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Proof by example Portraits of women in Dutch mathematics

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When was it that you first realised you wanted to be a mathematician?
"My passion for mathematics and science was something that started quite early, but it took me a while to really make a final decision. During my high school studies, I chose the scientific track, with physics, chemistry, maths, biology. At that time, it was already clear that mathematics was the topic I enjoyed the most. Eventually, for my bachelor's degree, I enrolled in the engineering program. This choice was motivated by a chat I had with one of my high school teachers, who mentioned that mathematics is everywhere in engineering and that such bachelor would provide many more job opportunities. I thought that it sounded very appealing, so I decided to give it a try. I chose electrical and telecommunication engineering for my degree, but I quickly realised that I did not enjoy it as much as I had expected. However, being as stubborn as I am, I decided to just continue it and complete that degree. Looking back at those years, it was clear that the courses I liked the most were the ones involving more math contents and fewer applications. So, after completing my bachelor's degree, I decided to enrol myself in the mathematics master program at the Polytechnic University in Barcelona, and right away I felt that it was the right choice.For my master's thesis I started working in the field of discrete mathematics, and I think that was the best choice for me, as proving results in discrete mathematics did not require so much theory background as other math fields. On top of that, I really liked the topic I picked up and I wrote my master's thesis on applications of linear algebra in spectral graph theory."

You have a PhD from Tilburg University. What took you to the Netherlands?
"It was 2011, and Willem Haemers, who would become my future PhD supervisor, came to the Polytechnic University of Catalonia, in Barcelona, to teach a summer course on spectral graph theory and related topics. Back then, I was working on my master's thesis on that same topic. Not only did my master's supervisor (Miquel Anel Fiol) encourage me to attend the lecture series, but he also mentioned my name to my future PhD supervisor, who was looking for students to join his group in the Netherlands, so I ended up moving to Tilburg."


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How do you look back at your move to the Netherlands?
"It has been almost ten years, and I am really enjoying my life here. To be honest, in the beginning, I felt a bit lonely and homesick, missing the life I had in Barcelona, which is a beautiful city, a lively metropolis. On top of that, I missed my research group and teaching colleagues at the university in Barcelona: we had a very nice community. So, on one hand, I was somehow sad to leave this behind, but at the same time, I saw my move as a challenge which would bring me new adventures. So I said to myself: 'OK, let's see if I can make a new life here, learn new things and learn from one of the best researchers in the field.' What started as a challenge became an extremely positive experience: the PhD was going smoothly, I slowly started making new friends. I enjoyed my time, and after finishing my PhD, I realised that I actually did not want to leave the Netherlands. And because of not wanting to leave the Netherlands, instead of a postdoc offer in the US, I ended up accepting a lecturer position at Maastricht University. I still recall that some math colleagues mentioned that this would put my research career in risk."

Can you tell us more about this?
"The lecturing position in Maastricht entailed 100 percent teaching duties. To the best of my possibilities, I still kept doing research and I kept going to conferences. The academic year 2015–2016 was quite a hectic one, but the Operations

Research group in Maastricht University, and my mentor Stan van Hoesel, were all very supportive, encouraging me to keep working on my ongoing research projects and replacing me when I was invited to give a talk in a conference. A year after, I became an assistant professor at Maastricht University, but my research had started to be affected by my teaching load, which was still pretty high. This is why, after discussing with Leo Storme, I decided to apply for a personal research grant from FWO in Belgium in order to join his research group in case of being successful. I was awarded the grant, and this allowed me to combine positions in both Maastricht and Ghent universities. In this way I could learn new topics like incidence geometry from my colleagues in Belgium, and at the same time this allowed to substantially reduce my teaching load at Maastricht University."

What kind of problems are you currently thinking about?
"My research concerns algebraic graph theory, which means that I study graphs through the lens of the *spectrum* (eigenvalues of a certain associated matrix to a graph). Graphs are often used in real-life applications in order to model networks of different natures, from social networks to logistic or biological networks. In particular, I look at the spectrum of a graph and investigate which structural and combinatorial properties can be deduced from the graph spectrum."

And can you actually 'hear' the shape of a graph?
"Unfortunately, the eigenvalues do not provide us with complete information about the graph: there are examples of different (non-isomorphic) graphs which share the same spectrum (cf. Figure 1). But not all is lost: in some cases, within certain graph families, eigenvalues are enough to completely characterize such graphs. So I believe that the spectrum is, for sufficiently large graphs, a unique fingerprint of a graph. My research aims to further the understanding of when one can use the spectrum to characterize graphs. For the cases where the spectrum does not fully characterize a graph, I am interested to find some other alternative graph invariants that complement it in such a way that we can complete the picture and obtain full information."

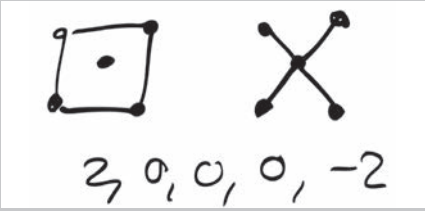

Figure 1 Smallest pair of non-isomorphic graphs having the same eigenvalues.

Do you also work on real-life applications of graphs?
"Very recently I was involved on an applied paper with people in industry, which was joint work with a former colleague from Maastricht, Alexander Grigoriev, and a master student, Stefanie Niemzok. This work was based on a real case study provided by a company, and the main goal was to improve a search engine for a database consisting of printed circuit boards. We showed that the information about the circuit boards can be stored in terms of graph invariants, like the graph spectrum or the degree sequence, which require much less memory and enable a quicker recognition of board equivalence. To me, this provided the perfect application to test the discriminating power of the spectrum to distinguish thousands of electric motherboards. It was a very nice practical experience, much more down to earth than my usual research."

You were recently awarded a Klein-1 grant from NWO. Can you tell us about the project?
"The main goal of this NWO project is to develop new techniques to construct different graphs having the same spectrum. In some sense, we are still far from understanding which are the graph properties that the spectrum cannot detect. This research project will provide a step further in this direction."

What do you like the most about being a mathematician?
"My main motivation for being a mathematician is that this job lets me spend most of my time learning new things, compared with some other jobs. I love the freedom it gives and the creativity it entails; I very much enjoy this aspect of my job. No two days are the same: I get to work on a variety of problems, and every time the approach is different. When working on discrete mathematics problems, you need to think out of the box, come up with a new idea, develop new methods. To me, it is a very happy and rewarding moment when I first conceive a solution to a problem I have been working on for a while. And of course, there is also the beauty aspect: when you arrive to a nice proof after months of thinking, it is very satisfactory. I think that mathematicians are guided by the aesthetics as much as intellectual curiosity."

Is there anything you found difficult in your career as a mathematician?
"To be honest, I look back to my PhD years with some nostalgia, since then I had plenty of time to focus on my research. Now there are many other things on my plate, some of which I enjoy a lot, like supervising students or teaching, and others less, such as bureaucratic tasks. As for obstacles, the process of applying for permanent positions was rather stressful. Compared to the amount of postdoctoral positions, there are not so many tenure-track positions. This process was a bit complicated by the fact that I wanted to stay in the Netherlands."

Is there anything about your work that you are proud of?
"I think one result that I am proud of goes back to a combinatorics graduate workshop in the US that I attended it during my last PhD year. As participants, we had to propose problems to work on, and the most voted ones would be the ones we would work on for two weeks. Luckily, my problem was selected so we worked on it for two weeks. It was an old conjecture by Graham and Lovász on the coefficients of the characteristic polynomial of the distance matrix of a tree. To be honest, the conjecture was just the motivation for me to state several smaller problems on the distance matrix. But in the end, we ended up partially solving the conjecture, and publishing two papers. This was a really unexpected development. Looking back, the conjecture was actually quite easy to solve. But putting the proof ideas together is something that happened thanks to this collaboration. So that was very exciting and rewarding.