Mina Askari
(*School of Computer Science*)

Presentation: Tuesday, 3:20 p.m.
Room: DC 1304

Bringing Smalltalk Blocks to Java Through Transformation Techniques

Co-Authors: R. Al-Ekram

Many areas in software engineering benefit from the use of program transformation. One important application of program transformation is the programming language extensibility and syntactic transformation. In this paper we describe our experiment on using program transformation techniques as means to extend Java programming language with Smalltalk like blocks. We use the Stratego/XT toolset to define the extensions to grammar and to transform the extended syntax of the source program to some comparable construct of the base language in such a way that the behaviours of the source and target programs are equivalent. The grammar definition is used to generate parse table and signature files. The parse table is used by the generalized parser to produce AST from the programs written in the extended language. Stratego programs, consisting of rewrite rules and strategies, generate transformers to transform the extended Java programs into regular Java programs using the signatures. These programs transform the block constructs into equivalent Java anonymous class declarations. Because declaration of blocks and using them in a program can take few different forms, there should be different transformation rules to handle each of these separate cases. We implemented two basic forms of block declaration and discussed the approaches for implementing the rest of them. Based on our experiment we conclude that extending the syntax of a language via program transformation, without any extension to the language functionality, can provide simpler syntax that is convenient to use, but it does not provide any real power to the existing language.
World Relevance: An approach for extending the syntax of a language via program transformation, without any extension to the language functionality.

Alireza Bayat
(*Department of Civil Engineering*)

Presentation: Tuesday, 3:40 p.m.
Room: DC 1302

Numerical Investigation and Field Monitoring of Karun Bridge Abutment

Co-Authors: M.H. Sadaghiani, A. Adedamola

Karun Bridge is part of a national highway project underway in southern Iran. The bridge is a 336 m steel arch structure that weighs more than 2500 tons and crosses the Karun River 270 meters above the river valley. The bridge will be the largest suspended bridge in the Middle East. Cantilever construction is to be used to construct the bridge from both sides simultaneously. The weight of the bridge is to be carried by two abutments and four piers that are anchored to exposed weathered rock mass. Loads on the abutments and piers include significant cantilever loads and moments during bridge erection and wind loads. To better understand anticipated displacement within the rock mass, and the behaviour of the anchorage system a Discrete Element Method (DEM) analysis was performed. Due to the sensitivity and magnitude of the project, a field monitoring program was implemented to measure the performance of the rock mass during and after the construction and to validate the DEM analysis. This paper discusses the rational for choosing the DEM, a detailed description of the numerical program and a description of the field monitoring and instrumentation program. The numerical model reasonably simulated the actual behaviour of the rock mass abutment and the anchorage system. The study showed that DEM could closely simulate rock mass stability with discontinuities; DEM gives 3mm maximum displacement for the concrete block on the upper abutments compared to 2.7mm measured.
World Relevance: Karun Bridge is the largest bridge in Middle East. This paper discusses the rational for choosing the DEM, a detailed description of the numerical program and a description of the field monitoring and instrumentation program.

Robin Blanchard
(*Department of Health Studies and Gerontology*)

Presentation: Monday, 11:50 a.m.
Room: DC 1302

Examination of the Reliability and Validity of the Activity-Specific Balance Concerns for Long Term Care (ABC-LTC) Scale

Co-Authors: Dr. A. Myers

Fear of falling is an independent risk factor for falls in older adults. To date, however, most research has been conducted with community seniors. This study evaluated the reliability and validity of the newly developed ABC-LTC (Activities-specific, Balance Concerns for Long Term Care) scale, a tool to measure this construct in residents living in LTC. This scale was examined with respect to: (1) item and scale properties; (2) stability and reproducibility of scores; (3) feasibility and reliability of staff versus researcher administration; as well as (4) convergent and discriminative properties. A total of 101 ambulatory residents were successfully administered the ABC-LTC via interview. The ABC-LTC was re-administered to 44 residents within 14 days to assess temporal stability. Inter-rater reliability was examined by having staff members administer the tool to residents within 24 hours following researcher administration. The BBS, the TUG, and the Self-paced Walk Test were administered to 64 residents. The scale demonstrated good item-total correlations, high internal consistency, test-retest reliability and inter-rater agreement. Scores on the ABC-LTC were significantly related to balance, functional mobility, gait speed, and volitional mobility. Scores were also able to discriminate residents in terms of mobility, use of walking aids, requiring assistance with transfers and general fear of falling. The newly developed ABC-LTC scale is a promising, easily administered tool for assessing fall-related concerns relevant to LTC residents. The tool shows good scale properties, temporal stability, convergent and discriminate properties. A head-to-head comparison showed this multi-item tool was superior to a general fear of falling question.
World Relevance: This is the first tool designed to measure concerns for falling specifically in long term care. Falls remain a problem post-institutionalization and this tool may be used as a part of an effective fall prevention strategy.

Allan Caine
(*School of Computer Science*)

Presentation: Tuesday, 4:00 p.m.
Room: DC 1304

A Simplified Method of Determining the Direction of Parallel Optical Snow

Co-Authors: R. Mann

It has been shown that in parallel optical snow there exists a set of motion planes in the 3D power space. These motion planes intersect at a common line called the bowtie axis. The direction of motion of the parallel optical snow is orthogonal to this bowtie axis. However, this method requires the computation of a 3D Fast Fourier Transform (FFT) of all of the frames of the image sequence. The 3D FFT is computationally intensive. The method needs sufficient memory and storage for the output of the FFT and the 3D power space. Instead, we propose a different method, which works in phase angle. It needs only two frames of the image sequence to determine the direction of the parallel optical snow. As it turns out, the same bowtie axis is found in the phase angle space of the cross power spectrum of the two frames of the image sequence. The direction of the optical snow is also orthogonal to the direction of the phase angle space's bowtie axis. This method is highly advantageous. The 3D FFT of the whole image sequence is replaced by two 2D FFT's. From these two 2D FFT's, the phase angle of the cross power spectrum is readily computed, the axis found, and the direction of motion determined. In summary, our method reduces the dimensionality of the problem, which yields computational savings.
World Relevance: The study of optical snow is a relatively new area of research in the Artificial Intelligence vision community. Advances made in the simplification of computational methods are of paramount importance.

Aphrodite Dracopoulos
(*School of Optometry and Department of Biology*)

Presentation: Tuesday, 9:50 a.m.
Room: DC 1302

Alternative In vitro Methods for Ocular Irritancy Testing and Biocompatibility Screening of Medical Devices

Co-Authors: V. Bantseev, J. G. Sivak

Purpose. The in vitro uptake and release behaviour of benzylkonium chloride (BAK) with silicon-containing (lotrafilcon and galyifilcon) and p-HEMA-containing (etafilcon and vifilcon) hydrogel contact lenses was studied via extract analysis by several alternative in vitro assays, including the Bovine Lens Assay. Methods. Contact lenses were soaked in a solution at varying concentrations of BAK (1%, 0.1%, 0.01%, and 0.001%) for more than 24 hours at room temperature. After exposure contact lenses were placed in a saline solution for a total of 7 days at 37° Celsius. Bovine lenses were exposed to the extract for 15 minutes, rinsed with saline and M199 and then incubated in culture medium at 37°C and 4-5% CO2. The Bovine Lens Assay measures the potential for ophthalmic irritancy of an extract by evaluating its effect on the optical properties of the lens with a scanning laser system for 72 hours after exposure. Results. It was demonstrated that exposure to extracts obtained from silicon-containing lenses were significantly more damaging to the lens at higher concentrations then that obtained from the p-HEMA-containing contact lenses. Compared to controls ($n=5$, $p<0.05$) loss of sharp focus was evident with extract obtained from silicon-containing 1% BAK increasing from 0.29±0.03 mm (SEM) to 1.09±0.21 mm (SEM), whereas p-HEMA-containing at 1% BAK had no effect. Conclusion. In vitro assays can be used with extracts to determine the potential effects of various contact lens polymers on the hysiological/functional properties of the lens and on the integrity of an epithelium in culture.
World Relevance: Concerns related to the inhumane treatment of live animals when toxic materials are placed directly on the eye are emphasized by the relative insensitivity of the Draize test. Developing a battery of in vitro alternatives would have the potential to replace such inhumane and unethical animal experimentation.

Issmail Ellabib
(*Department of Systems Design Engineering*)

Presentation: Monday, 10:50 a.m.
Room: DC 1302

Multiple Ant Colony System for the Vehicle Routing Problem With Time Windows

Co-Authors: O. Basir , P. Calamai

Due to the complexity of the Vehicle Routing Problem with Time Windows (VRPTW) and its relevance to a wide range of real-world applications, many heuristics have evolved for efficiently generating high quality solutions to these problems. Ant Colony Optimization is a relatively new metaheuristic technique inspired by the foraging behaviour of colonies of ants. The typical Ant Colony Optimization metaheuristic is very amenable to parallelization, not just as the parallel version of a sequential algorithm intended to provide speed gains, but as a new kind of metaheuristic of higher efficiency and efficacy. In this work, we apply the concept of parallel processing to enhance the strength of the Ant Colony System for solving the VRPTW. The performance of the multiple independent colony approach over the single colony approach is studied using a probabilistic model. New exchange strategies based on a weighting scheme are introduced under two different types of interactions that define the communication topology among the colonies. The assessment criteria indicated that exchange strategies based on the proposed weighting scheme had a positive influence on performance compared with the other exchange strategies. From the experimental results obtained on the Solomon problem data sets, the multiple colony employing the global weighting exchange strategy was the best performer overall.
World Relevance: Addresses the most common routing and scheduling problem that appears in some of the transportation systems.

Leah Hagreen
(*School of Planning*)

Presentation: Tuesday, 4:20 p.m.
Room: DC 1302

Distribution and Bioavailability of Sediment-Associated Metals in the Slave River Delta, NWT

Co-Authors: M. Stone, D. Milburn (Dept of Indian Affairs & Northern Development)

The Slave River delta is a highly productive and biologically diverse ecosystem located on the south shore of Great Slave Lake in the Northwest Territories. There is concern regarding the water quality of the Slave River due to the transfer of sediment-associated contaminants from upstream sources and from long-range atmospheric transport (Gregor et al., 1997). Previous research identified metal levels in some samples of suspended and deposited sediment of the Slave River and Slave River delta either meet or exceed Canadian sediment quality guidelines (McCarthy et al. 1997; Milburn et al., 2000). This study examines the bioavailability of sediment-associated metals and the distribution of these sediment-associated metals across the delta. Such information is required to assess the potential risk to the nearby First Nations community of Fort Resolution and to the ecology of the delta. Surface sediment samples were collected at 18 sites and analyzed using ICP-MS for total metals (25 metals), grain size and organic carbon content using standard methods. Membrane dialysis peepers were employed to quantify dissolved metal concentrations in pore-water near and at the sediment surface, with analysis for 25 metals using ICP-MS. Four-week metal bioaccumulation tests were conducted on cultured *Hyalella azteca* using the Imhoff settling cone technique (Borgmann and Norwood, 1999). The relatively high rates of survival (mean = 80%) observed suggest low sediment toxicity. Data are presented and interpreted in the context of current legislative and policy frameworks developed to manage northern environments of high ecological significance.
World Relevance: Metal contamination of waterways worldwide has significantly impacted human and ecological health. Understanding metal bioavailability in this delta will both aid in the protection of the local ecosystem and provide important information on the cycling of metals within Canada's north.

Christina Hallett
(*School of Optometry and Department of Biology*)

Presentation: Tuesday, 2:00 p.m.
Room: DC 1302

In Vitro Alternatives to In Vivo Ocular Toxicology Testing

Purpose: This study employs surfactants of known ocular toxicities, sodium dodecyl sulfate(SDS), benzalkonium chloride(BAK), Tween20, and TritonX-100, to explore in vitro alternatives to in vivo ocular toxicology testing using in vitro assays. Methods: Sodium Fluorescein Permeabilty Assay (SFPA) – Filter inserts containing Manin-Darby Canine Kidney (MDCK) cell monolayers were treated with test chemical concentrations for 15 min and washed with buffered saline. Inserts containing treated monolayers were placed in balanced salt solution, loaded with sodium fluorescein and incubated at room temperature for 20 minutes. Fluorometer measures of fluorescence of leaked sodium fluorescein were made. Agar Overlay Test – Mouse fibroblast (L929) cells were overlaid with agar-Minimum Essential Medium and stained with 1.0 % neutral red dye. A disk saturated with test chemical was placed on the agar-MEM layer and incubated at 37°C with 5.0 % CO2) for 18 hours. The zone of decolourization and the percentage of cellular lysis were observed. Results: The SFPA was a sensitive and objective assay also able to test recovery from toxicity. However, it produces erroneous results for highly viscous chemicals and those of high toxicity. The semi-quantitative Agar Overlay Test adequately measured effect of highly toxic test chemicals, but without a high level of sensitivity. In addition, 1.0 % neutral red reacts with concentrations of SDS >1.0 % to produce unreadable agar overlay results. Conclusions: These findings indicate that the in vitro assays investigated have both advantages and disadvantages, which are essential to understand when proposing their use as in vitro alternatives to in vivo ocular toxicology testing.
World Relevance: Development of a battery of in vitro ocular toxicology tests has the potential to replace the current industry standard, the in vivo Draize test.

Sameena Haque
(*School of Optometry*)

Presentation: Tuesday, 10:10 a.m.
Room: DC 1302

Corneal Refractive Therapy for Hyperopia, Measured With Optical Coherence Tomography

Co-Authors: D. Fonn, L. Sorbara, T. Simpson

Purpose: To investigate topographical thickness changes of the total cornea and corneal epithelium, following a single night of hyperopic CRT® rigid gas permeable lens wear, using optical coherence tomography (OCT). Methods: Twenty subjects wore a CRT® contact lens on one eye for a single night. The lenses were designed to temporarily reduce hyperopia through corneal steepening. The untreated eye served as a control. Baseline corneal and epithelial thickness was measured at 9 points across the horizontal meridian using OCT. Immediately following lens removal on eye opening the next morning and at 1, 3, 6 and 12 hours later, corneal and epithelial thickness of both eyes was measured using OCT at the same locations. An additional measurement was taken 24 hours later to observe recovery. Results: Twenty subjects completed the study. At lens removal, the treated eye showed central and paracentral corneal swelling of 8.8 ± 2.2% and 8.1 ± 3.4% respectively, (Re ANOVA; p=0.000), with central and paracentral epithelial thickening of 21.5 ± 8.6% and 15.9 ± 11.4% respectively, (p=0.000). Central corneal swelling in the control eye was 3.1 ± 1.6% and central epithelial thickness increased by 12.7 ± 7.4% (both p=0.000). Corneal swelling of both eyes had returned to baseline within 3 hours. Conclusion: CRT® lenses for hyperopic correction, when worn overnight, caused a greater increase in central corneal and epithelial thickness than the paracentral area. A reduced response was seen in the control eye. Both eyes recovered rapidly from the thickness changes induced.
World Relevance: Reversible refractive correction for hyperopia (long-sightedness) is a new research area, as only myopes have been catered for until now. Patients who are apprehensive of permanent laser refractive surgery would welcome this procedure.

Mohadeb Hazra
(*Department of Chemical Engineering*)

Presentation: Monday, 10:10 a.m.
Room: DC 1302

Experimental and Modeling Studies for Hydrogen and Filamentous Carbon Production From Methane Cracking Using a Ni based Catalyst

Co-Authors: E. Croiset, A. Elkamel

Hydrogen is one of the most efficient and ecological friendly fuels. It is clear now that fossil fuels will dominate as the hydrogen source in the near to mid term future. The objective of this thesis is to study the process of catalytic cracking of methane into hydrogen and carbon. The key to develop an efficient catalyst may lie in a better understanding of the reaction mechanism at the molecular level. The critical need in this respect is to devise a rigorous and practical model that can quantify the catalytic properties of active sites in terms of intrinsic parameters such as rate constants and activation energies of reaction steps. The aim of this study is therefore to develop a rigorous micro-kinetic model and to validate it against experimental measurements. Kinetic data including carbon formation and deactivation were measured for methane cracking over Ni/Al2O3 catalyst and a microkinetic model was also developed to analyze the data. The model takes into account carbon formation (encapsulating and filamentous) and also catalyst deactivation. The deactivation is described at the microkinetic level. The changes in activity are related to the changes in the surface site coverage of different species caused by an increase in the surface site coverage of encapsulating carbon. Parameter estimation studies were carried out in order to determine the values of the kinetic parameters needed in the model. Sensitivity analysis is also conducted on the model which helps to identify the significant steps in the reaction mechanism.
World Relevance: Fuel Cell

Shah M. Jahinuzzaman
(*Department of Electrical and Computer Engineering*)

Presentation: Monday, 9:30 a.m.
Room: DC 1302

Threshold Voltage Stability of Amorphous Silicon Thin-Film Transistor in AMOLED Display Driver Circuits

Co-Authors: A. Sultana, K. Sakariya, A. Nathan

The active matrix OLED (AMOLED) display is a new generation display that, compared to the ubiquitous LCD, has a variety of attractive features like wider viewing angle, faster response time and lower power consumption. However, the driving scheme of AMOLED display is more intricate and comprises of on-pixel analog circuits in order to source stable drive-current to the OLED. These circuits are usually realized with amorphous silicon (a-Si:H) thin-film transistor (TFT) because of its large area compatibility and low cost process. However, a-Si:H TFT is inherently disadvantaged in terms of stability since it exhibits a metastable shift in threshold voltage when subject to prolonged bias stress. This shift can be a major constraint for the analog functionality of the TFT in OLED display pixels. In this work, we have analysed and modeled the threshold voltage shift of the TFT under constant drain current stress, which is the typical bias condition in hitherto reported pixel driver circuits. The constant current stress has the characteristics of continuously adjusting gate bias that compensate for any shift in threshold voltage by keeping a constant density of band-tail carriers in the channel region. Taking this into account, we develop a power law model based on the mechanism of dangling-bond defect creation, the rate of which shows a non-linear dependence on the band-tail carrier density.
World Relevance: Threshold voltage shift model is a tool for predicting the lifetime of the TFT, and hence the OLED displays prior to manufacturing.

Michael Jarrett
(*Department of Electrical and Computer Engineering*)

Presentation: Tuesday, 1:20 p.m.
Room: DC 1304

Constructing an Autonomic Computing Infrastructure

As our ability to create faster and increasingly powerful computing systems grows, so does the complexity of the systems we create with them. Unfortunately, our ability to manage such systems has not seen the same growth, and thus the cost of maintaining computer infrastructures has grown at an unsustainable rate. Autonomic computing looks to address this issue by delegating many of the management tasks of a computing system back to computers, directed by high-level policies. Such capabilities are often described in terms of self-* capabilities: namely self-configuration, self-optimization, self-healing, and self-protection. A popular architecture described in literature for autonomic computing divides systems into three layers of 'autonomic elements'; a layer to manage high-level applications, a layer to manage groups of resources, and a layer of elements each managing individual resources. Each autonomic element acts as the control of a feedback loop: monitoring and controlling their respective systems. We have realized that this architecture maps naturally to a software agent based design. To demonstrate the effectiveness of this mapping, we have implemented a basic autonomic computing system, built on the Java-based Cougaar multi-agent system framework. We evaluate our implementation by using it to manage a simple web application. The resulting system successfully demonstrates several simple self-* properties, and serves as a much needed platform for further research into autonomic computing techniques.
World Relevance: Allows computer infrastructures to operate more reliably and efficiently, while reducing the number of human administrators required to maintain these systems.

Wei Jiang
(*School of Computer Science*)

Presentation: Tuesday, 1:40 p.m.
Room: DC 1304

Ordering in Query Processing and Optimization

Co-Authors: D. Toman

The requirement to study ordering of databases stems from two main issues: first, the output of a query is required to be sorted in a specific order; second, if the input is known to be ordered in a certain way, sort-based operations, such as join, duplicate elimination, etc., can be implemented more efficiently, which are most costly in query processing as we know. We outline a framework to generate query plans in the order context, so that unnecessary sort operations are avoided, and hence the costs of query processing can be reduced significantly. In our approach, ordering throughout query processing is captured by manipulating an virtual tuple identifier. A relation is viewed as ordered relation, denoted by a pair (R, o), where R is a standard relation and o is the order of relation. Order-preserving operators are defined over ordered relations. A description logic reasoner is applied to order inference during query optimization. There are two main results: first we find a complete set of operators that we need to express first-order queries with order in presence of constraints; second, we propose transformation rules to rewrite query plans to more efficient ones, considering the database schemas.
World Relevance: Studying ordering in databases will significantly reduce the costs of processing query, and benefit all applications, not only in traditional databases, but also non-traditional semistructural databases, such as XML databases.

Graeme Kemkes
(*Department of Combinatorics and Optimization*)

Presentation: Tuesday, 2:00 p.m.
Room: DC 1304

Long Cycles in Random Graphs

A graph is a model of the connections among various objects, such as the connections between computers in a computer network. In many applications, these connections are generated at random. For example, connections between computers can fail randomly. The theory of random graphs allows us to model these random connections. Although the connections may be random, much of the structure of a random graph can be calculated with high probability. For many years, researchers have known that the structure of a random graph changes fundamentally when the number of connections is increased above half the number of the objects. This is an example of a phase transition, which is an important theme in many areas of science. The structure of these random graphs is not completely understood. The purpose of this research was to determine their structure more accurately. The parameter studied was the length of the longest cycle in the graph. This is the longest sequence of connected objects, where the last one is also connected to the first one. To analyze this parameter, techniques from the theory of probability and asymptotic were used. A new estimate was obtained. This gives people a better understanding of the structure of these random graphs.
World Relevance: This work may have applications to the study of phase transitions in science.

Christine J. Khandl
(*School of Planning*)

Presentation: Tuesday, 4:40 p.m.
Room: DC 1302

Assessing the Effects of Stormwater Management Ponds on Urban Streams Using Benthic Macroinvertebrates in the Grand River Watershed, Ontario

Co-Authors: Dr. M.F.A. Stone, Dr. D.R. Barton

Since the early 1980's, a wide range of stormwater management practices have been implemented in municipalities throughout Ontario to mitigate the negative impact of stormwater runoff on urban watercourses. Among these practices, stormwater management ponds have been identified by the Ontario Ministry of the Environment as effective end-of-pipe controls for water quality treatment. While several researchers have focused on the treatment efficiencies of various ponds, less is known about the effect of pond effluent on the ecology of urban streams. This study examined the effect of stormwater management pond effluent on urban watercourses using a benthic biomonitoring approach. Field research was conducted in five streams located in residential areas within the Regional Municipality of Waterloo and the City of Guelph in May and June, 2004. Benthic macroinvertebrates were collected on artificial substrates placed in the stream channels above, within and below the pond outlets. Changes in benthic macroinvertebrate community structure were quantified using a number of summary indices. Several stormwater management ponds had a negative impact on the benthic macroinvertebrate communities in receiving streams, but others had no perceptible effect. Various summary indices suggest that this impact may be the result of organic pollutants and sediment from the stormwater management ponds. The magnitude of effect appears to be dependent upon the original condition of the benthic macroinvertebrate community. Benthic macroinvertebrates can be used as effective biomonitoring tools to assess the impact of stormwater management pond effluent on the ecology receiving streams.

World Relevance: Benthic biomonitoring data can assist policymakers and planners in monitoring, developing and implementing improved stormwater management practices that will protect watersheds and public health.

Yi Lin
(*School of Computer Science*)

Presentation: Tuesday, 4:40 p.m.
Room: DC 1304

Fast Image Completion

Co-Authors: B. Cowan

In computer image editing, we often want to move or remove an object on an image. This will leave a hole on the background. It may be easy for human being to figure out what should be filled in, but it is not for computers. How to deal with problem efficiently always attracts concerns in computer image processing area. Previous work addresses this challenge mainly in two ways. One is inpainting, which works fast, but only be able to work well on small-scale regions. The other is texture synthesis, which fills large regions with stationary or structured textures, but is very slow. So how to make it fast and good is our goal. My solution is based on a patch-based best-fit searching strategy, in which each partly-known patch, centered in a pixel with some of its neighbours in the known part, is filled by searching the known part of the image for a patch of pixels closely matching the known neighbours. This keeps the linear structure and texture of the image. We found that exhaustive searching strategies used in previous work is the main reason of slowness; most of best matches are in the neighbourhood of the target patch. If one match for a target patch has been found, the match for its neighbouring target patch usually lies in the first match's surroundings. Inspired by this spatial continuity, we introduce a very fast searching strategy. Experiments show that all the examples in this paper can be done in a few seconds.

World Relevance: Our image completion algorithm works fast and produces good results compared with previous work.

Anna Lomanowska
(*Department of Health Studies and Gerontology*)

Presentation: Tuesday, 10:50 a.m.
Room: DC 1302

Early Social Experiences and Propensity for Addictive Behaviour in Rats

Co-Authors: D. McCutcheon, S. Rana, L. Parker, P. Wainwright

Addiction is amongst the most common behavioural disorders in the Western world. While the mechanisms of addiction are only beginning to be understood, numerous studies suggest that environmental insults during childhood, such as neglect or abuse, are associated with an increased likelihood of addictive behaviour in adolescence and adulthood. In order to gain more insight into the developmental processes behind this phenomenon, the present study examined the effects of early social experiences on behavioural functioning in later life using an animal model of post-natal (artificial rearing) and juvenile (isolation housing) social deprivation. The results indicate that early social deprivation in rats, particularly during the initial post-natal stage of development, has profound consequences on performance in behavioural tasks designed to assess the functioning of neural systems involved in addiction. These findings emphasize the formative role of early experiences in establishing future addictive tendencies. Further research using this model should reveal the causal mechanisms behind this process, and thereby shed light on possible preventive interventions.
World Relevance: The prevention and treatment of behavioural disorders is limited by our knowledge of the causal factors. This study advances our understanding of the impact of early experiences on brain and behavioural development by providing vital information about the etiology of behavioural disorders and addiction.

Masoud Makrehchi
(*Department of Electrical and Computer Engineering*)

Presentation: Tuesday, 3:00 p.m.
Room: DC 1304

A Corpus-Based Unsupervised Keyword Extraction

Co-Authors: M. Kamel

Keywords are very important elements in searching and accessing Documents, including web pages, articles, patents and so on. They can be considered as a set of terms (single or multiple-word terms, called phrases), which describes the document in a search process. Keyword is a term used as an entry point into an index which serves to identify files, records, texts, or other data containing the key or some related word, such as a synonym. In other words, any significant term (word or phrase), especially a term used to describe the content of a document is called keyword. In this presentation, an unsupervised keyword extraction method based on corpora is presented. After representing each document in the collection by a set of weighted candidate keywords, the problem is translated into finding appropriate weight for each candidate. In order to determine the weight, first, all terms of the vocabulary are mapped into a two-dimensional space called class-collection map by obtaining two proposed measures called significance and relevance for each term. At the second step, the mapped terms are grouped into three categories, namely, features, keywords and stop words which are discriminated by their contributions to the meaning of the documents. Instead of a clustering approach for grouping purpose, a rule base is provided. The method is independent of the language of documents and data dimensionality. It does not require the use of dictionary, thesaurus nor natural language processing.
World Relevance: Information Technology Market, E-business, Search engines, Natural language processing.

Jennifer Marshall
(*Department of Electrical and Computer Engineering*)

Presentation: Monday, 9:50 a.m.
Room: DC 1302

A Comparative Evaluation of Power Management Systems for a Fuel Cell Vehicle

Almost all automobile manufacturers have invested in the development fuel cell vehicles. The motivation behind this has been the escalating concerns about energy security, dwindling fossil fuel reserves, and the adverse environmental effects of operating internal combustion engine vehicles. The initial and operating costs of fuel cell vehicles have to be dramatically reduced and many technical problems in hydrogen handling, fuel cell reliability, and power management have to be solved before fuel cell vehicles can be commercially available. This paper documents a comparative evaluation of power management strategies for a fuel cell powered small SUV, with the objectives being high vehicle performance and high vehicle efficiency. An analytical approach for selecting the fuel cell module size and energy storage system is presented. Also, possible DC/DC converter choices are reviewed, and a general control strategy for the overall system is proposed.

World Relevance: Fuel cell vehicles have the potential to replace traditional internal combustion engine vehicles, which have contributed to the depletion of the world's fossil fuel reserves and caused adverse environmental effects. A high efficiency power management system for a fuel cell vehicle will increase the commercial prospects of this technology.

Jessica Meyer
(*Department of Earth Sciences*)

Presentation: Tuesday, 4:00 p.m.
Room: DC 1302

Retardation of a Large Organic Contaminant Plume in Fractured Sedimentary Rock

Co-Authors: Dr. J. Cherry, Dr. B. Parker

The behaviour of a large organic contaminant plume, migrating laterally in flat-lying sandstone, is being studied using a combination of methods: chemical analyses of closely spaced rock core samples, geochemical and isotopic analyses of groundwater from depth discrete multilevel wells, packer testing, pumping tests, borehole geophysical logging, and flow metering. The plume is defined by 291 sampling points many of which have been sampled regularly for the past 12 years. The plume originates from a DNAPL source zone occurring in fractured sandstone between 43 m below ground surface (bgs) and 54 m bgs. Since the formation of the DNAPL zone 40 to 50 years ago, the plume has traveled 2.5 km horizontally between 45 m bgs and 55 m bgs in fractured, bedded sandstone. The data obtained from rock core contaminant profiles, monitoring wells, multi-level systems, and pumping tests suggest that the contaminants are transported in a highly interconnected fracture network not dominated by any specific fracture or structural feature. The average annual migration rate of the plume-front, 63 m/yr, obtained by dividing the plume length by the plume migration time, is one-fourteenth the average linear groundwater velocity of 890 m/yr determined using Darcy's law in combination with potentiometric surface maps, bulk hydraulic conductivity measurements, and fracture observations. The rock core chemical analyses show measurable diffusion haloes confirming that diffusion-driven contaminant mass transfer from the fractures into the rock matrix (matrix porosity of 10 to 25%) contributes strongly to plume-front retardation relative to the groundwater velocity.

World Relevance: The organic contaminant plume being studied has relevance because it is the first documented field case of organic plume front retardation in a fracture sedimentary rock setting.

Nitin Mohan
(*Department of Electrical and Computer Engineering*)

Presentation: Monday, 9:10 a.m.
Room: DC 1302

Design Issues for Large-Capacity TCAMs

Co-Authors: M. Sachdev

Ternary content addressable memories (TCAMs) are attractive for high-speed packet forwarding and classification in network switches and routers. Emerging applications and new Internet protocol (IPv6) require large-capacity TCAMs, which pose new challenges for designers. Implementing wide TCAM arrays is difficult because the lower noise margin between "match" and "mismatch" conditions degrades the reliability of match line sensing. This problem is getting worse with technology scaling due to increasing transistor leakages. In this work, we analyze this problem and explore the possible solutions. Traditionally, the static power of a TCAM has been much smaller than its dynamic power due to the parallel search operation. The dynamic power of TCAMs is decreasing by technology scaling and architecture-level techniques. In addition, technology scaling is increasing the static power consumption. Both these trends are making the static power a significant portion of the total power consumption in TCAMs. In this work, we present a technique to reduce the static power in SRAM-based TCAMs without affecting the speed of operation. We analyze the circuits and present the trade-offs of using this power-reduction technique. The simulation results show a significant reduction in the static-power (up to a factor of 11) for an SRAM-based TCAM in 0.13 µm technology. Our simulations using Berkeley predictive technology model (BPTM) further demonstrate that the effectiveness of this technique increases in sub-100 nm technologies.
World Relevance: TCAMs are used in lookup intensive applications such as high-speed packet forwarding and classification in network routers.

Lakshman Nagapatnam Subbaraman
(*School of Optometry*)

Presentation: Tuesday, 11:50 a.m.
Room: DC 1302

Determination of Lysozyme Deposition on Silicone Hydrogel, Group II and Group IV Contact Lenses as a Function of Time

Co-Authors: M.A. Glasier, M. Senchyna, L. Jones

Purpose: To determine lysozyme deposition as a function of time in group IV, group II and silicone hydrogel (SH) contact lenses using an in vitro model. Methods: 4 individual Acuvue (AV; Gp IV), SofLens 66 (SL; Gp II) and SH lenses (Focus Night&Day (FND), PureVision (PV) and Acuvue Advance (AA)) were doped in 1mL of simple lysozyme solution (1.9 mg/ml) containing ^{125}I labelled lysozyme. The lenses were doped for time periods ranging from 1 hr to 28 days at 37^{o}C. Following the specified doping period, radioactive counts were determined using Beckman Gamma Counter. Results: Lysozyme accumulated rapidly on AV lenses (1 hr, 98±8 µg/lens), reached a maximum on the 7th day (1386±21 µg/lens) and then reached a plateau, with no further increase occurring (p=NS). Lysozyme accumulation on Gp II and SH lenses continued to increase across all time periods, with no plateau being observed ($p<0.05$). After 28 days of doping, FND lenses deposited 4.2±1 µg of lysozyme while PV and AA lenses deposited 19.4±3 and 16.8±4 µg of lysozyme respectively. Conclusion: Radiochemical analysis is a sensitive and effective technique to determine the small quantities of lysozyme deposited on SH lenses. The kinetics of contact lens deposition is material dependent. Lysozyme deposition occurs rapidly with Gp IV materials before reaching a maximum, while SH and Gp II materials progressively accumulate lysozyme, with no plateau occurring.
World Relevance: These results help in providing a better understanding of the fundamentals of protein deposition on contact lenses. First study to look at the kinetics of lysozyme deposition on silicone hydrogel lenses.

Ali Nasseri Moghaddam
(*Department of Civil Engineering*)

Presentation: Tuesday, 3:20 p.m.
Room: DC 1302

Use of Numerical Simulations to Explain SASW Field Measurements

Co-Authors: G. Cascante, C. Phillips, J. Hutchinson

This research uses numerical models to explain the results of two SASW field tests in the presence of a void. The Fourier spectra of the field data contain a region with high energy concentration, in the proximity of the void. Numerical models are constructed and the responses at the surface of the medium and around voids of different sizes and embedded depths are monitored. The numerical results show that part of the incident energy is trapped in the void region. The trapped energy bounces back and forth between the boundaries of the void until it is attenuated by radiation. The effect of the trapped energy is seen as a concentration of energy over the void region in the frequency domain. The amount of trapped energy is a function of the size and embedment of the void as well as the frequency content of the source. Moreover, the void absorbs part of the energy and radiates it as body waves. The numerical observations conform closely with the field data. Therefore the recorded responses at the surface carry valuable information about the void. The characteristics of the void can be extracted from the surface responses by analyzing the responses in time, frequency and spatial domains.
World Relevance: The presented technique is able to reduce the cost of geophysical investigations and to predict the potential damages to infrastructures.

Nguyen Nguyen
(*Department of Electrical and Computer Engineering*)

Presentation: Tuesday, 4:20 p.m.
Room: DC 1304

An Improved Transport Protocol With Loss Discrimination

The topology of networks is changing. As wireless networking grows in popularity, hybrid networks consisting of both wired and wireless connections become the norm. Unfortunately, data transmission services (i.e. transport protocols) have not evolved with the networks they are employed over. The Transmission Control Protocol (TCP) is still the dominant transport protocol in use today. TCP was designed for wired networks, where packet loss is a symptom of network congestion. In response to packet loss, TCP performs congestion control by decreasing its rate of transmission. In wireless networks, packet loss is most often the cause of transmission errors over the physical channel, not congestion. In this environment, using TCP results in lower bandwidth efficiency and throughput. This implies that a transport protocol must be able to differentiate between congestion and transmission losses in order to achieve optimal performance. We propose a loss discrimination scheme for hybrid wired/wireless networks where congestion occurs at a single point: the bottleneck. Using kernel density estimation and a stochastic queuing model, we characterize the traffic arriving at the bottleneck. Based on this characterization, we derive a discriminator to distinguish between packet losses caused by congestion and packet losses caused by transmission errors. Because all statistics are collected online and no changes are required at the intermediate routers, our loss discrimination scheme is realizable and can be rapidly deployed. Experimental results show that incorporating it into TCP improves performance, making TCP more suitable for today's networks.
World Relevance: The aim of this research is to improve network performance. Optimal network performance is critical in the efficient transmission of data, especially multimedia, over the Internet.

Shankaran Ramaswamy
(*School of Optometry*)

Presentation: Tuesday, 1:00 p.m.
Room: DC 1302

Does Refractive Surgery Affect Night Vision in Police Recruits?

Co-Authors: J. Hovis

Purpose. Reduced night vision as a complication of refractive surgery has been an ongoing concern for policing agencies. In order to address this concern, we evaluated the low light level visual acuity and contrast sensitivity of police recruits and officers. Methods. There were two subject groups. The refractive surgery group consisted of 27 subjects and the non-refractive surgery group had 85 subjects. Visual acuity and contrast sensitivity were measured under both room illumination and dim illumination. The room illumination test series included high contrast acuity, low contrast acuity and Pelli-Robson contrast sensitivity. The dim illumination test series included high contrast acuity, low contrast acuity, Pelli-Robson contrast sensitivity, license plate number acuity (with and without glare) and the Mesotest. Results. The general trend in the findings was that the refractive surgery group had a small but significant decrease in visual performance (0.02 to 0.04 log units). The exceptions were the Pelli-Robson contrast sensitivity (both light levels) and the Mesotest without glare where there were no significant differences between groups. The other general trend in the data was that poorer performing refractive surgery subjects fell outside the range of the control group. Conclusions. Although there was a significant decrease in low light level visual performance on individuals who have undergone refractive surgery, it's unlikely to have any practical impact on their average performance. Nevertheless, since the some individual s fell outside the control group's range, there it may be necessary to have a screening process.
World Relevance: The aim of this study is determine whether night vision of police officers is adversely affected by refractive surgery.

Kevin Regan
(*School of Computer Science*)

Presentation: Monday, 11:10 a.m.
Room: DC 1302

Indirect Reputation Assessment in Electronic Markets

Co-Authors: R. Cohen

The Internet allows for A2A commerce at an unprecedented scale; anyone can do business with anyone. These new Internet markets are populated with buying and selling software agents. This research presents a system for buying agents in electronic markets to avoid bad sellers by modeling the reputation of a seller. The model proposed by Cohen and Tran is extended to provide a method for the exchange of indirect information about the reputation of sellers among buying agents. The subjectivity that arises when buyers use different standards to model seller reputation is addressed and a way to correct for any systematic differences between these reputations is developed. We assume that the indirect reputation shared by buyers may not be truthful and provide a model for the reputation of other buyers along with methods to minimize the impact of deceptive buyers. In particular buyers who have fallen into disrepute are ignored and information gathered after a purchase is used to update the reputations of all buyers involved. This work is of interest to anyone who wishes to address the issues of deception and cooperation in electronic markets, in order to model the reputability of sellers for purchasing decisions. We discuss how the algorithms proposed in our model can protect against harm from deception and can provide important improvements over models that do not make use of ratings provided by other buying agents, for scenarios where the buyer is new to the marketplace and lacks experience with the potential sellers.
World Relevance: This research provides methods for designing electronic marketplaces that enable buyers to make effective decisions about sellers by making careful use of information provided by other buyers.

Ronan Rogers
(*Department of Biology and School of Optometry*)

Presentation: Tuesday, 9:30 a.m.
Room: DC 1302

In Vitro and Ex Vivo Wettability of pHEMA and Siloxane-Based Contact Lens Polymers

Co-Authors: L. Jones

Purpose: A contact angle measuring device was used to determine the in vitro wettability of daily disposable (DD) and silicone hydrogel (SH) lenses. Ex vivo measurements were made on Etafilcon A after soaking in various care regimens. Methods: Lens materials (DD: Etafilcon A, Hilafilcon A, Ocufilcon B, Nelfilcon A; SH: Lotrafilcon A, Lotrafilcon B, Galyfilcon A, Balafilcon A) were analysed directly from the packing solution and after soaking in care regimens for 12 hours. Contact angles were also measured after soaking lenses for 5 minutes in saline for 8 cycles to determine the residence time of the regimen and/or packing solution on the lens. Regimens included: Sensitive Eyes® (B&L), Complete® MoisturePLUS™ (AMO), OPTI-FREE® EXPRESS® (OFX; Alcon), ReNu MultiPlus® (RMP; B&L) and SoloCare® Plus (SCP; CIBA Vision). Results: Lens material and rinsing time significantly impacted contact angles ($p<0.001$). Initially, Ocufilcon was the least wettable DD (60°). After rinsing, all DD materials rapidly developed high contact angles (less wettable) of >60°. Group II materials (Hilafilcon/Nelfilcon) retained the lowest contact angles (most wettable). Balafilcon had the highest SH contact angles (115°) through all cycles. Galyfilcon was the most wettable SH initially, but rapidly developed contact angles similar to Balafilcon. Lotrafilcon materials retained the most wettable surfaces (75° - Lotrafilcon A; 50° - Lotrafilcon B). Contact angles of SH lenses were significantly lower after soaking in SCP and OFX. Other solutions had minimal impact on wettability. Acuvue lenses soaked in OFX and examined ex vivo after 8 hours of wear had low contact angles (<10°) compared to lenses soaked in RMP (>80°). Conclusion: SH materials are less wettable than pHEMA-based hydrogels and can be modified by soaking in care regimens. Contact angle analysis provides valuable data on in vitro and ex vivo wettability of hydrogel polymers. Study funded by Alcon.
World Relevance: Results from these studies will directly impact the 100 million people who wear contact lenses worldwide, 50% of whom suffer from discomfort with their lenses. The data will be used to develop lens materials and care regimens that provide better wetting surfaces and enhance comfort for lens wearers.

Jeffrey Semple
(*Department of Biology*)

Presentation: Tuesday, 9:10 a.m.
Room: DC 1302

Glowing Yeast: The Study of Orc6 in Cell Cycle Progression

Co-Authors: L.F. Da-Silva, E.J. Jervis, J.J. Heikkila, B.P. Duncker

The cell cycle of any organism is governed by a complex network of protein factors. Many of these factors are under clinical investigation as potential biomarkers for cancer, as they indicate cells undergoing division. Replication factors originally identified in yeast have proven to be useful to monitor cell proliferation in human cells. The Origin Recognition Complex (ORC) is bound to origins of replication throughout the cell cycle, and acts as a platform for initiation factors bind in a specific sequence and initiate DNA replication. All six members of ORC are essential for cell viability, however; only Orc6 is not required for the complex to bind to origins. I am investigating the function of this protein. Fluorescence, live-cell imaging showed that Orc6 remains localized to the nucleus throughout the cell cycle in a punctate pattern similar to other initiation factors, consistent with a role in S phase and not other phases of the cell cycle. Interestingly, after synchronizing cells at various stages of the cell cycle, and depleting Orc6, we observed cell cycle arrest at both the G1/S boundary and in mid-S phase. This suggests that Orc6 may play more than one role in S phase. Depletion of Orc6 at G2/M was shown to impair the G1 association of other replication factors. Further insight was gained through protein association studies, which showed that Orc6 interacts with various components required in DNA synthesis. To date, our results indicate that Orc6 is required for the efficient progression of both the initiation and elongation stages of DNA replication.
World Relevance: Fundamental insight into DNA replication. Future implications in our understanding of cancer, and potential therapeutic properties.

Jessica Socha
(*School of Computer Science*)

Presentation: Tuesday, 1:00 p.m.
Room: DC 1304

Genetic Algorithms, Simulated Annealing and Tabu Search for Lossless Data Compression

This paper proposes two new approaches for lossless data compression: simulated annealing (SA) and tabu search (TS). The effectiveness of these algorithms will be demonstrated by comparing them with genetic algorithms (GA) and Huffman encoding using both redundancy reduction and computation time as metrics. It will be shown that SA and TS outperform GA and Huffman encoding for non-uniform data sets. Hybrids of genetic algorithms with simulated annealing and tabu search (GA/SA and GA/TS respectively) will also be proposed. Of the algorithms presented, the most effective is the GA/TS hybrid. This paper is the first to propose the use of SA, TS and hybrid algorithms for the lossless data compression problem.
World Relevance: Data compression is essential to save both storage space and transmission time. Without efficient data compression algorithms, mass storage systems can reach their capacity quickly and networks may be forced to use their full bandwidth for data exchange.

Wanhua Su
(*Department of Statistics and Actuarial Science*)

Presentation: Tuesday, 3:00 p.m.
Room: DC 1302

An Efficient Model for Statistical Detection With Applications to Drug Discovery

Co-Authors: Dr. M. Zhu,
Dr. H. Chipman

In a typical statistical detection problem, we have data {Yi,Xi}(i=1,2,...,n),where Xi is the predictor vector of the ith observation and Yi, taking value either 0 or 1, is its corresponding class label. Instead of classifying the unseen data into two groups in a binary classification problem, the objective of a statistical detection problem is to identify class-1 observations, which are extremely rare. Several typical examples of the statistical detection problem include drug discovery, direct mailing, and information retrieval. In this talk, we have proposed a paradigm to deal with statistical detection problems. Under our framework, we only need to model the class-1 observations, and adjust locally according to the density of their class-0 neighbours. We applied our method to the NCI data, which is a real drug discovery data set. The goal is to identify those active compounds from a huge collection of chemical compounds. Active compounds refer to those chemical compounds that can inhibit HIV-1 virus. Only 2% out of 14,906 compounds in the NCI data set are active. We compare the performance of our model to that of K-Nearest Neighbours (KNN) and Support Vector Machines (SVMs), results show that our model is effective to detect the active compounds. Statistical explanations of why our approach is appropriate and efficient are also provided.
World Relevance: Our model is useful and efficient in detecting items belonging to a rare class from a huge database.

Jonathan Teichroeb
(*Department of Physics and School of Optometry*)

Presentation: Tuesday, 1:40 p.m.
Room: DC 1302

Protein Deposition Onto Implantable Biomaterials Measured With Quartz Crystal Microbalance (QCM)

Co-Authors: J.A. Forrest, L.W. Jones

The purpose of this study was to investigate the fundamental principles involved in protein deposition onto model hydrogel systems using novel techniques. Protein adsorption has long been a problem with compatibility of biomaterials. Designing new materials for internal or external implantation must address the question of how to effectively control this adhesion. Protein deposits from ocular tear film tend to build up on contact lenses. This can cause enhanced biocompatibility in some cases, but optical clarity degradation and more seriously elicit allergic immune responses occur in other cases. The deposition of protein was assessed by Quartz Crystal Microbalance (QCM), which is a powerful technique capable of measuring changes of 1ng/cm^2 (about a monolayer coverage of water). Using this method, the deposition of lysozyme onto polyHEMA contact lens material was determined. From these measurements, protein deposition as a function of concentration was extracted. Adsorption kinetics were also contained in the data. Results indicated that protein deposition onto hydrogels occurred rapidly and was partially non-reversible. There were also indications that some no-rub solutions were only slightly more effective than rinsing with saline solution. Small proteins, such as lysozyme, are frequently able to penetrate the lens matrix of certain Group IV lenses. A measure of the matrix bound protein can be made by varying the thickness of the polyHEMA films. Further work investigating the impact of the degree of cross-linking and the influence of additives such as Methacrylic acid (MAA) must be undertaken.
World Relevance: Biomaterial engineering is a rapidly growing field with over 100 million people using contact lenses alone. Protein deposition is an important factor affecting the compatibility of these materials.

Subha Venkataraman
(*School of Optometry*)

Presentation: Tuesday, 1:20 p.m.
Room: DC 1302

The Impact of Simulated Light Scatter on Retinal Capillary Blood Flow Using Scanning Laser Doppler Flowmetry

Co-Authors: C. Hudson, E. Harvey, J.G. Flanagan

Purpose: To determine the impact of simulated light scatter on scanning laser Doppler flowmetry (SLDF) assessment of retinal capillary blood flow. Methodology: Ten normal subjects (mean age 24years, SD 1.7) participated in the study. Varying concentrations of polystyrene microspheres (Polybead ™Polysciences Inc., USA) were suspended in optically clear cells to simulate light scatter. The microsphere concentrations used were 0.05%, 0.03%, 0.02%, 0.01% and only water. With no cell in place, 3 baseline SLDF images were acquired each of the optic nerve head (ONH) and of the macula using the Heidelberg Retina Flowmeter (HRF). Subsequently, SLDF images were acquired with each of the light scatter cells mounted in front of the HRF. Results: The baseline (i.e. with no cell in place) group mean capillary blood flow using the HRF custom analysis of the ONH, nasal macula, fovea and temporal macula was 226.68 a.u (SD 191.63), 176.52 a.u (SD 39.46), 192.65 a.u (SD 53.92), and 163.89 a.u (SD 83.11), respectively. Retinal capillary blood flow was significantly higher in the ONH, nasal macula, fovea and temporal macula with increase in microsphere concentration ($p<0.0001$). Retinal capillary blood flow was found to significantly increase relative to baseline for the 0.03% and 0.05% cell concentrations (Dunnet's post hoc test). Conclusions: An artifactual increase in capillary blood flow in all areas of the retina and ONH was produced by the simulated light scatter model. Caution needs to be exercised in the interpretation of retinal capillary blood flow measurements in patients with cataract.
World Relevance: Non-invasive assessment of retinal blood flow offers the potential to predict the development of life threatening vascular diseases. Increased understanding of extraneous factors that can confound retinal blood flow is a necessary precursor to this ultimate aim. This study addresses a potential confounding factor for the assessment of retinal blood flow.

Hua Wei
(*Department of Combinatorics and Optimization*)

Presentation: Tuesday, 3:40 p.m.
Room: DC 1304

A Stable Iterative Method for Linear Programming

Co-Authors: M. Gonzalez-Lima, H. Wolkowicz

We present a numerically new primal-dual interior/exterior-point method for linear programming. Our method does not form the usual normal equations, NEQ, or augmented system. Sparsity is maintained. The work of an iteration consists almost entirely in the approximate solution of a well-posed linearized system, using PCG. We present numerical examples where roundoff error causes problems for NEQ and present numerical tests with direct solvers as well as iterative solvers with preconditioners. We show that for some problems, iterative methods are more than ten times faster than the popular NEQ based direct method. Our tests show that our method takes direct advantage of sparsity and stability of the data.
World Relevance: May improve the accuracy and stability of current commercial Linear Programming solvers. This technique may be used on Semidefinite Programming, for which numerical problem is more severe.

Hong Yang
(*Department of Chemical Engineering*)

Presentation: Tuesday, 11:10 a.m.
Room: DC 1302

Salt Effects on the Self-Assembled Nanostructures of a Metal Ion Binding Peptide

Co-Authors: M. Pritzker, P. Chen

Self-assembling peptides are new promising materials with a number of potential applications in nanotechnology. EAK16(II)GGH is one example of these peptides which can serve as a potential template for metallic nanowire fabrication. Among many parameters that affect the peptide nanostructures, salt type and salt concentration are the most important factors. In our work, we investigate the effect of copper salts of different anions (SO42-, Cl- and NO3-) on EAK16(II)GGH self-assembled nanostructures. Atomic Force Microscopy (AFM) is employed to characterize the peptide nanostructures. The morphology of peptide nanostructures depends strongly on the different anions added. Also, the dimensions of the peptide nanostructures increase with the increase of the salt concentration. To study the mechanism behind the formation of these different nanostructures, two approaches were adopted. First, surface tension measurements were conducted to determine the surface activity of peptide in the presence of the different copper salts. Using Axisymmetric Drop Shape Analysis-Profile (ADSA-P), we observed the surface activity of EAK16(II)GGH different depending on the nature of copper salt solution. Second, we employed Fourier Transform Infrared (FTIR) Spectroscopy to characterize metal and anion binding to peptide. The stronger binding of anions such as Cl- and NO3- to the peptide impedes the lateral aggregation of peptide and results in thinner and shorter fibres and aggregates than those formed in the presence of SO42-. Our study contributes to the understanding of the effect of salt on the peptide self-assembly, which is crucial to control the self-assembled nanostructures for metallic nanowire fabrication.
World Relevance: This research contributes to the metallic nanowire fabrication.

James Yantzi
(*Department of Systems Design Engineering*)

Presentation: Tuesday, 11:30 a.m.
Room: DC 1302

Carbon Nanotube Mediated, Low-Voltage Cell Lysis Device

Accomplishments like the completion of the human genome project in conjunction with IC fabrication technology have provided the groundwork for the next wave of biomedical and biotechnological breakthroughs. Many of these breakthroughs are coming in the form of lab-on-a-chip (LOC) diagnostic devices that perform fast, inexpensive, fully automated point-of-care lab protocols that can be tailored to almost any application. The aim of this study is to develop a low-voltage method to achieve cell lysis to extract intracellular biomolecules as an initial component to a multi-functional LOC device geared towards biomedical diagnostic tests. A DAQ card was used to generate pulsed electric fields from microfabricated electrodes on a glass substrate, which formed ceiling of the cell lysis device. A 50 micron thick shim layer was used to form the sidewalls of microchannels for cell samples to flow through. CNTs were deposited on a metal plate which comprised the lower boundary of the cell lysis channel. Cell lysis was imaged in real time, both with and without the use of CNTs using a Navitar optical microscope. Our results show that voltages required for cell lysis were considerably lower when CNTs were used to concentrate the electric field. The research has demonstrated that the high aspect ratio and conductive material properties of CNTs enable higher electric fields to be generated using lower voltages. As a result, battery operated hand-held biomedical diagnostic devices can be easily achieved to provide innovative solutions to healthcare problems in the post-genome era.
World Relevance: Carbon nanotube (CNT) mediated pulsed electric field (PEF) cell lysis enables extraction of DNA and proteins using much lower voltages than current techniques. The portability of Lab-on-a-chip applications requires that power requirements be minimized to a few volts.

Elizabeth Zajc
(*Department of Environment and Resource Studies*)

Presentation: Monday, 11:30 a.m.
Room: DC 1302

Modelling Urbanization Effects on Birds in the Greater Toronto Area

Co-Authors: Dr. S. Murphy

As urban areas increase around cities such as Toronto, there is great concern for the effect of this urbanization on wildlife. This project contributes to an area of study that determines the optimum way to plan landscapes for species persistence. The purpose of this research is to determine the effects of the area of available habitat, the amount of habitat surrounding that single habitat, the degree of fragmentation of the habitat and the amount of disturbance in the area surrounding the habitat on bird richness and abundance. This study is novel in that it tested the effects of these factors on birds adjacent to urban areas. All information and variables for this study were derived from a database of bird and vegetation data for the Greater Toronto Area collected by the Toronto and Region Conservation Authority. This study used a model competition method using Poisson statistical models to determine which variables best explain bird species abundance and richness. Preliminary results appear to converge on the best model to describe avian abundance and richness. In three separate model competition exercises, the model that included the amount of urbanization surrounding the habitat and habitat area accounted for the most variation and had the best fit for the data. These results have implications for conservation policy in Ontario; it indicates that conservation of native birds should account for the land-use surrounding habitat patches, not just the characteristics of the habitat.
World Relevance: The knowledge for conserving species coming from this project can inform efforts to protect our natural resources such as biodiversity. This is part of a greater effort to protect our ecological resources for the prosperity of future generations.