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

Svetlana Dubinkina

In 'Proof by example', Clara Stegehuis and Francesca Arici portray women in Dutch mathematics. This edition portrays Svetlana Dubinkina, assistant professor at the Vrije Universiteit Amsterdam. She investigates dynamical systems such as the weather with numerical methods. In this interview she tells about her research and her motivation for mathematics.

When did your interest in mathematics start?
"In school all technical subjects already fascinated me. Of course I did not yet know what mathematics really was. But my sister already decided to study physics, so I guess I then chose mathematics instead to be different from her. At university, I soon realized that mathematics was not at all the same as the computations in high school, but I still liked it very much."

And this is also why you chose to stay in academia?
"Yes. In fact, during the first day of my studies, the dean of the faculty gave a speech for all mathematics students. He told us that our university was very strong in mathematics, and that we could even do a PhD abroad with our degree here. That stuck in my mind, and I indeed ended up doing a PhD abroad. But I always wanted to do science, so that was never a question for me."

Could you describe what your research is about?
"My research is about dynamical models: systems of partial differential equations.

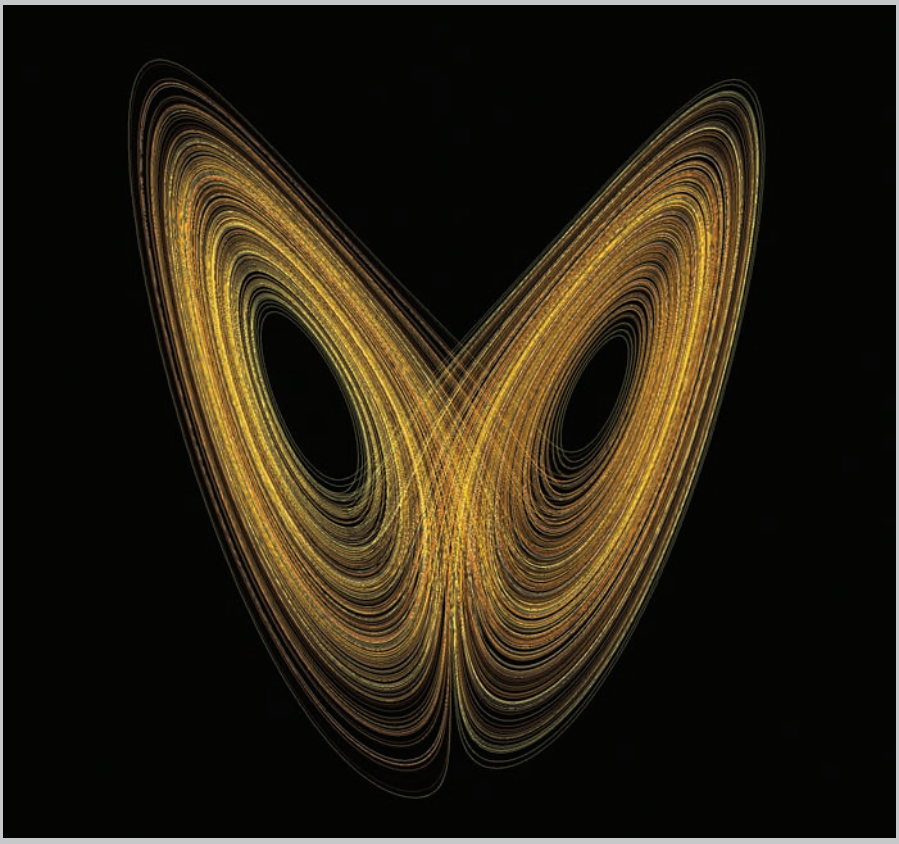
Photo: Victor Lacken

Svetlana Dubinkina

I am interested in their numerical approximations. Specifically, I investigate systems that satisfy the shadowing property. This property means that if you have a good guess for the initial state of your system, then a numerical approximation of the solution of this system is close to its real solution."

Can you give an example of such a system?
"You can think of the weather for example. You can predict the weather with a numerical approximation of a dynamical system. However, these systems are extremely chaotic. A small change in the initial condition leads to a completely different prediction. This is also why the weather prediction becomes more uncertain when you predict more hours in advance. We resolve this with *data assimilation*: combining the dynamical model with external data to improve the precision of the initial condition. In practice, these external data are for example provided by satellites.

In data assimilation you minimize a cost function to obtain a solution of the system. However, when you have a lot of data, this cost function becomes very noisy. Then you can get stuck in a local



In a chaotic system, a small change in initial condition leads to a completely different solution.

minimum of the cost function, while you would like to get its global minimum. In my work, I use an operator approach instead to circumvent this noisy cost function. By finding the zero of an operator, you find a solution of the dynamical system without using a cost function. With this method, we can predict much further in advance compared to the standard methods."

What is the most interesting problem you have been working on recently?
"Numerical approximations of dynamical systems often lead to many different solutions. However, only one corresponds to your real system. Together with my PhD student Nazanin Abedini I am working on investigating how close the different solutions from numerical approximations are to the real solution. I guess that this closeness depends on how much information one can observe. Going back to the example of the weather, you can for instance observe the temperature or the wind speed, but you can only observe them at weather stations. We hope that our method can show where these weather stations should be located to get the most accurate prediction. This would be a major breakthrough in weather forecasting!"

And what result are you most proud of?
"Until now, the shadowing-based data assimilation approach relies on the assumption that you observe everything. This is of course unrealistic from a practical point of view. In recent work, my PhD student Bart de Leeuw and I showed that you can also use shadowing-based data assimilation if you only have partial observations. I am really proud of this result, as we showed something that nobody was able to show in the previous twenty years!"

You seem very enthusiastic about your research. Are there still any parts that you do not like?
"I do not really mind being stuck at a problem myself. However, I feel bad when my PhD students are stuck, because then I never really know what to do. On the one hand, I do not want to jump in and solve everything for them. On the other hand, I also do not want them to be stuck forever and lose motivation. I still do not have a standard recipe on how to deal with such situations."

And what parts about research do you like the most?
"I like going to conferences and presenting my work. You get new ideas, and have lots of interaction. That is really motivating."

You also recently co-authored a letter by the COVID-19 task force of EWM. What was this letter about?
"Statistically, women take care of children or elderly more often than men. And when something like a pandemic happens, we often go back to these traditional patterns. This makes women less productive during this pandemic. I already had a permanent position when the corona crisis unfolded, so at least I did not have any pressure from having a temporary contract. But for untenured young women it can be more problematic, as they often also have small children to care for. So in this letter we ask universities and evaluation committees to take this possible productivity drop into account. For example by increasing the time window over which women with children are evaluated. We really do not want to lose talented young scientists because of a temporary situation like COVID-19."

Do you think that universities will listen to this request?
"We received many personal signatures from scientists who agree with the letter, even from outside mathematics. But beside that, organizations can also endorse the letter. Several organizations actually did so, such as KWG. So these organizations agree on the content of the letter. We hope that they will also act on it!"