Research Overview – UNCG Department of Computer Science

The Department of Computer Science at UNCG has a small but active faculty in a variety of research areas, with well-regarded work that has appeared in leading journals and conferences. The list below is organized faculty by expertise in broad, traditional areas of computer science, and the faculty profiles that follow give more detailed information. For more information, including links to project web sites and publications, see
http://www.uncg.edu/cmp/research.html

Algorithms and Theory of Computing
Francine Blanchet-Sadri
Stephen R. Tate

Artificial Intelligence
Nancy Green

Database Systems
Lixin Fu
Fereidoon Sadri

Networking
Jing Deng
Shan Suthaharan

Security and Cryptography
Jing Deng
Shan Suthaharan
Stephen R. Tate

Francine Blanchet-Sadri

Primary Research Areas: Algorithms and Theory of Computing

Other Expertise: Combinatorics, Coding Theory, and Logic

Brief Overview: Prof. Blanchet-Sadri's recent research activities and interests have dealt with combinatorics on partial words, or sequences from a finite alphabet that may contain a number of "do not know" symbols also called "holes," and have culminated in the first book on the topic, *Algorithmic Combinatorics on Partial Words* (Chapman & Hall/CRC Press, 2008). In molecular biology, partial words model regulatory elements of the genome that play a role in controlling the activity of genes. Partial words are useful in a new generation of pattern matching algorithms that search for local similarities between sequences. In this area, they are called "spaced seeds" and a lot of work has been dedicated to their influence on the algorithms' performance. Partial words can also have impacts in bio-inspired computing where they have been considered for finding good encodings for DNA computations.

Prof. Blanchet-Sadri has investigated several combinatorial properties of partial words and has made connections with problems in graph theory and number theory, in particular, with problems concerning primitive sets of integers, lattices, chromatic polynomials, vertex connectivity in graphs, etc. On the one hand, she has developed efficient algorithms related, in particular, to computing patterns such as periods in partial words which has important applications in data compression, theory of codes, and computational biology. On the other hand, she has proved, for instance, that the problem of deciding whether a finite set of partial words is so-called unavoidable is NP-hard, which is in contrast with the well known feasability results for unavoidability of a set of full words (ones without holes). Professor Blanchet-Sadri has also recently initiated the challenging number theoretic problem of classifying unavoidable sets of partial words of small cardinality and in particular those with two elements.

Jing Deng

Primary Research Areas: Wireless Networks and Security

Other Expertise: Mobile Ad Hoc Networks, Wireless Sensor Networks, Network Algorithms, Information Assurance

Brief Overview: Prof. Deng's research is focused on efficient and secure algorithms for wireless networks. There are mainly two issues in wireless networks, especially resource constrained ones: First, how can the information be efficiently delivered from source to destination? Secondly, how secure can such information delivery be when there are node failures, compromise, and captures? In recent research, Prof. Deng has worked on medium access control in wireless networks, information delivery in wireless sensor networks, key establishment in wireless networks, and secure routing in mobile networks.

Other recent projects of Prof. Deng have included service look-up in large wireless networks, efficient data forwarding, and broadcast scheduling in wireless networks.

Lixin Fu

Research Areas: Databases, Data Warehousing, and Data Mining.

Brief Overview: In data warehousing, a large amount of data from different sources are extracted, cleansed, and integrated into a large storage area. There are a lot of research activities that involve this back-end of warehousing, and Prof. Fu's research focuses on the front-end, investigating issues such as representation and efficient algorithms for complicated queries. Prof. Fu has successfully designed several efficient data cube algorithms.

Prof. Fu is investigating combining data mining and data cube, two important fields, resulting in an integrated information system that has more efficiency and capabilities. Initial results such as classification and clustering on data cubes are promising.

Nancy Green

Primary Research Areas: Artificial Intelligence (natural language processing, dialogue systems, user modeling, computational models of argumentation)

Other Expertise: Human-Computer Interaction (intelligent user interfaces and multimedia systems)

Brief Overview: Prof. Green's current NSF-sponsored research is on Artificial Intelligence (AI) methods for producing "natural arguments" for lay persons, e.g., to help a patient understand the reasoning underlying the diagnosis of his condition made by a healthcare professional. Another current project is on designing a dialogue system enabling a user to have conversations with a virtual patient simulating a person with Alzheimer's disease. In a recent project, she designed a system for estimating the perceptual effort required to interpret bar charts; the estimate of perceptual effort is used by a Bayesian reasoning system to summarize the communicative goal of the bar chart.

Fereidoon Sadri

Primary Research Areas: Database Systems and Information Integration

Brief Overview: Prof. Sadri's research has included work in modeling and management of uncertain information in database systems, addressing the handling of inaccurate information in databases. Data is often uncertain, in particular when it is obtained by means of data mining and automated information extraction. Prof. Sadri has developed an approach which is based on solid mathematical probability theory for the representation of inaccurate data and query processing for uncertain data. In other work, Prof. Sadri has investigated issues related to multi-database systems, developing powerful database query languages that allow data/metadata transformation (such as the pivot and unpivot operations), and studying query optimization for these languages. This research forms the basis for interoperability among multiple database systems with different schemas.

In Prof. Sadri's work on information integration from multiple sources, he considers the need for scalable decentralized data sharing which arises naturally in a wide range of applications, including enterprise data management, scientific projects undertaken across universities or research labs in biology, astronomy, and other domains, and data sharing among governmental databases. We have developed a framework and have implemented a system for a simple, intuitive, and efficient user interface to query a possibly large number of information sources without any knowledge of data representation details in these sources.

Prof. Sadri's most recent research has been on high-speed parallel processing of very large volumes of data using the "Map-Reduce" technique that was introduced by Google. In this approach, data is partitioned among large numbers (tens or even hundreds of thousands) of desktop computers that collectively process the data efficiently.

Shan Suthaharan

Primary Research Areas: Cryptosystems and Computer Networking.

Other Expertise: Image Analysis and Pattern Recognition, Image/Video Coding and Compression, Image/Video Watermarking and Image/Video Visual Quality Metric.

Brief Overview: Prof. Suthaharan's current research interest is focused on an applied area of computer science, involving traffic characteristics of the Internet and Local Area Networks, and the efficient and secure transmission of information across these networks. Prof. Suthaharan's research involves both advances in efficient algorithms for handling secure data transmission and experimental studies of existing network characteristics. More specifically Prof. Suthaharan's research is on (i) developing cryptosystems for memory and resource limited networks such as wireless networks and sensor networks, (ii) developing cryptosystems for secure transmission of text, image and video over an unsecure and bandwidth limited network, (iii) developing digital image/video quality metric for small devices such as cell phones and handheld devices, and (iv) modeling network characteristics and controlling congestion over computer networks such as the Internet, wireless and sensor networks. Complex Systems (Chaos Theory) modeling and moment invariants are used in the current research.

Stephen R. Tate

Primary Research Areas: Cryptography and Computer Security

Other Expertise: Algorithms, Data Compression, and Theoretical Computer Science

Brief Overview: Prof. Tate's recent research is focused on the following question: What additional capabilities are enabled when standard computing systems are augmented with simple secure hardware additions, such as the Trusted Platform Module being included in many current systems. In his recent research, Prof. Tate has shown how such augmented systems can be used to solve several problems that are provably impossible on standard systems, including realization of a "random oracle" and a non-interactive form of secure mobile agents.

Other recent projects have included new techniques for online/offline digital signatures (digital signatures in which most of the signature can be "pre-computed" before the message to be signed is known, followed by a super-efficient computation once the message is known), and intrusion detection techniques for encrypted protocols.