The continuing story of the Kissing Number Problem

"If you have an optimisation problem, come to us!"

Prestigious 'SIAG/Optimization Prize' for Frank Vallentin

Frank Vallentin (Germany, 1972) of the Optimization Group contributed to the solution of a long-standing, classical puzzle in geometry: the 'kissing number' problem.

Do try this at home. Take a ping pong ball and count the maximum number of equally-sized, non-overlapping ping pong balls that can simultaneously touch it. If you got '12', then great, you empirically found the correct 'kissing number' for three dimensions, just like Isaac Newton did in 1694. It took until 1953 for the answer '13' given by Newton's opponent David Gregory to be proven wrong by a rigorous mathematical proof. Later, the kissing numbers for dimensions 4, 8 and 24 were determined. And now Frank Vallentin has solved yet another part of this sexily named problem.

Computer-assisted proof

Together with a colleague, he gave a unified proof of all known kissing numbers and found new upper bounds in all other dimensions up to 24. "We extended a method that was developed at CWI to solve a similar problem. It took us six months to develop the theory and another two months to do the computations. In August 2006 we were able to generate a computer-assisted proof." The researchers published their results in 2008 and were recently awarded the three-yearly 'SIAG/Optimization Prize' of the Society for Industrial and Applied Mathematics.

VIDI grant

Frank received a framed certificate and was invited to give a plenary lecture. "It was all about fame", he says, smiling. Fortunately, in 2009 he was awarded the rather more profitable VIDI grant for research on 'difficult optimisation problems', enabling him to employ two PhDs and a postdoc.

The group will further develop the unique method Frank used to help solve the kissing number problem, a combination of semi-definite programming and harmonic analysis. "The first technique usually only works with finite objects and the latter only with infinite objects. I am trying to combine those two. So it is always an interplay between discrete and continuous mathematics."

M&Ms

The kissing number problem is relevant to many scientific fields, says Frank. "The methods for the kissing number in three dimensions can be applied in material science. If you want to design a very stiff material, for example, you need to pack the particles as densely as possible. We are also working on the densest packing of shapes like M&Ms or tetrahedra. That is much more complex, because here it matters how you rotate the objects. The techniques for high dimensions are useful, for instance, in designing error correcting codes that enable safe delivery of electronic data."

Co-supervising

Frank studied all over Europe before coming to Delft. In Dortmund he obtained two Master's degrees, in Computer Science and Mathematics ('which was more fun!'). Following his PhD in Zurich & Munich, he worked as a postdoc in Jerusalem. When his girlfriend found employment as an architect in Rotterdam, he chose an academic career in the Netherlands, first at CWI, later at EEMCS's Optimization Group. "I think all TU Delft students should have some knowledge of optimisation", he says. "Together with the Electrical Power Engineering Group we are supervising a BSc student in finding the optimal transport of electricity. So if you have an optimisation problem, come to us!" ■

Ineke Temming

Frank Vallentin heeft de 'SIAG/Optimization-prijs' gewonnen voor zijn wiskundig onderzoek naar het kusgetal. Dat is het grootste aantal bollen dat tegelijkertijd een centrale bol kan raken, zonder overlap. Hij leverde een overkoepelend bewijs voor de bekende kusgetallen, en vond nieuwe bovengrenzen voor de onbekende kusgetallen tot 24.

De unieke methode die hij ontwikkelde is gebaseerd op semi-definite programming en harmonische analyse. Franks onderzoek heeft toepassingen in gebieden als materiaalkunde en foutcorrigerende codes in telecommunicatie. De sectie Optimalisering stelt haar kennis graag beschikbaar aan studenten en medewerkers met optimaliseringsproblemen. ■