Tracking crime in real time

August 8 2011

Almost everything we do leaves a digital trace, whether we send an email to a friend or make a purchase online. That includes law-abiding citizens — and criminals. And with digital information multiplying by the second, there are seemingly endless amounts of information for criminal investigators to gather and process.

Now Prof. Irad Ben-Gal, Dr. Eugene Kagan and Ph.D. student Aviv Gruber of the Department of Industrial Engineering in Tel Aviv University's Ibi and Aladar Fleischman Faculty of Engineering are using these digital traces to catch criminals and beef up homeland security against the threat of terrorism, developing high-powered context-based search algorithms to analyze digital data on-the-fly. With the ability to process new pieces of information instantly, these algorithms move at a high speed to support ongoing investigations.

This research was recently presented at the Convention of the Institute for Electrical and Electronic Engineers (IEEE) in Israel, and details of the algorithms will soon be published in the journal *Quality Technology & Quantitative Management*.

Sherlock Holmes goes digital

Like digital files, people are always on the move, Prof. Ben-Gal says. It's not enough to process the information you have and assume the output will remain relevant. "If the object is moving, modelling and eventually catching it is mathematically complex," he says. Prof. Ben-Gal and his fellow researchers work with leading companies in homeland security on

how to establish patterns of terrorist or criminal activity using mostly communication files. New pieces of information are automatically plugged in to existing data, and the algorithm's analysis of the criminal's movement or pattern is reformatted.

The algorithm works like a computerized sleuth, taking pieces of information such as phone calls, emails, or credit card interactions and reducing them to a set of random variables for further analysis. All of these communications are actually pieces of one long message waiting to be decoded, explains Prof. Ben-Gal. In a single telephone call, for example, there are several variables to consider — the recipient of the call, its length, the location of the caller himself. Once all this is known, the algorithm not only assesses patterns of crime to predict future movements, but also creates a probability map displaying the possible locations of the person or group of interest.

Like a topographical map, the probability map is divided into zones where the subject (a criminal, a terrorist organization or a drug dealing ring) is likely operating. Each zone is assigned a statistical level of probability that the subject is there. Although refining the programming of the original algorithm could take some hours, each new piece of information afterwards can be processed in a matter of milliseconds, and the analysis can be used instantly.

Our algorithms can help officials to use the available information wisely, Prof. Ben-Gal says. If they have one shot at obtaining a suspect, the location of highest probability is a good bet. Zones of lower probability can be ruled out and attention can be focused in increasingly specific areas. With more time to spare, it's an adaptive searching game – lower probability zones can sometimes yield more information.

A gathering cloud of big data

According to Prof. Ben-Gal, these algorithms are designed to deal with the phenomenon of "big data," the ever-growing amount of information available to crime fighters in the technological environment. But beyond tracking the bad guys, they offer solutions for our more legitimate world — from marketing to computer file sharing.

Prof. Ben-Gal points to companies such as Amazon, IBM and Apple, which have effectively put similar algorithms to use. Amazon, for example, generates purchasing suggestions based on books, music or products you have already purchased or browsed. Apple's forthcoming iCloud, a service that wirelessly stores digital content, will need algorithms to locate moving files when they are needed and deliver them to various devices.

Prof. Ben-Gal says that this research can also lead to near-future consumer enhancements such as location-based marketing, which targets consumers based on their location, notifying them on their mobile devices of deals in their local area.

Provided by Tel Aviv University