Dutch Prize for ICT Research 2011

Computer Science Research on Models, Maps and Motion

Computational Geometry - Algorithms

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 1995 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 (Kunstacademie). Since March 2011 she is 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 algorithm design, and computer graphics.

RESEARCH ON MOTION DATA

Over the past years the availability of devices that can be used to track moving objects 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. Flow maps are still not standardized, but a new algorithmic method that uses edge-bundling and computes crossing-free flows of high visual quality. This method is based on spiral lines, defined mathematically by Bettina Speckmann and her group. Spiral lines naturally suggest targets and smoothly bundling lines. To draw one, they start with a thin spiral few bypassing obstacles, which is then thickened, then smoothed using mathematical optimization tools that prevent overlap.

Maps and motion data are one of the most efficient ways to communicate information. They help people to make decisions in navigation, spatial planning, or risk management. Maps also communicate geophysical information, and generally aid the process of public opinion and consensus building. Decision makers and the general public benefit from high quality carto- dale, on-demand, 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 websites, in newspapers, infrastructure 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 similarly and by avoiding self-intersections. Most flow maps are still drawn by hand and art is known. A new automatic method exists. Bettina Speckmann presented a new algorithmic method that uses edge-bundling and computes crossing-free flows of high visual quality.

Three important steps in the construction of a flow map.