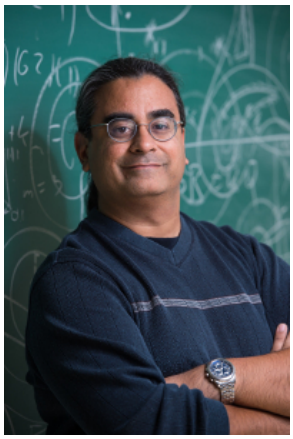
Atlantic Association for Research in the Mathematical Sciences

Research - Outreach - Community

# Newsletter

Autumn 2017

## Message from the AARMS Director



Greetings AARMS community! Since I last wrote to you in Summer 2016, our Institute has been diligently pursuing its mission of supporting mathematical sciences research, advanced training, and outreach throughout Atlantic Canada. In this newsletter you will find in-depth descriptions of several AARMS initiatives from the recent past; my purpose here is to highlight just a few of AARMS's many other activities.

One of the most exciting AARMS developments is the appointment of two new collaborative research groups (CRGs). One of these is the Statistical Learning for Dependent Data with Applications in Medicine and Environmental Science CRG under the administration of Ying Zhang from Acadia University. This CRG involves ten faculty members from four Atlantic Universities, and aims to address emerging statistical learning and computing issues motivated by multidisciplinary collaborations related to big data. The CRG's first event will be an AARMS workshop on "Health Data Analytics" at the annual Science Atlantic Math, Stats & CS conference to be held in Fredericton on October 15, 2017.

The other new AARMS CRG is called Dynamical System and Spatial Models in Ecology, and is under the administration of Amy Hurford from the Memorial University of Newfoundland. This group will use their expertise to address regionally vital issues such as the propagation of invasive green crabs throughout Atlantic Canada and the treatment of salmon lice in aquaculture. You can read much more about this CRG in Dr. Hurford's article in this newsletter.

Another new development is the formation of a standing AARMS committee on Industrial Collaboration. This new body is chaired by Richard Karsten from Acadia University, and includes Hong Gu (Dalhousie), Scott MacLachlan (MUN) and James Watmough (UNB). The committee's purpose is to oversee, promote and expand AARMS's academic-industrial collaboration activities. Also, it is responsible for the administration of the memorandum of understanding between AARMS and Mitacs that provides expedited peer review for internship applications from Atlantic Canada. If you know of a student from Atlantic Canada who would be a good candidate for a Mitacs Accelerate internship, be sure to let our Industrial Committee know (aarms.math.ca/contact); we can help streamline the process.

The AARMS Summer School was held for the first time at the University of Prince Edward Island in 2017. The topic was financial mathematics, and the school was a great success by all measures. Next year, the Summer School's main topic will be Big Data Analytics, and it will again take place in Charlottetown; more details will be available soon.

Some of you might have noticed that our website at aarms.math.ca has gone through a significant structural and visual refresh. All the content from the old site is still there, but should now be easier to find. The new front page features a slideshow where we plan to showcase both the Institute's activities as well as mathematical sciences research from the region. So if you have a visually striking research image that you want to share, or you have any comments or suggestions for our website, please let us know. Finally, if you find yourself wanting even more news from AARMS than you can find in our newsletters or on our website, be sure to follow the Institute on twitter: @AARMS_math.

*- Sanjeev Seahra*

## UPEI Math Camp

The annual UPEI Math Camp was held May 5-7, 2017. All PEI high schools were invited to identify and nominate talented and interested students. Funds permitting, the intention is to try to accept all applicants. This year there were 19 students in attendance. Over the weekend, the students participated in education sessions conducted by faculty members from the UPEI School of Mathematical and Computation Sciences. The students also competed in team problem solving, math relays, and math trivia. During evening hours, social activities included a pizza and games night, and a movie night. In addition to faculty participation, five undergraduates volunteered their time to the camp. The undergrads supervised students during the various competitions, as well as spent social time with the students. The camp provides a great opportunity for undergrads to mentor younger students.

# News

## New Collaborative Research Groups

Every two years AARMS issues a call for proposals from groups of mathematical scientists who are interested in forming an AARMS-funded Collaborative Research Group (CRG). This typically consists of Atlantic Province University researchers with common research interests who wish to collaboratively develop their research programs. Members of a CRG typically organize intensive workshops, share PDF appointments, coordinate graduate training programs, propose and assist in AARMS summer school programs, jointly supervise graduate students, and carry out other activities supporting their research programs. In 2017 we are pleased to be funding two new groups: Statistical Learning for Dependent Data under the Administration of Ying Zhang at Acadia University, and Dynamical Systems and Spatial Models in Ecology under the Administration of Amy Hurford at Memorial University. What follows is an introduction to the second of these groups:

The AARMS collaborative research group (CRG) on Dynamical Systems and Spatial Models in Ecology (http://amyhurford.weebly.com/aarms-crg.html) began activities in September 2017. The CRG is composed of group members from Memorial University, the University of New Brunswick, Dalhousie University, St. Francis Xavier University, and the Department of Fisheries and Oceans in St. John's, alongside invited national and international experts, and with the involvement of graduate students studying mathematical biology in Atlantic Canada.

The goals of the CRG are to derive and analyze new mathematical models for ecological processes with an emphasis on marine ecology. These models will be integrodifference, partial differential, or delay differential equations and may involve parameters with spatial or temporal dependencies. This CRG blends expertise in the mathematical analysis of dynamical systems, with expertise on the derivation of mathematical models in ecology, and capitalizes on past work led by several group members. Specifically, this CRG will develop models that describe the invasion of green crab and the chemotherapeutic treatment of salmon lice in aquaculture. CRG subgroups are investigating topics related to habitat heterogeneity and boundary conditions for integrodifference equations, bacterial aggregation, propagation speeds for reaction-diffusion equations, and threshold conditions for salmon lice outbreaks.

Planned group activities through until September 2018 are to host an annual CRG meeting in Fredericton around the time of the summer Canadian Mathematical Society Meeting (June 1-4, 2018). At this meeting progress to date and future plans for grant writing and publications will be discussed. In addition, we plan for invited speakers to visit the CRG host institutions throughout the academic year. Anyone interested in participated in research or events related to this CRG should contact Amy Hurford (ahurford@mun.ca).

## An AARMS Postdoc Stays in New Brunswick: Dr. Rory Lucyshyn-Wright

Having recently completed an AARMS Postdoctoral Fellowship at Mount Allison University (2015-2017), I am now working at Mount Allison as an Assistant Professor on a limited term appointment. Earlier, I was an NSERC Postdoctoral Fellow at the University of Cambridge (2014-2015) and the University Ottawa (2013-2014), after having completed my Ph.D. at York University in 2013 under the supervision of Walter Tholen. My research is multifaceted, blending category theory, geometry, and analysis. My recent AARMS Postdoctoral Fellowship was a period of great productivity, including the writing of seven research papers and the publication or acceptance of six. In the past two years I have also spoken at six conferences, in Vancouver, Ottawa, Halifax, and Braunschweig, Germany.

One aspect of my research concerns dualization processes and dualities in functional analysis, topology, order theory, and harmonic analysis. In this regard, my paper titled Functional distribution monads in functional-analytic contexts will soon appear in the journal Advances in Mathematics. In July, I gave an invited plenary talk at the International Category Theory Conference CT 2017 in Vancouver, titled Algebraic duality and the abstract functional analysis of distribution monads, on a categorical study of dualization that captures as examples several classical dualities such as the Pontryagin duality.

Another aspect of my research concerns structures of differential geometry that occur not only in the category of smooth manifolds but also in algebraic geometry, homotopical algebra, and computer science. In particular, J.E. White's sector forms generalize differential forms to include higher-order differentials of smooth functions. One of my AARMS PDF supervisors, Geoffrey Cruttwell and I showed that sector forms constitute a cosimplicial abelian group and so determine a cochain complex, whose cohomology remains to be characterized. With Richard Blute we have also recently studied affine structures in categories of geometric spaces, on the basis of our recent studies of connections in tangent categories.

Another of my AARMS PDF supervisors, Robert Rosebrugh and I have recently proved results on the updating of database views within certain categorical settings for database theory, characterizing the conditions under which such views can be updated in an optimal way.

While at Mount Allison I have also enjoyed teaching, both as an AARMS PDF and now as a faculty member, including courses in Calculus and Real Analysis as well as upcoming courses on Complex Variables and Numerical Analysis.

## CAIMS Conference 2017

This year, the Canadian Applied and Industrial Math Society (CAIMS) conference took place in beautiful Halifax, Nova Scotia, Canada on July 17–21st. There were around 150 participants, mostly from Canada, but also with a strong international representation, especially from the US. The meeting had five themes: data science, industry, fluids, differential equations, and numerical methods. In addition, there were sessions on collective behaviour and stochastics.

The conference featured plenary talks by award winners, including winners of prizes for best PhD thesis, the CAIMS/PIMS early-career research prize (for researchers within 10 years of their PhD), the CAIMS/FIELDS Industrial prize, and the CAIMS research prize. The CAIMS research prize was awarded to James J. Feng. In his prize lecture, he discussed collective motion of cells inside a thin channel. A central question is the following: how can unidirectional motion be initiated and maintained in the absence of any chemical gradients or inertia? Feng and his students showed, using direct numerical simulations, that such anisotropic motion can be a result of isotropic cell-to-cell interactions as well as interactions with a channel wall, and is initiated spontaneneously when there is sufficient cell density.

One of the highlights was a public lecture, supported by both CAIMS and AARMS (Atlantic Association for Research in Mathematical Sciences), featuring Chad Topaz, who discussed swarming. It was a very entertaining and lively affair, with public participation in swarming experiements! One of the experiments involved changing the frequency of synchronized clapping by having a select group of participants accelerate the clapping rythm. That particular experiment was judged "inconclusive", so I hope Chad will have a chance to make further such experiments in the future and report the results here! The lecture was very well received, and its was well attended by the public at large, at least judging by the questions at the end, many with a philosophical bent.

One of the largest themes was numerical methods, with over 40 talks, although many of them overlapped significantly with other themes, such as DEs and fluids. Dynamical systems had a particularly large presence, and it overlapped with multiple themes of the conference. There were many talks on related topics, such as stability and bifurcation of nonlinear waves, dynamics of fluids, asymptotic methods for PDEs, "classical" dynamical systems, nonlinear PDEs, numerical methods for DEs, reaction–diffusion systems, collective behaviour, and stochastics. The fluid dynamics sessions focused on two areas: the dynamics of thin fluids and geophysical fluid dynamics. Through these two extreme scales of fluids, the talks discussed a wide range of research methods: laboratory experiments, theoretical analysis, and numerical simulations. The research also ranged from fundamental mathematics of understanding singularities in dynamics to the applied problems of particle separation. The sessions came from a range of universities, with speakers from California, Oxford, Edinburgh, and Western Canada.

It was interesting to note that the industry session was dominated by topics related to data science and statistics. In the past CAIMS conferences, most of the industrial talks revolved around questions of manufacturing. This year, however, while manufacturing was still one of the main themes, there was a clear trend towards talks on data science. While this may be partly a reflection of the organizers' tastes, the trend towards data science is also a reflection of the trends in society as a whole.

To conclude, CAIMS conferences showcase Canada's strengths in applied math. On one hand, it is very diverse and is of interest to a wide range of students and researchers from numerous subdisciplines. On the other hand, it is not so big that one gets lost. Perhaps as a result of its relatively small size, there is a certain cohesiveness and cross-over between the various sessions that is less apparent in bigger conferences such as Snowbird. Next summer, the CAIMS conference will be held in Toronto. I hope many of you will attend.

## Workshop on Combinatorics of Group Actions and its Applications

During the week from August 28 to September 1, the workshop "Combinatorics of Group Actions and its Applications" took place at the Atlantic Algebra Centre of Memorial University. The workshop, organized jointly by the Atlantic Algebra Centre and the Network of Ontario Lie Theorists, attracted over thirty researchers from all over the world: Belgium, Brazil, Bulgaria, Canada, Germany, Great Britain, Israel, Japan, Spain, and the United States. The workshop included three minicourses. The first one was given by Eli Aljadeff on current developments in the theory of polynomial identities, where the classical results of Aleksandr Kemer have recently been clarified and generalized. The second minicourse, by Vesselin Drensky, was concerned with group actions on relatively free algebras, including the history of some famous problems in algebra such as the Jacobian Conjecture and the existence of wild automorphisms. The third, by Alberto Elduque, focused on the development of quaternions and octonions starting from W. R. Hamilton's historical discovery, and their relation to crossed products and classical Lie groups. Besides these minicourses, there were many research talks by mathematicians at different stages of their career: established researchers, postdocs and graduate students.

The workshop was made possible through support from Memorial University and funding from three of Canada's mathematics research organizations: the Atlantic Association for Research in the Mathematical Sciences, the Fields Institute, and the Pacific Institute for Mathematics. It was the most recent in a long series of events hosted by the Atlantic Algebra Centre.

## Annual Postdoctoral Fellowship Competition: New rules

On October 14 the annual AARMS Postdoctoral Fellowship Competition will open for applications. We are seeking to award fellowships to beginning researchers who submit high quality research proposals to be supervised by faculty at AARMS universities in Atlantic Canada. AARMS will award $17,500/year towards the salary of the successful applicant as well as up to $1500 in travel funding. Fellowships are normally for two years, although funding in the second year is dependent upon satisfactory performance in year one.

One new aspect of this year's competition is that following the initial application phase, the proposed supervisors will have time to read through submitted materials from multiple applicants who are interested in working with them, and to then select their preferred proposal(s) to go forward. This "dating app" function should enable proposed supervisors to make a more informed choice about which candidates they are most interested in working with.

### Schedule

**October 14 –** MathJobs.org will begin accepting Stage 1 applications

**November 14 –** Stage 1 application deadline. All material from applicants, including letters of reference, must be received by MathJobs.org by 11:59 pm, Atlantic time.

**November 14 – 21 –** AARMS contacts potential supervisors named in Stage 1 applications.

**December 14 –** Stage 2 application deadline. Letters of support from potential supervisors must be received by 11:59 pm, Atlantic time.

**February 3 –** Deadline for the assessment phase. Initial offers on Postdoctoral fellowships are made within the next few weeks.

**September 1 –** Start time for the fellowship.

For more detailed information please visit our website: https://aarms.math.ca/pdfrules/

## MSRI Opportunities

s a sponsor of MSRI, AARMS is able to offer the following limited funding opportunities to faculty and students at universities in Atlantic Canada:

**Graduate Summer Schools:** MSRI covers the travel and local expenses of 2-3 students to attend one of its Graduate Summer Schools. The rate for travel reimbursement is up to USD $600 for students from US and Canadian universities. If you wish to nominate one or more of your students to attend, please contact the AARMS Director. All nominations for 2018 graduate summer schools must be sent to us by November 10, 2017. More details are found here: www.msri.org/web/msri/scientific/workshops/summer-graduate-school

**Visits by MSRI Members:** AARMS can invite MSRI members to visit and give a colloquium or seminar talk at universities in Atlantic Canada. MSRI provides partial support for the member's visit (at present, up to USD $250). If you would like us to invite one of these members to your university please contact the AARMS Director. The list of MSRI members that may be available to visit is found here: www.msri.org/web/msri/about-msri/member-directory

**Travel Support for Attending BIRS Conferences and Workshops:** MSRI will provide partial travel funding (up to a maximum of USD $750) for postdoc or ladder faculty members of Academic Sponsor Institutions to attend workshops at the Banff International Research Station (BIRS). If you wish to take advantage of this opportunity you must make the request to the workshop organizer, as there are only two such travel support awards available for each conference. The organizer is the person who will decide to whom these awards should be allocated. If you are allocated one of these awards then let us know. AARMS will bill MSRI and your reimbursement will come from AARMS.

## East Coast Combinatorial Conference

The 12th ECCC (East Coast Combinatorics Conference) was held July 20-21st, 2017 at the University of New Brunswick Saint John. There is a vibrant combinatorial community in Atlantic Canada. This annual conference series was designed to bring together regional mathematicians and computer scientists interested in all aspects of combinatorics, and has regularly done so with generous support from AARMS for over a decade. The scope of the conference is intended to cover most aspects of modern combinatorics, including but not limited to graph theory, extremal combinatorics, combinatorial optimization, probabilistic combinatorics, combinatorial number theory, design theory, finite geometries, and applications of combinatorics to computer science. The conference has consistently provided an intimate venue for researchers in Atlantic Canada with combinatorial interests to disseminate their research, share ideas, introduce students to the "conference experience", and to foster collaboration throughout our region.

The highlights of the conference include the two plenary talks. Aiden Bruen spoke on graphs,geometries, block designs, codes and their interconnections, and Brett Stevens spoke on design theory, tournaments and cryptography. Both talks were well received and included open problems. Also of note was the presentation, proposal, and discussion led by Keith De'Bell regarding the establishment of an Atlantic Research Group focused on the Mathematics of Social Networks. There was keen interest in this rather exciting venture, and active discussion ensued. Those interested in the project have continued discussions, and it is likely that a formal research group will be realised as a result.

# Recent and Upcoming Events

**2017 Science Atlantic AARMS Workshop**
Organizer: Ying Zhang
Location: University of New Brunswick, Fredericton
Date: October 15, 2017
Contact Information: Ying Zhang (ying.zhang@acadiau.ca)

This October 15th, University of New Brunswick Fredericton (UNBF) will be hosting an AARMS Workshop on Statistical Learning and Health Data Analytics, as a post-event of the Annual Conference for Science Atlantic Mathematics, Statistics and Computer Science. The workshop is organized by an AARMS Collaborative Research Group (CRG), Statistical Learning for Dependent Data under the Administration of Ying Zhang. The Science Atlantic AARMS Workshop will promote the statistical research in the region through numerous confirmed speakers and it will strengthen connections among professors and researchers in the field of statistical learning and health data analytics. Most importantly it will provide the training opportunity in this highly demanded multidisciplinary field to students that are not available in their own university program.

**26th Foundational Methods in Computer Science Workshop**
Organizer: Robert Rosebrugh
Location: Mount Allison University, Sacville
Date: June 7 – 10, 2018
Contact Information: Robert Rosebrugh (rrosebrugh@mta.ca)

Foundational Methods in Computer Science is an annual workshop that brings together researchers and students in Theoretical Computer Science and Category Theory. The workshop will have presentations on areas such as quantum programming languages, restriction categories, database design, and the differential and resource logics. Past workshops have been held at universities across North America including University of British Columbia, University of Washington Spokane, University of Calgary, University of Ottawa, Colgate University, Dalhousie University, and Mount Allison University. Like its predecessors the 2018 workshop will be informal and interdisciplinary. This is a three day meeting featuring extended research tutorials aimed at students, and research talks by many of the participants.

**25th International Domain Decomposition Conference**
Organizers: R. Haynes, S. MacLachlan, H. Brunner
Location: Memorial University, St. John's
Date: July 22 - 27, 2018
Contact Information: Rob(tim@unb.ca)

Memorial University of Newfoundland is pleased to host the 25th International Domain Decomposition Conference, DD XXV, in St. John's, Newfoundland, Canada, July 23-27, 2018. A tutorial style short-course, providing both theory and practical computing, is tentatively scheduled for July 21-22, 2018. More details to come. If you think the short-course is of interest then hold off making travel arrangement until the schedule matures. The purpose of the meeting is to discuss recent developments in various aspects of domain decomposition methods bringing together mathematicians, computational scientists, and engineers who are working on numerical analysis, scientific computing, and computational science with industrial applications.




*Editor:*
*Danielle Cox*
*Danielle.Cox@msvu.ca*
*Assistant Editor:*
*David Langstroth*
*dll@cs.dal.ca*


*"Mathematics is the science of what is clear by itself."* -- *Carl Gustav Jacob Jacobi*