Clara Stegehuis
Faculteit EWI
Universiteit Twente
c.stegehuis@utwente.nl

Francesca Arici
Mathematisch Instituut
Universiteit Leiden
f.arici@math.leidenuniv.nl

Proof by example Portraits of women in Dutch mathematics

Sophie Huiberts

In 'Proof by example', Clara Stegehuis and Francesca Arici portray women in Dutch mathematics. This edition portrays Sophie Huiberts, Simons junior fellow at Columbia University, who recently defended her PhD thesis at CWI on algorithms for linear programming. In this interview she tells about her research and her motivation to pursue a career in mathematics.

When did you start to like mathematics?
"I had a great mathematics teacher in high school, who was very enthusiastic about it. Still, I thought that mathematics was a bit boring, as it did not touch upon any of the subjects that interested me as a teenager. However, I did like programming at that time, which I did as a hobby. At some point I found out that the algorithms I programmed also had inventors. For me, that was a real revelation, and being an 'inventor of algorithms' seemed like the best job in the world to me. These people were described as mathematicians and computer scientists, so this made it easy for me to choose my majors at university after high school: mathematics and computer science as a double bachelor program in Utrecht."

So you started to study computer science because you liked programming. So why are you a mathematician now, and not a computer scientist?
"In my master program I already chose for mathematics over computer science. I found the theoretical aspects of algorithms more interesting than implementing them in practice, on which the computer science degree put a heavy focus. I really liked my master graduation project, so when my thesis supervisor, Daniel Dadush posted a vacancy for his first PhD student, I applied for this position, and that is how I got into research professionally."

Sophie Huiberts

What is your research about?
"Funnily enough, my research is still about algorithms, so that interest stuck with me. I now focus on a very particular type of algorithms: the ones used in linear programming and integer linear programming. These types of algorithms solve optimization problems that can for example create train schedules, allocate personnel to different tasks or design large sports competitions. In theory, these algorithms can take a very long time to run. Nevertheless, in practice these algorithms are extremely fast. Some algorithms for linear programming run in exponential time in the worst case, but in practice they run in linear time. Integer linear programming is even NP-hard in theory, but in practice, it can be solved quickly as well. I investigate how this difference between theory and practice arises, and try to come up with theoretical models that better explain why these algorithms work so well in practice."

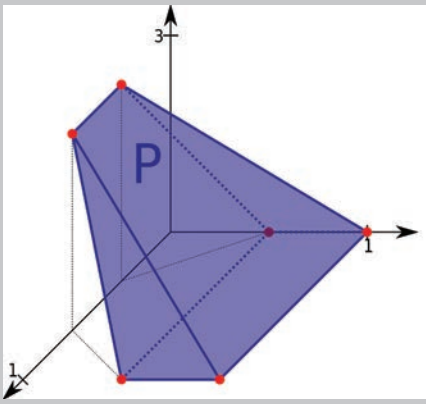
How do you approach this?
"For example, I can assume that the constraints in the linear program come from some probability distribution. Then, I can show that the algorithm runs in linear time in expectation. We interpret this as a way of arguing that a large class of linear programs can be solved in linear time."

Is there also a particular application of linear programs that you focus on in your research?

“Even though there are many applications of linear programs, my research is mostly abstract and purely theoretical. Recently though, we proposed a new algorithm that we think might be useful in practice. Then we implemented this algorithm, and tested it on real-world instances. This experience was a lot of fun. The actual implementation of the algorithms I investigate is very complex however, and accurately comparing different algorithms is not easy. I am happy that we can ignore many of these nuances when proving mathematical theorems.”

What result of your research are you most proud of?

“I am most proud of my recently published results on the diameter of polytopes. When you have a set of linear inequalities, the set of feasible solutions to this system becomes a high dimensional polytope. You can view the polytope as a graph, where all corners are nodes, which are connected by the edges of the polytope. One question that you can then ask is: what is the diameter of this graph? In other words, what is the longest distance between any two vertices in this graph? We studied this question for random polytopes, where there were no mathematical results known yet. After working on this problem for a while, we proved that the diameter of the graph of a random polytope is close to the average distance between two random vertices. This means that most distances in this graph are similar, so the result is quite strong. But I am most proud of the fact that this was the first project where I was really



A 3-dimensional polytope

in the lead as a scientist. During the beginning of your PhD, you usually rely on your supervisor for guidance, and they often give you problems to work on, broken up into manageable chunks. This was the first time that I really took the lead in a project, and I ended up being the one to give specific tasks to my coauthors to complete. This experience gave me a lot of confidence and made me certain that I would like to remain in academia.”

And how did you decide to apply for the Simons fellowship that you now have?

“I was a bit doubtful about the postdoc phase. Most postdocs I knew were often stressed by their uncertain and temporary positions. This was not something I wanted for myself. I therefore decided to only apply to two positions that seemed great to me. If they both would not work out, I would leave academia. One of the positions was here as a Simons fellow at the University of Columbia. Someone I knew asked if they could nominate me for it, and of course I said yes. In the end, I even got offered both positions I applied for, so that made me more certain that I am welcome in the research environment. As a fellow, I have a three year position with a grant and not many obligations. This makes the postdoc experience much more pleasant.”

What do you like the most about doing research?

“I like the fact that I am sometimes the first person who finds the solution to a particular problem, the first person ever to know a particular fact. This is a very special experience, and I can be happy about it for weeks. I also really like the fact that I can sit in my office, and just think about a problem for a while without time pressure.”

And what do you like the least?

“The main thing I do not like about academia is the uncertainty in being an early-career researcher. After your PhD it is nearly mandatory to go abroad for a temporary postdoc. Still this upheaval of your life gives you no assurance that you can stay in academia for the long term. This uncertainty can be stressful, because you always have to think about where to apply next, and wonder when you will ever have a permanent contract, and are away from your local community and loved ones. Many people say that experience abroad is important, but I believe this does not have to come with a lack of job security. If universities want their researchers to have international experience, why can they not offer permanent positions with the option to go abroad? This would make early-career academia less stressful and probably more productive. After all, you can focus better on your research when you are not stressed about job insecurity.”