The emerging discipline of network science examines the interconnections among diverse physical and engineered networks.

At the University of Maryland, researchers are making significant contributions to this interdisciplinary field, developing algorithms and tools to advance network behavior. Their work involves the very latest network technologies, including information networks, social networks, biological networks, sensor networks and communication networks.

CRITICAL CONNECTIONS

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Network Research

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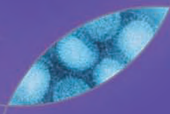

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INFORMATION | NETWORKS

In the age of electronic information overload, V.S. Subrahmanian, who directs the University of Maryland Institute for Advanced Computer Studies, has developed **software that retrieves information from millions of newspaper articles and other open source materials on the Web in semi-real time.** STORY accesses and digests a vast amount of materials, far beyond what researchers could physically review in months or years. Using information derived by STORY, researchers were able to provide a division of the U.S. Army with information regarding the history, politics and culture of several Afghan tribal groups before the division's deployment to Afghanistan. The research team is also developing algorithms to model and predict future behavior, such as how such warring tribes are likely to behave under particular sets of circumstances.

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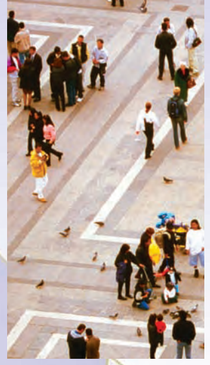

SOCIAL | NETWORKS

Visualizing and analyzing social networks is a challenging problem that is receiving growing attention. Lise Getoor, associate professor of computer science, has focused on link mining and relational mining—**statistically-based methods for extracting information about the relationships among different persons or things** to study data and databases. The methodology has been applied to bibliographic entries, email archives and public health datasets, and Getoor has utilized the technique to analyze the social network datasets of terrorists and terrorist attacks.

The group also has developed tools for analyzing dynamic group membership in social networks. One of the latest tools, C-Group, focuses on changing group memberships over time and provides users with a flexible interface for defining groups interactively and viewing the changing group memberships in pairs of individuals of interest.

Using link-based and group-based classifications, Getoor and her team have studied privacy implications in social networks with mixed public and private user profiles. The visual analytic tool they have developed gives users alternate views for varied network sizes and provides users with different insights into grouping behavior.

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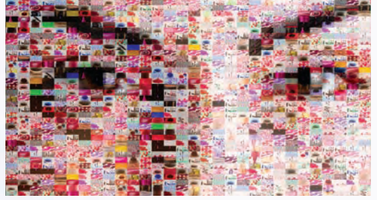


SENSOR | NETWORKS

A pioneer in the development of pattern recognition and computer vision software Computer Science Professor Rama Chellappa is working on **developing robust and efficient algorithms for detecting, tracking and recognizing humans and their activities using a network of video sensors.** Applying complex mathematical formulas and algorithms to recognize and compare still and video images, the technology could have widespread applications in security surveillance, as well as non-security applications in elder care and video indexing. Advanced face recognition software, developed by Chellappa, also has a range of surveillance applications. The software is based on a histogram of the face from multi-view video inputs that ultimately produces a texture map corresponding to the face.

Chellappa and his group are also developing efficient methods for building and tracking three-dimensional models of humans. Their sophisticated approach allows for dealing with the most complex poses. The segmentation results can be used to automatically estimate the size and shape of human body models, a process that is essential for accurately tracking human motion.

WWW.UMIACS.UMD.EDU/~RAMA/

INFORMATION TOOLS UNDER DEVELOPMENT

The SOMA (Stochastic Opponent Modeling Agents) Terror Organization Portal, or STOP, **predicts through social networking how terror groups will act and share data.** STOP used decades of data on the behavior of 30 major terrorist organizations, including Hezbollah, Hamas and Hezb-I-Islami, to predict future behavior from past actions and events.

The OASYS system looks at a collection of documents (in multiple languages) and assigns an "intensity" of opinion of a given document on a given topic. Based on a series of complex algorithms, the OASYS technology is capable of tracking the media on the Internet in many languages, measuring worldwide opinion on a variety of subjects.

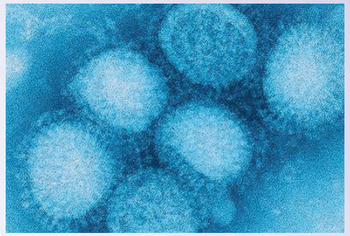
A software platform called GIDSTAR (Global Infectious Disease Surveillance Tracking and Analysis Repository) gathers information about diseases occurring around the world and tracks them in real-time to provide alerts to relevant public health officials well before a widespread outbreak occurs.

The RDF Extractor (T-REX for short) in development at the Laboratory for Computational Cultural Dynamics, allows users to specify an area of interest and related criteria. The T-REX system finds all instances of the required criteria by browsing millions of web pages and extracting relevant information from each page.

BIOLOGICAL | NETWORKS

Through his work in the Center for Bioinformatics and Computational Biology, Computer Science Assistant Professor Carl Kingsford and his group are designing graph algorithms to gain information from biological data. Recently developed high-throughput techniques are being used to sample protein-to-protein interactions from many organisms, creating a wealth of data that must be analyzed computationally. The team is developing **new algorithms and a suite of software tools to extract meaningful biological clusters from incomplete interaction data.** The resulting software will expand the capabilities of biologists working on particular protein complexes and pathways to make better use of network data.

In related work, through a computational search of all available sequences of the surface proteins of the H1N1 swine influenza isolates, Kingsford and this team found that a similar strain of the virus appeared in Thailand in 2000. His data collection shows that this strain has occurred



at least twice in the past ten years and that all previous such sequenced re-assortments were collected in Thailand, which produced only one documented human infection.

WWW.CBCB.UMD.EDU/~CARLK/

COMMUNICATION | NETWORKS

John Baras, Lockheed Martin Chair in systems engineering and founder of the Institute for Systems Research, is exploring a number of ways to **strengthen the security of broadband wireless communication networks.** In collaboration with the Army Research Laboratory, Baras and his team have developed a key exchange system that holds great interest for national defense systems, major banking companies and other industries in which secrecy is of great importance. The new technology allows for message encryption and its reversal while eliminating the potential for a third-party security breach by avoiding the need to actually communicate keys. Baras' work also focuses on how to build trust in communication networks. His team is using mathematical analyses to understand and predict the emergent behaviors of distributed trust management systems in autonomic networks and to explore how trust is a catalyst for collaboration.

Baras is also leading a Multidisciplinary University Research Initiative (MURI), a multi-agency Department of Defense program, to address fundamental questions about the role that time-scales, network dynamics, and correlations play on the performance and security of military communication networks.

WWW.ISR.UMD.EDU/~BARAS/

NEXT-GENERATION COMMUNICATION NETWORKS

The University of Maryland is home to North America's first, and the world's second, laboratory endorsed by the WiMAX Forum and **dedicated to creating applications for WiMAX, a next-generation technology for the Web and other wireless communication.** Computer Science Professor and Director of the Maryland Information Network Dynamics (MIND) Lab Ashok Agrawala is developing a new social networking WiMAX application for cell phones and PDAs. The MyeVyu prototype, created for University of Maryland students, will pinpoint a user's position on campus within about 10 feet and integrate data with map graphics, campus construction and transportation updates as well as other information. Agrawala is also developing V911, a public safety application for a smartphone.

WWW.CS.UMD.EDU/~AGRAWALA/