APPLIED RESEARCH IN ACTION

Master of Science in Applied Computing (MScAC)
2013-14 Projects

Computer Science
UNIVERSITY OF TORONTO

MESSAGE FROM THE DEPARTMENT CHAIR

This year, the Department of Computer Science (DCS) at the University of Toronto turns 50. Our faculty and students engage in ground-breaking research, teaching and entrepreneurship that has earned DCS a reputation as one of the top ten Computer Science departments in the world*.

Like the field itself, the impact of DCS-incubated research is widespread. With strong interdisciplinary partnerships with top institutions and researchers around the world, our work extends across areas from finance, to biotechnology, education, business, entertainment and beyond.

DCS believes industry partnerships are vital to maintaining our strength and impact as a leader in the field. The Master of Science in Applied Computing degree program is just one way we are furthering such valuable ties.

Research in Action – including the new Applied Research in Action – are opportunities to showcase the skills of our students and their great potential, and to stay connected to our industry partners. I thank this year's MScAC students for their contributions.

I invite prospective students and industry to explore the breadth and depth of the world-class research in DCS and to share with us their own ideas for new collaborations. Together our potential is limitless.

Sven Dickinson
Professor and Chair

*Shanghai Jiao Tong University's Academic Ranking of World Universities

MESSAGE FROM THE PROGRAM DIRECTOR

With the launch of the Master of Science in Applied Computing degree program in September 2010, DCS sought to educate the next generation of technical leaders, innovators and entrepreneurs by offering a unique professional program that unites research with industry internships.

In the last four years, the program has slowly grown from a class of six to more than 20 students, annually. We are also pleased to welcome **Matt Medland** (MScAC 2010) who recently joined our program as Associate Director, to help support our partnerships and student enrolment over the coming years.

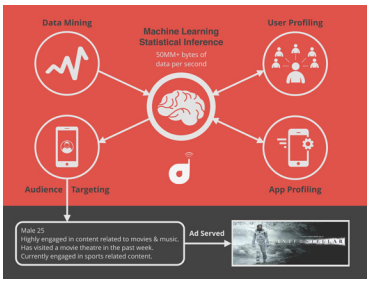
We believe the MScAC offers companies a unique opportunity to engage with experienced graduate students who will develop a significant project based on the application of research, from inception to completion. Current – and prospective students – will make a lasting contribution to the organization and further advance their career opportunities.

I congratulate the 2013-2014 class and thank our industry partners for their ongoing interest and support. We look forward to highlighting the accomplishments of our MScAC students at this inaugural Applied Research in Action showcase and at future events.

Professor **Eugene Fiume**
Director, Master of Science in Applied Computing program

Addictive Mobility

DATA MINING AND MACHINE LEARNING IN MOBILE APP ADVERTISING



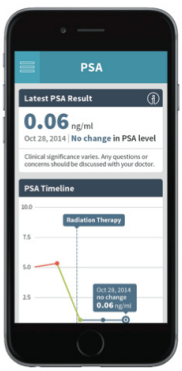
Addictive Mobility is a leading Canadian mobile advertising company, providing a technology platform for advertisers, brands, etc., to have their ads shown in a large inventory of mobile apps. User engagement and performance of ads are the selling point of the company's products and optimizing these metrics is the goal of the Data Science team. We try to optimize performance using different machine learning approaches that mainly try to predict certain aspects of an ad campaign or attributes about our users. Our research internship involved the inception and development of a user profiling system, which analyzes the massive amount of data that we receive and extract useful user profiles. A system to predict the age and gender of a user based on their profiles was also developed. A current project is segmentation and clustering of users based on their behavior and interests. We also built a low latency decision module integrated with Addictive Mobility's real-time bidding system, which makes decisions on which ad impressions to bid on. Some of the factors it incorporates includes a statistical model predicting user engagement level, and a smart bid price computation tool based on historical bid data.

Project team

Lubna Khader, **Megha Lakshmi Narayanan** and **Guilherme Trein**, MScAC students
Elie Mazzawi and **Naveed Ahmad**, Addictive Mobility
Professor **Anthony Bonner**

Centre for Global eHealth Innovation

DEVELOPMENT OF A PROSTATE CANCER PASSPORT: IMPROVING SELF-CARE AND CLINICAL MANAGEMENT

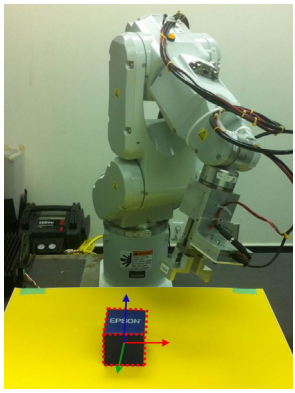


Prostate cancer is one of the most common chronic diseases among elderly men. A survivorship tool for prostate cancer is now being introduced in view of the fact that there is a need to improve quality of care. Hence, a novel tool is being developed to enhance disease self-management and patient-clinician relationships. The increased usage of hand-held devices for various purposes has led to the choice of mobile-web technologies with responsive design to develop the tool. This choice has saved a great deal of time and effort because of its reusability with respect to development (e.g. a single codebase can be used across platforms). The application is being built upon Google's AngularJS with Twitter Bootstrap and Sass on the front end and JavaEE server-side technologies on the backend. Tools like Grunt and Node.js contributed a first-class environment for the development of the application. The entire application is behavior-driven with Cucumber user stories written by experienced "Health Care Human Factors" specialists. Using powerful end-to-end testing and unit testing tools (such as Protractor and Jasmine, respectively) we are able to work in an environment that supports continuous integration with regression, smoke and unit tests. Finally, after the development comes to an end, the application will be used in a clinical trial to determine its effectiveness.

Project team

Priyamsa Maddila, MScAC student
Anthony Mei, Centre for Global eHealth Innovation
Professor **Eugene Fiume**

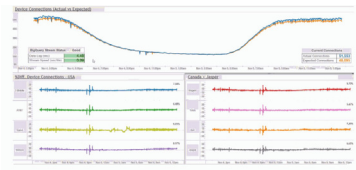
Epson
DETECTION AND 3D POST ESTIMATION OF OBJECTS FOR ROBOTIC MANIPULATION



Accurate pose estimation of 3D objects is essential for factory automation. The majority of existing vision solutions in the industry is still 2D and requires expert setup. We propose an accurate and fast 3D object detection system that is robust and easy to setup. Our system works by learning the object appearance from multiple views at training time and matching these views at run-time to a calibrated stereo pair of images. Our system is able to detect and estimate the 3D pose of a wide variety of objects. The resulting pose is accurate enough for pickup and other robotic manipulation tasks.

Project team
Amanjot Kaur, MScAC student
Alex Levinshtein, Epson
Professor **Sven Dickinson**

Geotab Inc.
REAL TIME BIG DATA ANALYTICS INFRASTRUCTURE AND APPLICATIONS



The project researches viability of harnessing cloud platforms to implement real-time streaming, management, analytics and visualization of diverse and multi-petabytes data at Geotab. Google BigQuery, Tableau and iPython have been used to provide a multi-dataset interactive support to Geotab's research and development for both internal and customer-facing analytical and diagnostic requirements. These include estimating traffic flow and cell networks quality, monitoring device connectivity, diagnosing engine data for optimized fleet management and other analysis by vehicle details tailored to specific needs.

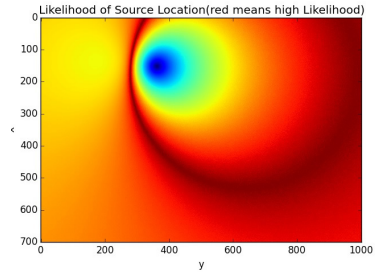
Project team
Vandana Saini and **Fiona Zhao**, MScAC students
Daniel Dodgson, Geotab Inc.
Professor **Mariano Consens**

Kobo
CONTEXT BASED WEBSITE OPTIMIZATION

Kobo is an eBook company dedicated to providing a world-class eReading platform to millions of users in 190 countries. Kobo offers one of the world's largest catalogues. With over 5 million books to browse, content discovery can be a daunting task for readers. In order to optimize content discovery, we adapt our website content to targeted groups of readers by making use of their purchasing, browsing and demographic data. We model targeted group content recommendations as a contextual bandit problem, in an exploration-exploitation scheme, in which an algorithm dynamically selects the optimal website layout for a pool of users, while simultaneously adapting the content of said website layout to maximize conversion.

Project team
Sagun Bajra, MScAC student
Inmar Givoni, Kobo
Professor **Brendan Frey**

MacDonald, Dettwiler and Associates Inc.
ADVANCED CONTROL AND DATA ANALYSIS IN SUPPORT OF UNMANNED VEHICLE OPERATORS



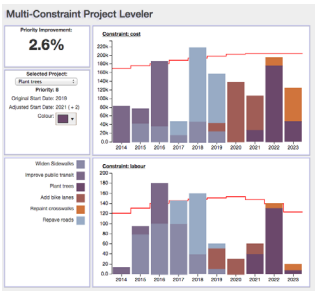
Mobile robots equipped with chemical, radiological and explosive detectors are deployed during events where CBRNE materials have been dispersed. Sending robots provides key reconnaissance data while reducing personnel exposure. Operators control the robots using live detector data and camera images displayed on remote operator stations. If the robots can simultaneously localize themselves and generate a map of the environment (SLAM), then the detector data may be overlaid on floor maps.

Interpretation of such data to map the contamination levels and locate the hazard in the environment is not a simple task. Measurements are sparse and inaccurate, and they are affected by the site geometry, presence of walls, air flow, etc. The robot may not have access to certain areas or paths. There may be several hazard sources and may also involve extended sources (e.g. a radioactive spill). Real time mapping may demand huge computation power.

The objective of the research is to develop comprehensive analytical tools that will assist mobile robot operators and first responders to make faster and more correct decisions. These tools analyze detector data, create contour maps, estimate hazard locations and provide guidance on where best to move next in order to take successive sensor readings that reduce the uncertainty of hazard locations. It will focus on developing methods for generating meaningful perceptual mapping models and visualization of CBRNE hazards from the raw data collected by mobile robots. Prototype solutions will be tested on synthetic data and tested in field experiments with realistic scenarios.

Project team
Yangji Hu, MScAC student
Piotr Jasiobedzki, MDA Inc.
Professor **Raquel Urtasun**

Riva Modeling Systems Inc.
MIXED-INITIATIVE OPTIMIZATION FOR RESOURCE-CONSTRAINED SCHEDULING

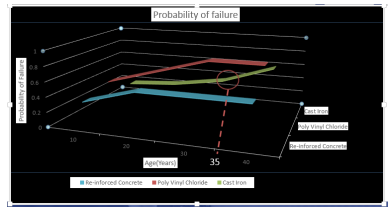


A software tool for scheduling projects with multiple resource constraints was developed. A variety of constraint programming, integer programming and local search techniques were applied to guide the user to optimal or near-optimal solutions. A mixed-initiative approach was used to allow for collaboration between the user and the software through a novel interactive visualization of the optimization problem.

Project team
Kiran Sachdev, MScAC student
Geoffrey Peddle, Riva Modeling Systems Inc.
Professor **Allan Borodin**

Riva Modeling Systems Inc.
ASSET MANAGEMENT USING MACHINE LEARNING TECHNIQUES

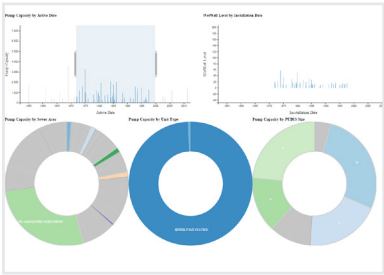
Concepts such as probability of failure and service requirements have led the Water Industry to employ a statistical approach of assessing and predicting pipeline performances. This could also lead to a system where the expenditure for maintenance and replacement of pipelines can be more accurately forecast using predictive modeling, than by traditional historical modeling.



The goal of the project is to perform an exploratory research to investigate the potential to extract knowledge by aggregating historical data across the company's clients and applying machine learning techniques on them. The goal is to create device prediction models that can forecast the condition of certain events (such as life of pipelines) using statistical analysis. We compare actual events to the current model's predictions. The research uses multivariate analysis with the aim of uncovering new features with sufficient predictive power to suggest potential improvements to their models. Moreover, the research would facilitate using a probability distribution to represent an asset's condition instead of just a single maximum likelihood value.

Project team
Sreekumar Rajan, MScAC student
Geoffrey Peddle, Riva Modeling Systems Inc.
Professor **Eugene Fiume**

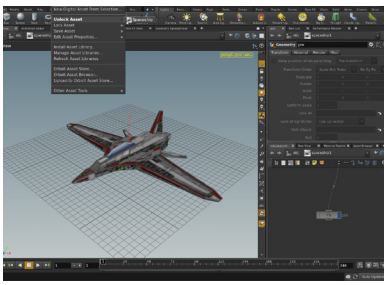
Riva Modeling Systems Inc.
DATA VISUALIZATION INCORPORATING SOCIAL COLLABORATION FOR ASSET MANAGEMENT



This project explores novel ways to visualize asset management data that would incorporate a social collaboration component. With these new visualization strategies users would be able to either create fully customizable charts for their data or to analyze large volumes of data by interacting with various views of the data. These visualizations could be exported by users for presentation purposes and would allow users to achieve more optimal results in asset management overall.

Project team
Qi Wang, MScAC student
Geoffrey Peddle, Riva Modeling Systems Inc.
Professor **Eugene Fiume**

Side Effects Software
RESEARCH ON 3D SOFTWARE USER INTERFACE DESIGN



How to define user requirements accurately and design user interfaces appropriately has been a very active research area, involving human-computer interaction and graphic design. Because of the scale and the complexity of three-dimensional (3D) animation software, making correct design decisions becomes tougher. Houdini is 3D animation software that is the main product of Side Effects. Using 3D animation software is always very challenging for users. It requires longer learning curves as well as interdisciplinary knowledge. As usage time increases, users become familiar with the functions and layout of Houdini and they turn into expert users. On the other hand, apprentice users may carry experience from other 3D animation software or have no experience with any similar software. The conflicts between expert users and apprentice users emerge from the different requirements and expectations they have of Houdini. This research project helps Houdini to develop a standard design process including collecting data, extracting user requirements and making design decisions.

Project team
Shuyuan Ma, MScAC student
Luke Moore, Side Effects Software
Professor **Eugene Fiume**

Toronto Rehabilitation Institute

SOCIAL ONLINE EXERCISE GAMES FOR SENIORS

Many seniors face an increased risk of physical injury and illness such as falls, heart attacks, and strokes, due to a lack of physical exercise. This risk is magnified for homebound and isolated seniors, who, in addition to an increased risk of physical illness, also face an increased risk of mental illnesses, such as depression. This project uses technologies such as the Microsoft Kinect in order to create an online environment where seniors can exercise and interact with each other. By integrating audio and video streaming as well as social networking into the exercise experience, this project creates a social aspect to exercising that is not available to most seniors. As a result, this project creates an environment that will motivate seniors to exercise more, as well as increase their mental and emotional well-being by providing them with a social experience. If successful, it will greatly reduce the number of physical injuries experienced by seniors, as well as significantly improve their quality of life.

Project team
Michael Margel, MScAC student
Bruce Haycock, Toronto Rehabilitation Institute
Professor **Eugene Fiume**

Wattpad

IDENTIFYING LITERARY STYLE WITH FUNCTION AND FREQUENCIES

Wattpad is interested in finding ways of bringing novel story recommendations to the surface as a complement to those recommendations based on collaborative filtering and semantic similarity. In this project, we examined ways of identifying stories with similar literary styles.

Contentful words are often used in natural language processing (NLP) tasks to measure similarity between documents. This gives a measure of semantic rather than syntactic similarity. Non-contentful words are typically discarded in NLP tasks, but authorship attribution studies have shown that the frequencies of these can be used to uncover the unconscious, discriminative aspects of writing style. We have discovered that they can likewise be used to identify stories with similar writing style and correlative readership. This provides a computationally cheap method for analyzing a large number of texts and uncovering literary similarity. We hope this research assists in making better recommendations overall, as well as finding readers for less recognized stories.

Project team
Craig Hagerman, MScAC student
Ivan Yuen, Wattpad
Professor **Frank Rudzicz**

ABOUT THE PROGRAM

The Master of Science in Applied Computing (MScAC) program is designed to educate the next generation of technical leaders, innovators and entrepreneurs by turning research into practical industry-based applications. Students in this program spend the first eight months studying with some of Canada's leading computer scientists and another eight months in an internship, where they will apply their research to real-world problems.

This brochure highlights the 2013-14 faculty and industry supervised student projects.

ABOUT THE DEPARTMENT OF COMPUTER SCIENCE

Founded in 1964, the Department of Computer Science (DCS) at the University of Toronto is celebrating 50 years of discovery, creation and success. DCS is home to 1,567 undergraduates, 245 graduate students and 66 faculty members. Through its undergrauate, graduate and professional graduate programs, 7,500 active DCS alumni are making further contributions to the field within industry and research.

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