Dutch Prize for ICT Research 2011

Bettina Speckmann

Bettina Speckmann is an associate professor at the department of mathematics and computer science of the Eindhoven University of Technology (the Netherlands). She received her diploma degree in mathematics from WWU Münster (Germany) in 1996 and her PhD in computer science from the University of British Columbia (Canada) in 2001. She spent two years as a postdoc at the Institute for Theoretical Computer Science of ETH Zurich (Switzerland) and became an assistant professor at TU Eindhoven in 2003. Since March 2010 she is a member of The Young Academy of the Royal Netherlands Academy of Arts and Sciences (KNAW), and since March 2011 a member of the Global Young Academy. Bettina's research interests include the design and analysis of algorithms and data structures, discrete and computational geometry, applications of computational geometry to geographic information systems, automated cartography, and graph drawing.

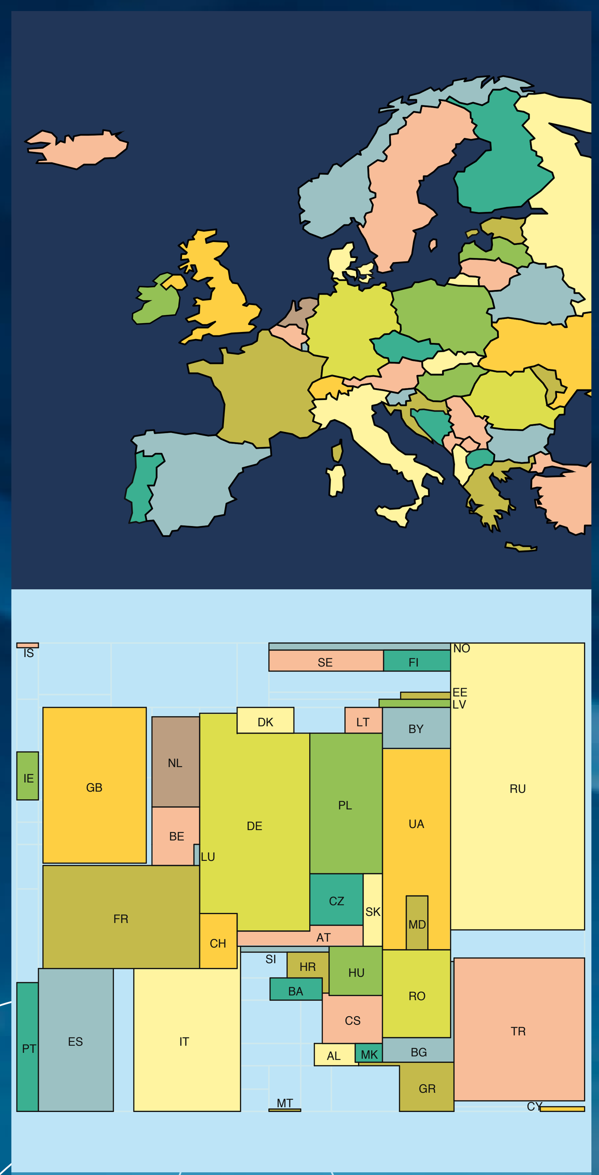
Computer Science Research on Models, Maps and Motion

COMPUTATIONAL GEOMETRY - ALGORITHMS

Computers generate more numbers about what is going on in our world than we can take in. Fortunately, they can also help us present numbers in ways that we can interpret visually -- as maps and diagrams. Computers, however, have no spatial insight; they need computer scientists to develop geometric algorithms that can collect the numbers and create meaningful, interpretable results.

Computer scientists develop algorithms that enable computers to efficiently and reliably work with data. An algorithm is a step by step sequence of instructions that performs a well defined task. It is natural enough to be understandable by humans, but precise and formal enough to be converted easily into a computer program.

Computational geometers focus on algorithms for geometry problems that come from many areas: robotics, databases, computer graphics, molecular biology and geographic information systems. Bettina Speckmann's research group produced algorithms to generate the maps below.



Cartogram showing European population as area

Flow map showing Scottish whiskey exports

Necklace map of 2010 World Cup soccer success

Symbol map of deaths from major earthquakes

RESEARCH ON THEMATIC MAPS

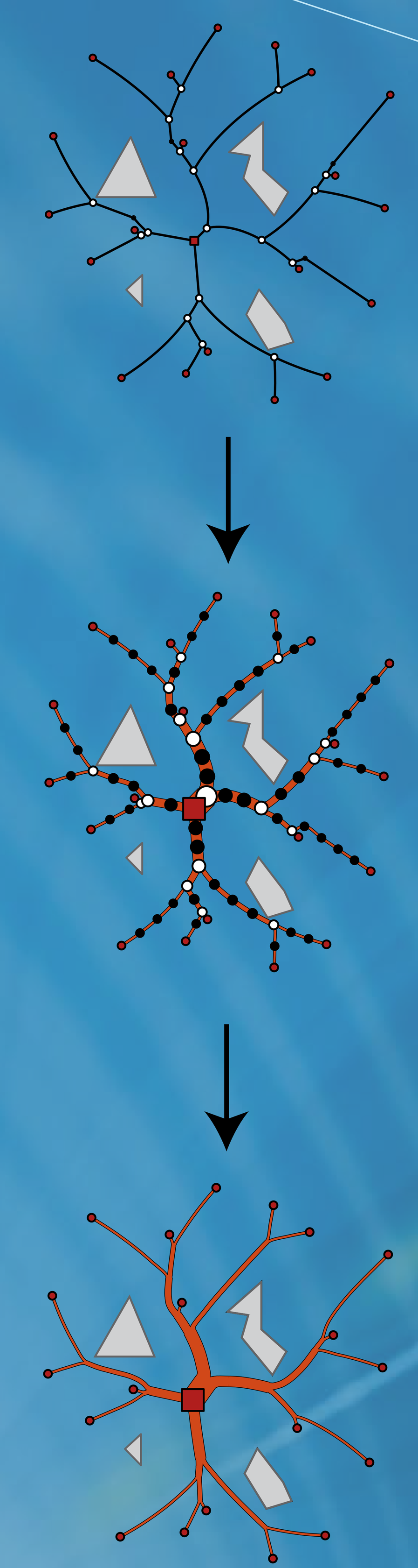
Maps are one of the most efficient ways to communicate information. They help people to make decisions in navigation, spatial planning, or risk and disaster management. Maps also communicate geopolitical information, and generally aid the process of public opinion and consensus building. Decision makers and the greater public benefit from high quality up-to-date, ondemand, and online map production, which necessarily has to be fully automated.

Thematic maps are special purpose maps for conveying specific information. They usually focus on a single theme and visualize such diverse topics as the gross domestic product per country, the effects of pollution on the water quality, or the migration patterns of animals. Thematic maps can be found on webpages, in newspapers, infrastructural reports, or biological studies, to name a few.

Flow Maps

An example of Thematic Maps are Flow Maps. Flow Maps are thematic maps that visualize the movement of objects, such as people or goods, between geographic regions. One or more sources are connected to several targets by lines whose thickness corresponds to the amount of flow between a source and a target. Good flow maps reduce visual clutter by merging (bundling) lines smoothly and by avoiding self-intersections. Most flow maps are still drawn by hand and only few automated methods exist. Bettina Speckmann presented a new algorithmic method that uses edge-bundling and computes crossing-free flows of high visual quality.

This method is based on spiral trees, defined mathematically by Bettina Speckmann and her group. Spiral trees naturally cluster targets and smoothly bundle lines. To draw one, they start with a thin spiral tree bypassing obstructions, which is then thickened, then smoothed using mathematical optimization tools that prevent overlap.



Three important steps in the construction of a flow map

RESEARCH ON MOTION DATA

Over the past years the availability of devices that can be used to track moving objects GPS systems, mobile phones, surveillance cameras, RFID tags, and more has increased dramatically, leading to an explosive growth in data about moving objects. Objects being tracked range from migratory birds to delivery trucks, sea turtles to sports players, hurricanes to suspected terrorists. Naturally the goal is not only to track objects but to determine typical or unusual patterns of behavior by doing trajectory analysis: computing similarity, clustering, classifying, simplifying, segmenting, and detecting the effects of time and space. The movements of animals, people and vehicles are embedded in a geographic context, which both enables and limits movement: cars can move on roads and turtles ride ocean currents, but people cannot walk on water and wolves cannot cross a wide river gorge.Most analysis algorithms for trajectories have so far ignored context, except for the display of results. Hence one of the big challenges for the coming years is to capture the essential properties of context and develop efficient analysis algorithms that are context aware.

Movements of individual lesser black-backed gulls breeding on the island Texel and tracked with UvA-BiTS (www.uva-bits.nl)
University of Amsterdam & Royal Netherlands Institute for Sea Research

IPN ICT Research Platform Netherlands
IPN Is the national platform for ICT research in the Netherlands. ICT research has an enormous impact on our everyday lives. We are often not aware that we make use of the results of ICT research dozens of times each day. IPN strives to give ICT research in the Netherlands a stronger position and more visible. By coordinating Dutch ICT efforts IPN functions as the national contact point for policy makers, politicians, industry and other groups in society. Researchers in computer science and closely related disciplines, such as electronics, communication and signal processing, are increasingly working together. IPN encourages this movement towards a single ICT research field and is actively contributing to this.
For more information: www.ictonderzoek.net

Netherlands Organisation for Scientific Research
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