



## Thematic Program in Computer Algebra July 1 – Dec 31, 2015

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During the second half of 2015, the Fields Institute hosted the Thematic Program on Computer Algebra. This program attracted some 125 individuals working in the subject's various areas.

The thematic program itself addressed current and emerging areas of importance in computer algebra. The areas of focus included linear algebra over exact or symbolic domains, algorithms for algebraic and semi-algebraic geometry, hybrid symbolic-numeric computing, algorithms for differential algebra and symbolic combinatorics, and certified algorithms and machine assisted formal proofs. The highlights of the thematic program included three workshops, a weekly series of special lectures at the Institute, and a graduate level course convened weekly. Preceding each of the three workshops, a senior workshop organizer gave an overview talk as part of the special lecture series. Another main element of the program was the series of Coxeter Lectures presented by Victor Shoup. The semester was also enhanced by hosting the East Coast Computer Algebra Day in early October. All of these activities were broadcast to other Ontario Universities via the Fields Live system.

The thematic program received major support from the Fields Institute, NSF and the Austrian Science Fund (FWF). Additional sponsorship came from Maplesoft Inc. and the French Consulate.

### **Workshop on Symbolic Combinatorics and Computational Differential Algebra**

The opening workshop of the program, held on September 14-19 combined the areas of symbolic combinatorics and computational differential algebra. Symbolic combinatorics covers a wide range of enumerative combinatorics and related fields. This includes for example algorithms and software for discovering and proving combinatorial identities as well as understanding analytic and algebraic properties of generating functions. In the differential algebra the central objects of study, differential equations and differential structures, are also central objects both in mathematics, engineering, physics, biological models and even now combinatorics.

### **Workshop on Linear Computer Algebra and Symbolic-Numeric Computation**

In the week of October 26-31, a two parts workshop was held in Linear Computer Algebra and Symbolic-Numeric Computation. Symbolic linear algebra is one of the core areas of computer algebra. Algorithms that combine techniques from symbolic and numeric computation have been of increasing importance and interest over the past decade. The necessity to work reliably with imprecise and noisy data, and for speed and accuracy within algebraic and hybrid-numerical problems provided the focus of the second part of the workshop.

### **Coxeter Lectures**

The three Coxeter Lectures by Victor Shoup from the Courant Institute provided one of the highlights of the week of the second workshop. On Friday, October 30 Victor Shoup was also presented with the 2015 ACM SIGSAM Richard D. Jenks Memorial Prize for Excellence in Computer Algebra Software Engineering for his library NTL. The Jenks Memorial Prize recognizes outstanding software engineering contributions in the field of computer algebra.

### **Workshop on Algebra, Geometry and Proofs in Symbolic Computation**

The third and final workshop of the program was held on December 7-16, 2015. This workshop featured three related subareas: Polynomial algebra, real algebraic geometry and computer-enhanced mathematical proofs and certified algorithms. Polynomial algebra lies at the heart of computer algebra while real algebraic geometry is mainly concerned with the study of semi-algebraic sets. In the latter the computational aspects renew connections with other areas of mathematics and computer science, such as optimization and control theory. The third part of the workshop focused on the formalization of mathematics and proofs. This is currently a very active area of research which recognizes the strong recent advances in mechanical mathematical systems.

### **East Coast Computer Algebra Day**

The East Coast Computer Algebra Day (ECCAD) has been a yearly event in North America since 1994. This year was held at the Fields Institute on October third in conjunction with the thematic program. The day was a nice mixture of three plenary talks, in this case by Johan Nielsen, Technical University of Denmark, Marc Moreno Maza of Western University and Marni Mishna of Simon Fraser University, student posters and conversation.

### **Plenary Lecture Series**

The special lecture series served a dual purpose. There were the three lectures by senior organizers, Peter Paule, Erich Kaltofen and Marie-Francoise Roy, respectively, which served to introduce each workshop to the long term visitors and students to the program. The remaining seven special lectures were by younger researchers, both PhD students and Post Doc. Topics ranged from symmetry methods, software for reducing differential equations about their local singularities, and real algebraic geometry. The talks were well attended and of very high quality, both in terms of presentation and content.

### **Computer Algebra Graduate Course**

Gilles Villard from ENS-Lyon, France was the Dean's Distinguished Visitor for the thematic program. One of his activities was the teaching of a graduate course in algorithms for computer algebra systems. This graduate level course was quite successful with students participating both locally (around 10 students) and from a distance. The latter group were made up mostly of 10 graduate students from Western University. The program greatly benefited from a number of long-term participants, including senior researchers, post docs and PhD students. These groups were from around the world with long term visitors coming from France (2), USA (3), China (2), Russia (1) and Canada (1). Post doc visitors came from France (2), Germany (1), China (4), USA (5), Canada (1) while PhD students from China (3), Canada (1), USA (2), Senegal (1), India (1) and France (1).

**Organizing Committee:** Stephen Watt (University of Waterloo), Erich Kaltofen (North Carolina State University, USA), George Labahn (University of Waterloo), Peter Paule (Johannes Kepler University, Austria), Marie-Francoise Roy (University of Rennes, France), Nikolay Vasilyev (Steklov Institute of Mathematics at St. Petersburg, Russia), Lihong Zhi (Chinese Academy of Sciences, China).