Submittee: Michael Lamoureux
Date Submitted: 2015-07-29 12:41
Title: 2015 PIMS Industrial Problem Solving Workshop
Event Type: Industrial-Activity

Location:
University of Saskatchewan

Dates:
June 15-19, 2015

Topic:
Mathematical and statistical modelling of industrial processes and problems, with a focus on solving real challenges proposed by industrial researchers.

Methodology:
The aim of the PIMS Industrial Problem Solving Workshop is to create a mutually beneficial link between researchers in industry and academic mathematicians/statisticians. Research workers with industrial and commercial concerns present one of their current technical problems, a total of five problems for the workshop. Leading specialists from the academic community study these problems in teams during the week-long workshop, and present the results of their study back to the industrial participants at the end of the week. This is a 5 day workshop, with most of the days and evenings spent on studying the problems at hand, applying mathematical and statistical methods, developing computer code and statistical analyses, and devising methods to solve the problem. Final reports are presented to the industrial sponsors on the last day of the event.

Objectives Achieved:
Five problems studied, with progress made on each that was quite remarkable given the complexity of the problems and the short timeframe for the event. Industrial participants were pleased with the results, indicate a willingness to continue the collaborations, sponsor student interns, and consider long-term job positions for similar students. An invitation was received from the journal "Mathematics-in-Industry Case Studies" to publish our results. ///

The participants worked very well together, despite the diversities of backgrounds: Faculty members, postdoctoral fellows, undergraduate and graduate students as well as industrial participants. It was great to see them also interested in socializing, getting together for dinner and conversations, before returning to their work.

Scientific Highlights:
The final reports on the last day of the workshop were identified as a highlight by many participants -- an excellent summary of the progress made over the week. Individually, we note several items: //

In the quantum gate design, it was a remarkable breakthrough to realize that the design problem was not really an optimization problem, but a feasibility problem -- mathematically, the two problems are related but with significantly different methodologies and algorithms required to solve them. This allowed a great deal of progress to be made on this problem. ///

For the microseimic problem, we developed several successful models for estimating the location of the fracking events, which the industry mentor indicates is new and implementable on their commercial system. ///

In the potash mine, and agriculture buyers market problems, it was quite interesting to see that not just optimization was important, but adding tools that allow the industrial user to see what constraints are important or "active" in the problem was a key design goal in the end. ///

The advertising problem was a real eye-opener for the academic researchers, as there was huge amounts of data, but in a wide variety of formats and types. Analyzing this was not a simple matter, and a great deal of work was done to get useful answers. ///

As a side event, we organized a tour of the Canadian Light Source, a state-of-the-art synchrotron on the University of Saskatchewan campus that attracts researchers from around the world to study materials and microscopic processes. It is a huge facility, bigger than a hockey arena and full of all types of interesting scientific equipment. Many workshop participants indicated this was a scientific highlight for them.

Organizers:

Salem, Walid Abou. Mathematics, University of Saskatchewan //
Lamoureux, Michael. Mathematics, University of Calgary //
Rios, Cristian. Mathematics, University of Calgary //
Spiteri, Ray. Computer Science, University of Saskatchewan //
Williams, JF. Mathematics. Simon Fraser University

Speakers:

Note: Full abstracts are attached in the PDF file with this report. ///

Names: Ehsan Zahedinejad, Barry Sanders //
Dept: Physics and Astronomy //
Org: University of Calgary //
Title: Design of a four-qubit quantum gate //
Abstract: Quantum Computing. We have successfully designed a procedure for realizing three-qubit quantum gates in four-level systems via quantum control. Such a design appears to be realizable in a superconducting quantum circuit architecture. Our goal is to extend the approach to design a four-qubit gate via quantum control. Such a gate is vital for coding quantum states to realize scalable fault-tolerant quantum computing. ///

Name: Matt McDonald //
Org: Fibre Optic Technologies //
Title: Microseismic hypocentre location, via distributed acoustic sensing //
Abstract: Distributed acoustic sensing (DAS) is a relatively new technique used for measuring strain in down-hole applications in oil and gas. The sensor consists of a single-mode fibre optic cable installed along the length of a well borehole, and connected to a laser and photodetector. In

current oil recovery technologies, it is important to monitor the production process by tracking events underground, such as fracturing and fluid flow. Much success has been had in monitoring hydraulic fracturing, using the fibre response as an indication of fracture effectiveness and relative fluid placement. However, due to the inherently single-component nature of DAS, it is inappropriate for use in traditional methods for determining fracture location (hypocentres) within the reservoir, despite the appearance of both P and S waves in the data. The proposed problem is to determine how single-component DAS data could be used to provide information about fracture hypocentres. ///

Name: David Callele //
Org: Ag Exchange Group, Inc. //
Title: Service Pricing to Value Received //
Abstract: We provide a data service that helps Buyers to directly find grain inventory held by Growers (farmers) and to make Bids upon that inventory. This data service has value, and our challenge is to identify a simple and transparent service pricing algorithm that reflects the value of the data to the Buyers. One problem is to maximize the amount that we can charge for access to the data service while presenting a supportable argument as to why we are a more cost-effective solution to meeting the Buyer's needs. We must also be able to justify variable pricing for different Buyers -- why are the fees different for each Buyer? ///

Name: Briana Brownell //
Org: Insightrix //
Title: What is a successful advertising campaign? //
Abstract: Advertising and marketing are a considerable expense for most companies. To show the return on investment (ROI), companies often seek some kind of measurement to assess their performance. Such measurements are notoriously difficult and present a complex optimization problem that has not yet been solved. With an increasingly fractured market, it is more and more difficult to provide a valid and reliable benchmark for advertising performance. Moreover, with changes in the way people see (or don't see) advertisements on new media such as pay-per-view, internet, and mobile apps, there are additional complications because of the overlap of the various media and difficulty gathering statistics for some media. Can an alternative, accurate, and statistically valid measurement for data gathered from several tracking surveys be created, for various purposes. ///

Names: Rob Kingwell , Todd Gaucher //
Org: Potash Corporation //
Title: Optimal scheduling for mining production //
Abstract: Managing a network of mines is a complex operation. Each mine has its own unique character, able to produce a range of products in a variety of capacities, some mines with space for on-site inventory storage, other mines with processing facilities to refine product into other marketable items, each mine with its unique transportation access and costs, and a variety of constraints on plant operations. Scheduling of shut-downs and starts-up of each mine can be a key step in determining the network operations. Ultimately the goal of a commercial mining operation is to maximize profits over a sustained period of time, taking into considerations the constraints of operation while responding to opportunities in the marketplace. Is there a general methodology or algorithm to reliably optimize operations of a network of mines, in order to maximize profit over a sustained period? ///

Links:
https://www.pims.math.ca/industrial-event/150615-pipsw

Comments / Miscellaneous:
Overall, this was a successful workshop. We had 5 excellent problems, the industrial proposers were pleased with the results, and all are keen on identifying internship opportunities and other ways to continue the industrial collaborations with the mathematicians. We also have an offer to publish the results in an excellent math applications journal. The organizing committee of Abousalem, Lamoureux, Rios, Spiteri, and Williams was very effective, once it was formed with all its members. We had a rich mix of established researcher and students, who worked very effectively together. And I think we can say most participants actually enjoyed the week-long activities, both in the academic and the social aspects.

File Uploads:
Additional Upload 1: http://www.pims.math.ca/files/final_report/IPSW_Program_final.pdf

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