

CSEE Research Review – Talk Abstracts

Friday, May 6, 2011

Department of Computer Science and Electrical Engineering
University of Maryland, Baltimore County (UMBC)

Session I

Gary Carter, *CASPR and Computational Photonics Laboratory*
Nonlinear Optics with Silicon Nanowires

Nonlinear optical interactions in materials can provide functionality in optical signal processing and optical communications. The challenge is to realize the required nonlinear functionality in an integrated optical platform. I will highlight recent work in silicon nano wires that has demonstrated this capability in a material that can be integrated with silicon electronics.

Yelena Yesha, *Center for Hybrid Multicore Productivity Research (CHMPR)*
Clinical Decision Support Systems for Personalized HealthCare

One of the most important advances in medicine today is the use of Personalized Medicine in patient care. This type of care involves the systematic use of an individual patient's medical and related information to optimize that patient's therapeutic care and diagnosis. More specifically, information about a patient's clinical, genomic and metabolic characteristics is used to tailor an individual's medical care to meet that individual's specific needs. In recent years, the amount of medical information available has increased exponentially, providing even more potential for dramatic improvements in Personalized Medicine and patient care. Advanced knowledge and evidence-base approaches that medical science is regularly providing can help identify individual patients that differ in their susceptibility to a particular disease or their response to a specific treatment, and offer solutions for the treatment of complex chronic diseases, such as Diabetes, in which a wide array of factors influence the dynamics of the disease. Along with these advances in knowledge, however, come equally critical challenges. Namely, how can this continuous flow of new knowledge be synthesized and disseminated in manner that is useful to everyday practitioners and their treatment of patients. Two examples that illustrate the benefits and challenges of this immense expansion of information include the Human Genome Project and the emerging field of Pharmacogenomics. The Human Genome Project was a 13 year, multi-national project that laid the groundwork for our understanding of the roles of genes in normal human development, which continues to generate ongoing, cutting-edge research. Emerging fields such as Pharmacogenomics examine the impact of genetic variation on a patient's response to medications, helping increase the efficacy and safety of medications. Although clearly related, there currently does not exist a medium that coherently integrates and presents medical findings such as these to bed-side practitioners. Further, there is not a system that combines the ability to disseminate cutting-edge medical information with related patient information. A system with such capabilities would substantially increase a practitioner's ability to provide the best medical care for patients and greatly advance the field of Personalized Medicine. Thus, we propose to develop a Web-based, clinical decision support system that can integrate information from a patient's medical record with updated genomic and molecular medical findings. This system would automatically deal with the challenges involved in the inclusion of data from heterogeneous sources, and its underlying algorithms would generate visualizations of data based upon the datasets under review and user requirements. The potential

impact of this is far-reaching. The system's intelligent interactions would help physicians provide improved, personalized care to their patients, including the best possible preventive and therapeutic interventions, while at the same time, sparing patients with the expense and potential side effects of less viable options.

Amy Ciavolino, Eliana Feasley, and Robert Deloatch (Advisor: Marie desJardins), *MAPLE Lab* -
Best research by BS students

Playing to Program: Towards an Intelligent Programming Tutor for RUR-PLE

Intelligent tutoring systems (ITSs) are automated programs that provide students with a one-on-one tutor, allowing them to work at their own pace, so they can spend more time on their weaker areas of the subject matter. The RUR1-Python Learning Environment (RUR-PLE), a virtual environment to help students learn to program, provides an interface for students to write their own Python code and then see a visualization of the code execution. RUR-PLE provides a fixed sequence of learning lessons for students to explore. We are extending the game-like environment of RUR-PLE to develop the Playing to Program (PtP) ITS, which consists of three components: (1) a Bayesian student model that tracks student competence, (2) a diagnosis module that provides tailored feedback to students, and (3) a problem selection module that guides the student's learning process. In this paper, we summarize the basic RUR-PLE system and our ultimate design for PtP, and describe a user study that we will use to evaluate the effectiveness of our Bayesian student modeling approach for predicting student performance.

Session II

Stephen Beale, *Institute for Language and Information Technology (ILIT)*

Documenting Endangered Languages Using Linguist's Assistant

The Linguist's Assistant (LA) is a practical computational paradigm for efficiently and thoroughly describing languages. LA is built on a comprehensive semantic foundation. We combine an ontological framework with detailed semantic features that together cover a substantial subset of the range of human communication. An elicitation procedure has been built around this central, semantic core that systematically guides the linguist through the language description process, during which the linguist uses LA's visual rule-building interface to create a grammar and lexicon that describe how to generate target language text from the semantic representations. The result is a "how to" guide for the language: how does one encode a given semantic representation in the language? LA also allows the linguist to gather language data in a more conventional manner. Input texts are semantically analyzed using a convenient mark-up interface, in effect adding them to the standard semantic corpus. Grammar rules and lexical information can then either be confirmed or adjusted, or new knowledge added that allows the built-in text generator to produce target text that is substantially equivalent to the elicited examples. The result is a "how did" guide for the language: how did a native speaker encode naturally occurring text? We will present an overview of LA's goals and functionality. We will discuss results and examples from using LA to describe six languages, including two languages in Vanuatu, where the presenter spent three years engaged in linguistic research. LA will be the backbone of a Fall 2011 UMBC Honor's College class.

Michael Grasso, *ebiquity*

Clinical Image Processing and Personalized Medicine

This talk will discuss two research efforts within the eBiquity Group dealing with clinical image processing and personalized medicine. The traditional method of cell microscopy is through the visual inspection, where observations are made based on variations in cells from their expected appearance. This visual approach to cellular pattern analysis is subjective due to observer variability, a lack of standardization, and a limited feature set. We present a computation approach to cellular image processing, which was applied to smooth muscle cells. This work quantifies cell asymmetry and other morphologic changes, to better understand how these cells interact with the surrounding environment. In addition, we present a summary our efforts to use genetic information for disease prediction. The occurrence of type 2 diabetes is rapidly rising in the U.S., and is responsible for significant morbidity and mortality. Advances in genetics have raised hopes that genetic testing may aid in disease prediction, treatment, and prevention. We experimented with machine learning techniques that combine genetic information with clinical risk factors, in order to increase the prediction of diabetes beyond clinical predictors alone.

Pramod Jagtap (Advisors: Anupam Joshi and Tim Finin), *ebiquity Group - Best research by MS student*
Privacy Preservation in Context Aware Geosocial Networking Applications

Recent years have seen a confluence of two major trends – the increase of mobile devices such as smart phones as the primary access point to networked information, and the rise of social media platforms that connect people. Their convergence supports the emergence of a new class of context aware geosocial networking applications. While existing systems focus mostly on location, our work centers on models for representing and reasoning about a more inclusive and higher-level notion of context, including the user's location and surroundings, the presence of other people and devices, feeds from social networking systems they use, and the inferred activities in which they are engaged. A key element of our work is the use of collaborative information sharing where devices share and integrate knowledge about their context. This introduces the need for privacy and security mechanisms. We present a framework to provide users with appropriate levels of privacy to protect the personal information their mobile devices are collecting including the inferences that can be drawn from the information. We use Semantic Web technologies to specify high-level, declarative policies that describe user's information sharing preferences. We have built a prototype system that aggregates information from a variety of sensors on the phone, online sources, and sources internal to the campus intranet, and infers the dynamic user context. We show how our policy framework can be effectively used to devise better privacy control mechanisms to control information flow between users in such dynamic mobile systems.

Session III

Tinoosh Mohsenin, *Energy Efficient High Performance Computing Lab*

Energy Efficient Architectures for Digital Signal Processing and Communication Applications

This talk presents several projects that illustrate the cross-domain optimization of algorithms, architectures, and implementations for emerging and future digital signal processing and communication applications.

Communications systems are becoming increasingly commonplace and appear in a vast variety of applications such as: mobile phones, portable multimedia and embedded systems. These applications require significant levels of complex digital signal processing and operate within limited power budgets. Moreover, they will have not only to allow for a variety of applications but they will also have to maintain connections and reconfigurability in different environments and communication standards. In this project we study, design and implement digital processors that utilize novel algorithms and architectures for reconfigurable complex communications systems. Processors across a wide variety of implementation architectures will be examined including: dedicated-purpose processors and many-core arrays.

Wireless medical technologies have created opportunities for new methods of preventive care using biomedical implanted and body-worn devices. The design of the technologies that will enable these applications requires correct delivery of the vital physiological signs of the patient along with the energy management in power-constrained devices. The high cost and even higher risk that entails to the battery replacement require that these devices be designed and developed for minimum energy consumption. In this project, we study a platform that can dynamically perform patient multi-parameter monitoring and wireless transmission. As an example, energy efficient and high accuracy detection of epileptic seizures are discussed.

Wenjia Li (Advisor: Anupam Joshi), *ebiquity Group - Honorable mention PhD research*

A Holistic Framework for Securing Mobile Ad Hoc Networks

A Mobile Ad-hoc NETWORK (MANET) is generally composed of a dynamic set of cooperative peers that are willing to relay packets for other peers. The nature of MANETs makes them extremely vulnerable to a variety of node misbehaviors. Numerous methods have been proposed to cope with node misbehaviors for mobile ad hoc networks. However, most of the existing methods attempt to deal with node misbehaviors from one single perspective, and they are not able to efficiently collaborate with each other to help better identify various misbehaviors especially in a dynamic and complicated environment. Moreover, existing methods are not aware of the context in which a misbehavior occurs, which can be used to distinguish truly malicious behaviors from faulty behaviors.

To address these drawbacks of existing methods, we study a holistic framework in this dissertation to secure MANETs. In this framework, we integrate the components of misbehavior detection, trust management, context awareness, and policy management. These components are tightly coupled, and multiple types of low-level information flows reported by various components are fused together in an intelligent and adaptive manner to generate some high-level alerts. In particular, the application of context and policies makes it possible to precisely capture the nature of misbehaviors and then act accordingly even in an extremely dynamic and complicated environment, which is common in MANETs. We conduct an extensive experimental study to validate and evaluate the performance of the security framework. Experiment results show that our framework outperforms previous methods in various application scenarios.

Richard Carback (Advisor: Alan Sherman), *Cyber Defense Lab - Best research by PhD student*
Scantegrity II Municipal Election at Takoma Park: The First E2E Binding Governmental Election with Ballot Privacy

On November 3, 2009, voters in Takoma Park, Maryland, cast ballots for the mayor and city council members using the Scantegrity II voting system—the first time any end-to-end (E2E) voting system with ballot privacy has been used in a binding governmental election. This case study describes the various efforts that went into the election—including the improved design and implementation of the voting system, streamlined procedures, agreements with the city, and assessments of the experiences of voters and poll workers. Despite some glitches, the use of Scantegrity II was a success, demonstrating that E2E cryptographic voting systems can be effectively used and accepted by the general public.

This paper was presented at the 2010 USENIX Security Symposium.

Standby Talk

Laura Zavala, *ebiquity*

Context-Aware Applications on Smartphones

The growing use of mobile devices such as smart phones, combined with the increasing capabilities they offer, brings new opportunities for ubiquitous computing and context-aware systems. Smartphones are programmable and come with a set of embedded sensors, such as ambient light and temperature sensors, accelerometer, gyroscope, GPS, microphone, and camera, which are enabling the emergence of personal, group, and community scale sensing applications.

We are working on a project which goal is to prototype and evaluate context-aware systems and services for mobile computing devices and to explore how these can exploit the capabilities of next generation networks to enable applications that deliver better user experiences. In particular, we aim to develop a high-level notion of 'context' that takes advantage of the current generation of smart phones to capture key elements of context: the user's location, the presence of other people and devices, and the apparent activities in which they are engaged. We have specifically focused on three tasks: ontology development, privacy policies and software architecture for collecting data.

This talk is an overview of existing work on context-aware systems, focusing on sensing applications on mobile phones for inferring user location and/or activity. We briefly describe our software architecture for collecting data and ongoing experiments with the data. We also present our work in ontology development, and privacy policies. Specifically: (1) a light-weight upper-level ontology that we have developed to represent various types of contextual information in pervasive computing environments, and (2) the use of Semantic Web technologies to specify high-level declarative policies to provide users with appropriate levels of privacy to protect the personal information their mobile devices are collecting including the inferences that can be drawn from the information.