriction: coins can not touch each other. Whoever is the last to put a coin on the table - meaning that he fills the last spare room between the other coins - is the winner and he wins all the coins present on the table!

The table is bigger than one coin - otherwise the game is over after the first move - and all used coins should be of identical size and composition.

For one of the pirates, there exists a strategy for which he can always win this game. Who is this: J.J. Hoven, who moves first or J.J. Boske, who moves second? And which strategy does he use?

Can you figure out the puzzle?
Please enter your solutions at www.Nekst-Online.nl/Puzzle. A crate of beer or a delicious pie, whichever the winner prefers, 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!

Asset | Econometrics congratulates...

Name **Bart de Peuter**
Title Selecting Priority Customers by Making Customer Lifetime Value Predictions, Using Automated Machine Learning
MSc BAOR
Supervisors M.P. Rothfelder MSc, Dr. N.F.F. Schweizer

Name **Tim van der Heijden**
Title Warehouse Planning at Rhenus Logistics
MSc BAOR
Supervisors Prof.dr. G. Kant, Prof.dr. B. Melenberg

Name **Kim Leliveld**
Title Using OR to analyze and improve access to health care
MSc BAOR
Supervisors Prof.dr.ir. H.A. Fleuren, Dr. R.C.M. Brekelmans

Name **Thomas van den Hurk**
Title Marketing budget allocation across media channels using multivariate adaptive regression splines
MSc BAOR
Supervisors Dr. J.C. Engwerda, Prof.dr. B. Melenberg

Name **Evert de Beleir**
Title Collective buffers in a new Dutch pension system with individual pension pots The impact of the non-negative constraint
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Title The Valuation of European Options in an Uncertain Environment
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Name **Anouk Claassen**
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Title Reduction of Student Dropout by Predicting Student Performance
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Title The FLYBACK Decision Model for Targeting Flying Blue Program Offers
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Title How do urban refugees live?
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Title Barto, a Bayesian Binomial Rating Method Applied to Professional Tennis Matches
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Title The Effect of Labor Income on Optimal Portfolio Choice
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Name **Mark Evertsz**
Title A panel data approach to mortality modeling
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Name **Wouter Merkx**
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Name **Giovanni Castro Lancheros**
Title Robust Estimation of Dynamic Fixed-Effects Panel Data Models with Indirect Inference Methods
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Name **Thomas van Manen**
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Name **Freek Voss**
Title Comparison of insurance loss predictions by Support Vector Machines and Generalized Linear Models
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Title The option to exit
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Name **Grigor Samsonian**
Title An Analysis of the Robust Option Pricing Model
MSc QFAS
Supervisors Dr. N.F.F. Schweizer, Prof.dr. B. Melenberg

... on obtaining their Master's degree

Agenda

WED **07** NOV
Cycling Dinner & Drink
The Cycling Dinner is the perfect way to have nice food and meet new people! After the Cycling Dinner, our Monthly Drink at Café De Nachtwacht will take place where everyone can have a chat over a few drinks.

TUE **13** NOV
Monthly Afternoon
At the Monthly Afternoon you can catch up with your fellow econometricians, have some drinks and snacks together, and play games like Mario Kart and 30 Seconds. Everyone is welcome to come and swing by our rooms from 16.00 hours onwards!

WED **14** NOV – FRI **16** NOV
Finance Expedition
The Finance Expedition is the perfect opportunity for you to gain insight in the financial business world by visiting prominent financial institutions at their offices. Each company offers a challenging case in the field of either Asset Management, Corporate Finance or Risk Management.

FRI **16** NOV
Asset Lustrum Cantus
Maybe you know or have already heard about the legendary COdE beer cantuses, but this cantus is going to be even more amazing because of Asset's second lustrum. Join us now and have an unforgettable night at the Koepelhal in Tilburg!

TUE **20** NOV
Freshmen Activity
While the activity itself is not currently known yet, we can assure you it will be a memorable evening where lots of new friendships will be made. Make sure to save the date!

FRI **23** NOV – SUN **25** NOV
KOALA Weekend
KOALA Weekend is organized for all Former Active Members of Asset | Econometrics. The program remains a secret, but unfortunately no actual koala's will be involved. Come and travel back in time with us and relive the good old days in style of the 90s!

TUE **27** NOV
Econometrics in Practice Day
Discover the practical side of econometrics during the Econometrics in Practice Day! At this event you can meet several employees from different companies and explore your future career opportunities. All second-year econometrics students and older are welcome to participate!

FRI **30** NOV
Sports Activity
Since it is important to stay fit during the colder days, Asset | Econometrics will organize a Sports Activity at the end of November. Not that sporty yourself? You are still very welcome to come and enjoy a cup of hot chocolate with us during this day.

TUE **04** DEC
St. Nicholas Drink
As the days become shorter and nights become colder, it is again time for our annual St. Nicholas Drink. Tradition even says that the good old man will bring us a visit to read some poems and hand out some presents. Can you tell us who has been naughty or nice in the past year?

FRI **07** DEC
Active Members' Day
The Active Members' Day (AMD) is organized to thank all active members for their efforts. We are curious to find out what the AMD committee has in store for this activity!

THU **13** DEC
Monthly Afternoon
It's time to come out of the library for a change and take a break from studying for your exams. So come to our Monthly Afternoon and catch up with your fellow econometricians at our rooms!

THU **20** DEC
Christmas Dinner
Before going home over the holidays, let's first celebrate Christmas with your fellow econometricians during our last event of 2018. We hope to see you again next year!

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

You've nearly completed your degree, and you're ready for what's next: a job that will inspire you, make you think and put your skills to the best use.

Our unique perspective allows us to see the connections between talent, assets and ideas that can drive performance and growth. Powered by market analytics, behavioral insight and a culture of seamless execution, our colleagues work with you to design and implement lasting solutions that turn risk into a path to growth.

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