AMS
American Mathematical Society

Mathematics Events at the 2011 AAAS Meeting

Mathematics and Collective Behavior

Iaian Couzin (Princeton University) began the symposium by describing how information is shared in groups, for example, how a swarm of bees finds a good nectar source. He studied **information transfer** using simulations with a group of 200 "individuals." In such a group, even when only 5% of the group have knowlege about where to go, the group will still follow, even though there are no designated leaders in the group. If two small groups within the larger group have different ideas about where to go, the group will head in the average direction when the angle between the two directions is less than 120°, but when the angle is 120° or more, the group will split in two along the two different paths. (Photo by Jose Luis Gomez de Francisco.)

Couzin also talked about **migration**. His group has found that individuals surrender some of their detection abilities (which have a cost) and move with the group. Once these abilities are surrendered, they are hard to recover. So, for example, in Northern Canada, hunters don't kill the leaders of a migrating group so that the group can still move effectively. Also, if a species' migration route is distrubed because territory is fragmented, it is amost impossible to restore the route.

Readers may be more familiar with the collective behavior associated with humans in cars. **Anna Nagurney** (University of Massachusetts Amherst) talked about congestion in networks, especially **traffic** on roads. It is estimated that the cost of being stuck in traffic is about $100 billion per year in the U.S. There are two types of networks: *user-optimized*, in which individuals make their own decisions based on what is best for them, and *system-optimized*, in which the decision-making is centralized. Problems in the latter are large-scale and non-linear. She cited examples of Braess's Paradox, in which adding a road increases traffic, including one from Seoul, where, in 2002, a six-lane road was removed and traffic decreased. Nagurney has derived a unified network performance measure to study which nodes and links in networks really matter to the system's performance.