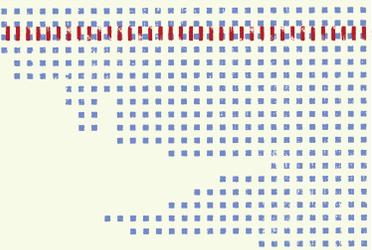
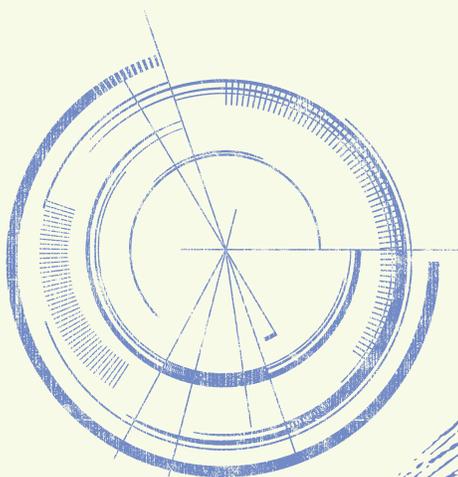
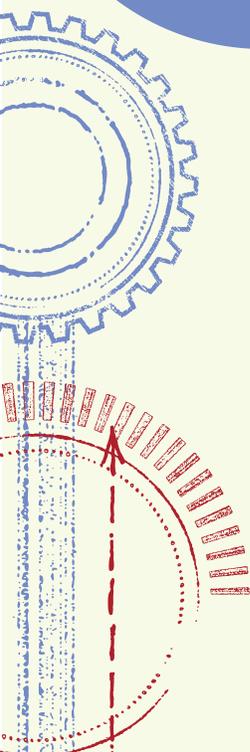


AARMS

Atlantic Association for Research
in the Mathematical Sciences



2018 Annual Report



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1 Introduction

In 2018, AARMS has continued to pursue its mission of supporting Mathematical Sciences research, education, and outreach throughout Atlantic Canada. In fact, in 2018 AARMS has expanded its efforts with the creation of two major new programs: AARMS Industrial Problem Solving Workshops and AARMS-Girl Guides STEM camps. Both of these, as well as the rest of AARMS's activities in 2018, are described in detail below; here, I will touch upon a few highlights, as well as some rather significant challenges looming on the horizon.

Each of AARMS's core programs is functioning smoothly, and we are supporting a wide range of activity throughout Atlantic Canada. Our two current collaborative research groups (CRGs) are active and pursuing their research goals in spatial ecology and statistical learning, respectively. Our conferences and workshops program remains popular and well-subscribed by the community. Over the past year, one of the larger events we supported was the international Domain Decomposition Methods 2018 conference at Memorial University in collaboration with Canada's other mathematical institutes (Fields, PIMS and CRM). We also committed significant resources to support special sessions at the Canadian Mathematical Society's 2018 Summer Meeting at the University of New Brunswick (UNB) in Fredericton. The 2018 AARMS Summer school on Data Analytics at the University of Prince Edward Island was a huge success and rather heavily oversubscribed. This year, the Canadian Statistical Sciences Institute (CANSSI) sponsored the attendance of five students in the Summer School. Also in 2018, AARMS funded postdocs at Memorial University, UNB, Mount Allison University, and Dalhousie University.

AARMS Outreach activities continue to grow and diversify. We completed the search for our second outreach coordinator early in 2018, and the successful candidate began his position on August 1. AARMS is both supporting and leading initiatives aimed at increasing the participation of traditionally underrepresented groups in the Mathematical Sciences. One of these is the AARMS-Girl Guides STEM Camps, the first of which was held at UNB in May of 2018. This event involved over 500 girls aged 9-17 participating in STEM-based workshops run by university faculty over a two day period. The event was very rewarding to organize, and extremely inspiring to participate in. Our NSERC PromoScience grant to support the inaugural UNB camp has been

renewed for three additional years. Plans for the next camp to be held at Dalhousie in May 2019 are well underway.

AARMS has also expanded its outreach efforts aimed at Indigenous youth. In addition to continuing our support for initiatives such as the successful “Connecting Math to our Lives and Communities” program run by St Francis Xavier University, we have recently partnered with CANSSI to support Institute of Big Data Analytics at Dalhousie’s new program: “Big Data for the Mi’qmaq Elementary and High School Students”.

AARMS held its first ever Industrial Problem Solving Workshop (IPSW) in early July at Dalhousie University. This event involved around 35 university faculty, postdocs and graduate students working collaboratively on mathematical sciences problems presented by five Atlantic Canadian companies. The problems ranged from detecting violent behaviour in security camera footage using machine learning to using advanced techniques from pure mathematics to validate engineering designs. Our industrial partners were extremely pleased with the event, which has, to date, spawned several NSERC Engage applications, a Mitacs Accelerate Fellowship, and a few informal job offers. AARMS is grateful to the IPSW’s sponsors, which included PIMS, Mitacs, NSERC, Dalhousie and Springboard Atlantic. The AARMS Executive has decided to make this an annual event, and the next edition will be at UNB (Fredericton) in July 2019.

On the funding side, AARMS is facing considerable uncertainties. The Province of Nova Scotia has signalled a desire to change its funding mechanism for AARMS, and we are currently in discussions with multiple departments about a way forward. Our funding arrangements with Newfoundland and New Brunswick both expire in 2019, and we are preparing to negotiate renewals.

Federally, AARMS continues to lobby for the expansion of NSERC’s Collaborative and Thematics Resources in the Mathematical Sciences (CTRMS) program in collaboration with the other Canadian Mathematical Sciences Institutes (PIMS, BIRS, Fields, CRM, and CANSSI). We have recently been informed that the current CTRMS grant has been extended for one more year, and the final payments will be in Spring of 2020. We are therefore anticipating applying to NSERC for continued funding in 2020.

In conclusion, I would like to express my appreciation to the AARMS Executive, AARMS Board, AARMS Scientific Review Panel, and wider Atlantic mathematical sciences community for their sustained efforts in driving all of our programs and initiatives. AARMS is grateful for the continued support of a number of organizations, including the provinces of New Brunswick, Newfoundland and Labrador, Prince Edward Island, and (hopefully) Nova Scotia; NSERC; and all of AARMS’s member universities. I would also like to thank PIMS, Fields, CRM and CANSSI for their ongoing and valued collaboration. Finally, special recognition is due to David Langstroth for his excellent administration of AARMS’s affairs.

Sanjeev Seahra
AARMS Director
March 2019

2 Report on Funding

2.1 Province of Nova Scotia

In the spring of 2018, the Province of Nova Scotia signaled a desire to move our funding program from the dept of Labour and Advanced Education (LAE) to the Dept of Education and Early Childhood Development (EECD). Up until this point LAE had been supporting AARMS to the amount of \$100,000/year. When we met with EECD, it was clear that this department's mandate had much stronger overlap with AARMS's outreach programs than our research activities.

We have therefore appealed to the province of Nova Scotia, reminding them that core AARMS lies within the LAE mandate in advanced education. We persuaded them to accept a new 5-year proposal in which AARMS is jointly funded by LAE and EECD. We are awaiting a response. At the time of writing we have no funding commitment from Nova Scotia.

2.2 Province of Newfoundland and Labrador

In 2014, AARMS signed an agreement with the Research and Development Corporation of Newfoundland and Labrador (RDC) in which they would contribute funds to support a program of AARMS activities in that province. The amount of funding was defined as a proportion of the costs for salaries for postdoctoral fellowships, graduate students and summer students and for travel expenses related to AARMS CRGs, workshops etc. A system of reporting and reimbursements after the event was set up.

It is unfortunately the case that the financial management of this project has become bureaucratically complex, necessitating a thorough review by the Financial Services department at Memorial University and a delay in processing payments. In 2018, we concluded the review of the first few years of the project and funds have been accordingly transferred. We are optimistic that the project will be wrapped up, administratively in 2019 with all funds appropriately distributed and accounted for.

2.3 Province of Prince Edward Island

In 2018 we signed an agreement with the Province of Prince Edward Island for support in the amount of \$5,000 for one year. It is our hope that this becomes an annual amount.

2.4 Province of New Brunswick

Our five year funding agreement \$50,000/year has come to an end and will need to be renewed.

2.5 Memorial University

Our five year funding agreement \$30,000/year has come to an end and will need to be renewed.

3 Report on Activities

3.1 AARMS Collaborative Research Groups (CRGs) Program

3.1.1 Dynamical Systems and Spatial Models in Ecology



In September 2018 we received the first full year report from the CRGs **Dynamical Systems and Spatial Models in Ecology**, under the administration of Amy Hurford from the Memorial University of Newfoundland. This group uses 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. The CRG completed its first year of activities on September 1, 2018.

CRG funds have been spent on activities that have benefited AARMS member institutions MUN, UNB, Dalhousie and St. Francis-Xavier. One manuscript has been submitted, and 27 talks were given by CRG members or invited guests at the CMS meeting in Fredericton. One talk was given at a Fields Institute workshop, and an invited speaker (Knutsdottir) gave talk at Dalhousie and St.

Francis-Xavier. The principle CRG activity during the last year has been to establish subgroups and begin collaborative research.

3.1.1.1 Members

- Eric Pedersen (DFO)
- James Watmough (UNB)
- Theodore Kolokolnikov (Dalhousie)
- Crawford Revie (UPEI)
- Gregor McEwan (UPEI)
- Garrett Otto (U of Ottawa)
- Xiaoying Wang (U of Ottawa)
- Mohammad El Smailly (UNB)
- Chunhua Ou (MUN)
- Xiaoqiang Zhao (MUN)
- Yuan Yuan (MUN)
- David Iron (Dalhousie)
- Olga Vasilyeva (MUN - Grenfell)
- Lin Wang (UNB)
- Myriam Barbeau (UNB)

3.1.1.2 Activities

Sept 2017

- Hildur Knutsdottir visited Dalhousie and St. Francis-Xavier as part of the bacterial aggregation subgroup's activities.

Oct 2017

- Plans for first year activities of the CRG were written up and published in the AARMS newsletter.

Nov 2017

- New group members Crawford Revie (UPEI) and Gregor McEwan (UPEI) were invited to the group due to their expertise on sea lice.

Jan 2018

- J. Smokey began his PhD at MUN. Joey is supervised by A. Hurford and is leading CRG research on green crabs and heterogeneity in integrodifference equation models. Joey's research is in collaboration with several other CRG members and he has been working closely with A. Beyk Zadeh, a PhD student supervised by J. Watmough at UNB.

March 2018

- CRG members participated in the Fields Institute workshops on 'Human-environment systems: feedback and management' (A. Hurford, J. Watmough, M. Lewis, M. Neubert, C. Cobbold, M. Krkosek) and 'Pollinators and pollinator modeling' (J. Watmough, J. Smokey).
- A. Hurford continued collaborative research with C. Cobbold and Peter Molnar (University of Toronto-Scarborough during the visit to the Fields Institute).
- A. Hurford gave a talk 'The effect of environmental variability on the management of salmon farms' at the Fields Institute workshop and discussed collaborative research with CRG member M. Krkosek (University of Toronto).
- New members Garrett Otto and Xiaoying Wang (U of Ottawa) were invited to the group due to their expertise on integrodifference equations in heterogeneous environments.

April 2018

- The boundary condition subgroup had a video-conference on April 30, in preparation for our annual CRG meeting next month.

June 2018

- Amy Hurford, James Watmough, Myriam Barbeau, and Ali Gharouni organized the AARMS CRG annual meeting held in Fredericton, NB, May 31 and June 1, 2018. As this event was held directly before the Canadian Mathematical Society meeting, talks by individual researchers were deferred to the CMS meeting. The goal for the CRG meeting was to establish collaborative research and the organization of the meeting was based on the advice described here (<https://dynamicceology.wordpress.com/2015/02/26/the-secret-recipe-for-successful-working-group-meetings/>). Only two research talks were scheduled, and these speakers were selected to speak on topics directly related to the goals of the CRG: research pertaining to green crab and salmon lice.

Regional participants (14 – 7 graduate students, 5 faculty, 2 government researchers. 5/14 women)

1. Ali Beyk Zadeh (UNB)
2. Lin Wang (UNB)
3. Mohammad El Smaili (UNB)
4. Ruiwen Wu (MUN)
5. Fuxiang Li (MUN)
6. James Watmough (UNB)
7. Abdou Fofana (MUN)
8. Ali Gharouni (Department of Fisheries and Oceans (DFO) – St. Andrews, NB)
9. Eric Pedersen (DFO, St. John's)
10. Amy Hurford (MUN)
11. Myriam Barbeau (UNB)
12. Joey Smokey (MUN)
13. Joany Marino (MUN)
14. Joe Moran (MUN)

National/International participants (6 – 3 faculty, 1 PDF, 2 graduate students, 2/6 are women)

1. Mike Neubert (Woods Hole Oceanographic Institution, USA)
2. Jianhong Wu (York University)
3. Mark Lewis (University of Alberta)
4. Ao Li (UWO)
5. Xiunan Wang (UWO)
6. Yang Wang (UWO)

Total number of participants: 20.

Participants included Mark Lewis, a Senior Canada Research Chair and incoming president of the CMS, Jianhong Wu, a Senior Canada Research Chair, and Mike Neubert, a respected international researcher. The outcome of the CRG was to further refine and focus the subgroups within the CRG. The subgroups that emerged during the CRG meeting are:

1. Review paper
2. IDE with boundary conditions
3. Delay diffusion equations
4. Sea lice
5. Spread rate in reaction diffusion equations

Our goal is that these subgroups will produce publications, but we are still in the early stages of the collaborative research. We also began planning a writing retreat pertaining to subgroup 1.

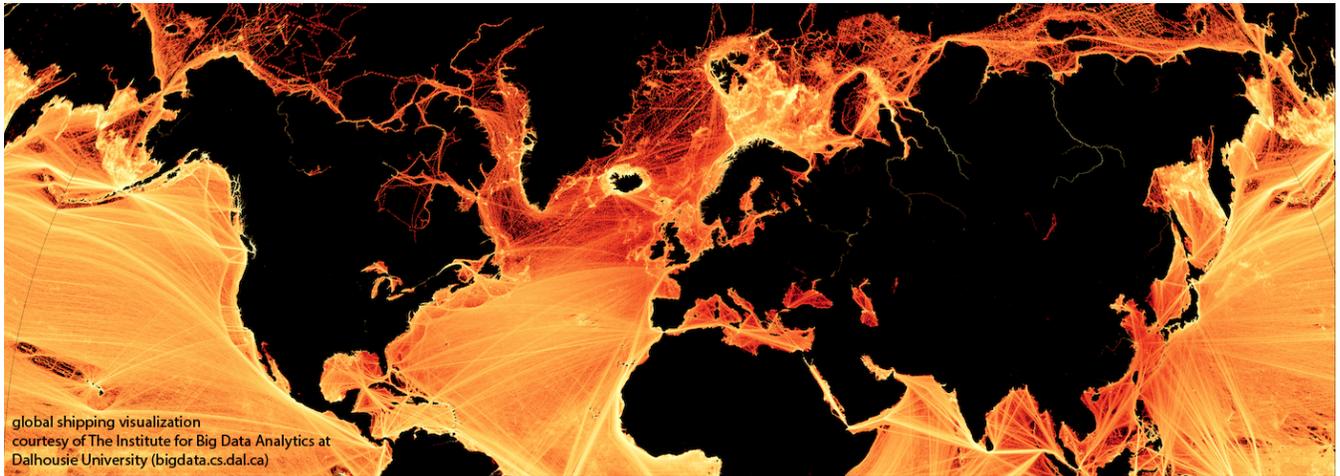
- CRG members attended the Canadian Mathematical Society meeting and organized two special sessions. See details here:
https://cms.math.ca/Events/summer18/sessions_scientific#me and here:
https://cms.math.ca/Events/summer18/sessions_scientific-dsa

August 2018

- M. El Smailly (UNB) visited MUN to collaborate with C. Ou as part of the ‘Speeds of propagation in reaction-diffusion systems with general non-linearities’ CRG subgroup.
- The paper ‘Skewed temperature dependence affects range and abundance in a warming world’ by CRG members A. Hurford (MUN) and C. Cobbold (University of Glasgow) was submitted and is under review at Proceedings of the Royal Society London B (IF 5.61).
- J. Smokey has emailed Cynthia McIntosh (Department of Fisheries and Oceans – St John’s) to begin working on a data sharing agreement for green crab research. This work is in collaboration with other CRG members from UNB and the Department of Fisheries and Oceans (DFO).

- A. Hurford (MUN), X. Wang (UWO), and X.Zhao (MUN) are working on collaborative sea lice research, which has been ongoing for the past few months.

3.1.2 Statistical Learning for Dependent Data



Another new CRG which began its activities in September 2017 is Statistical Learning for Dependent Data under the administration of Ying Zhang (Acadia). 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.

3.1.2.1 Members

- Paul Cabilio (Acadia)
- Hugh Chipman (Acadia)
- Hong Gu (Dalhousie)
- Tariqul Hasan (UNB)
- Wenjiang Jiang (Yunnan Normal)
- Toby Kenney (Dalhousie)
- Renjun Ma (UNB)
- Jianan Peng (Acadia)
- Gary Sneddon (MSVU)
- Connie Stewart (UNB)
- Guohua Yan (UNB)
- Ying Zhang (Acadia)
- Henrik Stryhn (UPEI)
- Wenjiang Jiang (Yunnan Normal U., China)

3.1.2.2 Activities

Below are details on the activities undertaken by the CRG over the last 12 months.

3.1.2.2.1 Workshop

On October 15, 2017, the CRG organized an AARMS workshop on Statistical Learning and Health Data Analytics, as a post-event of the annual Science Atlantic Mathematics, Statistics and Computer Science Conference at the University of New Brunswick Fredericton. Statistical research in the Maritime region was promoted through numerous talks by researchers in the field of statistical learning and health data analytics. The workshop also provided students with a training opportunity in this high-demand multidisciplinary field. There were 51 participants at the AARMS workshop:

- 13 faculty including 3 invited speakers from the field of statistics
- 1 science Atlantic conference statistics keynote
- 2 invited speakers from the health data sectors
- 16 graduate students
- 16 undergraduate students
- 3 guests

All participants are regional except for 3 participants (keynote speaker Amy Wu from York University, a graduate student from University of Waterloo, and a guess participant from China). This number was way above the expected attendance of approximately 20 people. Hugh Chipman (SSC President; Acadia University) presented an overview of statistical learning methods that are essential in learning from data. Ted McDonald (Director, NB Institution for Research, Data and Training; University of New Brunswick) and Samuel Stewart (Director, Health Data Nova Scotia; Dalhousie University) discussed recent developments in data driven health research in New Brunswick and Nova Scotia. A Maritime Health Science Collaborating Centre was proposed by Ying Zhang and Anja Haltner (Acadia University) to promote research in health through collaborations among researchers in academia and health industries. In the afternoon, statistical learning methods with applications in medicine were presented by Amy Wu (York University), Hong Gu (Dalhousie University), and Renjun Ma (University of New Brunswick), including topics on graph-based change-point tests for high dimensional data, statistical learning methods in emergency diagnosis and human microbiome analysis, and the analysis of dependent data with various correlation structures.

The workshop was proudly sponsored by Science Atlantic, Atlantic Association for Research in the Mathematical Sciences, Canadian Statistical Sciences Institute Health Science Collaborating Centres, and UNB Fredericton. The workshop report was submitted to AARMS on November 9, 2017.

3.1.2.2.2 Maritime Statistical and Health Sciences Collaborating Centre

The Maritimes have a very long health research history and rich research resources. There are various health organizations, medical faculties, and health research centres/networks. One advantage in the Maritime region is the well-organized and comprehensive provincial healthcare databases that motivate many evidence-based health research projects. These projects often

require significant data linkage, data processing, and high-quality statistical analyses and modelling procedures. Hence, in this region, there is a high demand for collaboration between health researchers and statistical scientists. Working together, the CRG has established the Maritime Statistical and Health Sciences Collaborating Centre (MSHSCC). Our application to have MSHSCC designated as a Canadian Statistical Sciences Institute (CANSSI) Health Sciences Collaborating Centre (HSCC) has been successful. CANSSI has granted a total of \$15,000 seed project funding to further develop MSHSCC matching a total of \$6,000 from Acadia Research and Graduate Studies. For three years beginning April 1, 2018, we will be able to use this designation, and we may apply to have it renewed at the end of that time. MSHSCC as one of twelve CANSSI HSCCs in Canada involves four university programs and eight health organizations in the Maritime region. The mission of MSHSCC is to strengthen ties among our statistical science programs and our regional/provincial health organizations. This will make our students more competitive in the employment market and build research capacity in health sciences research, leading to improvements in health care.

3.1.2.2.3 Invited conference sessions

The CRG has proposed two invited sessions for the 2019 Statistical Society of Canada (SSC), May 26-29, in Calgary:

- Recent Developments in Statistical Methods for Skewed Longitudinal Data and Multivariate Count Time Series with Medical Research Applications
- New Developments in State-space Modeling Approaches for Ecology and Environmental Research

The objectives of these two sessions are to promote/exchange the research outcomes arising from the CRG to a national audience. The applications in the first proposed session include the analyses of patient-controlled analgesia data and Framingham cholesterol data, exploring microbiome data, and the analyses of drug utilization time series. The applications in the second proposed session include the analyses of Canadian natural disaster data (1900-2016), Nova Scotia white-tailed deer data (1983-2013), and grey seal data. The CRG grant will be used to sponsor our HQP to attend this conference in conjunction with the SSC student travel awards. At the same time, the CRG is working to propose new invited session(s) for the International Chinese Statistics Association (ICSA) - Canada Chapter 2019 Symposium, August 9-11, Kingston.

In addition to the CRG talks, the group members have actively participated in international conferences/workshops. Some samples of these presentations are as follows:

- An Overview of Statistical Learning, Statistical Society of Ottawa Rendez-Vous 3, September 22, 2017. (Hugh Chipman)
- Test for trend in Environmental Time Series Data. ICSA - China Conference. Qingdao, Shandong, China July 2 to July 5, 2018. (Ying Zhang)
- Modelling interrupted time series data with application in medication use research. The 2018 International Statistical Academic Forum. School of Mathematics and Statistics, Qingdao University, July 5-8, 2018. (Ying Zhang)

- Detection of Trend Onset in Environmental Time Series. The 2018 Joint Statistical Meetings. Vancouver, July 29 to August 2, 2018. (Ying Zhang)
- Spatiotemporal Analysis of Environmental Health Risk. The 2018 Joint Statistical Meetings. Vancouver, July 29 to August 2, 2018. (Renjun Ma)

3.1.2.2.4 Collaborative grants awarded to the CRG members

- NSERC ENGAGE grant (with EhEye): \$24,960 (PI: Hong Gu)
Project title: Real-time statistical anomaly detection in video”.
- CANSSI MSHSCC seed project grant: \$15,000 (PI: Ying Zhang)
- CANSSI MSHSCC Acadia Research and Graduate Studies: \$6000 (PI: Ying Zhang)
- NSHRF Establishment Grant (PI: Emily Black, Dalhousie): \$149,739 (Co-Investigator: Ying Zhang).
Project title: Optimizing Antimicrobial Stewardship Interventions to Improve Management of Urinary Tract Infections in Hospitalized Adults

3.1.2.2.5 Joint HQP training

The CRG members have been long involved in joint supervision within their university programs. That has proved to be a winning strategy for small university research programs. Many congratulations to Dr. Hong Gu (Dalhousie) for her new postdoctoral fellow Dr Wei Zhou (2018/9-2021/8). Dr. Zhou will be co-supervised with Dr. Bielawski on research topics from spatial temporal analyses on lake microbiome communities, with a focus on predicting cyanobacterial blooms which occur in lakes worldwide and produce toxins posing a serious public health threat.

The AARMS CRG grant makes joint supervision across universities possible. Matching with NSERC individual discovery funds, the CRG grant has enabled the successful recruitment of a six-month postdoctoral fellow, Dr. Xingde Duan. Dr. Xingde Duan started on September 19, 2019. This is a research position, with the expectation that a significant portion of the time be spent developing statistical methodology for the analyses of dependent or time series data with applications in medicine and environmental, a research area initiated by the CRG proposal. Dr. Duan has already involved in the CRG collaborative projects between Acadia and UNB. Thus Dr. Duan will travel between Wolfville and Fredericton primarily under the joint supervision of Drs. Renjun Ma and Ying Zhang.

With the CANSSI MSHSCC seed project funding and the NSERC individual discovery grant, Anja Haltner (MSc) was hired as Research Associated (September 2018 - December 2019; and January 2019) for assisting with the AARMS CRG workshop and the MSHSCC designation proposal. Recently, the CRG submitted a Co-op Education Incentive (CEI) application to apply for matching fund to create a co-op position starting January 14, 2019 for 12 weeks. If successful, a co-op student will assist the CRG members to further develop MSHSCC and to coordinate the CRG activities.

A workshop is an effective element of joint HQP training. In the past year, four PhD, three Masters, and three undergraduate students attended the 2017 AARMS CRG workshop described

above with full travel support. In addition, the CRG students from Dalhousie and Acadia participated in the AARMS UPEI summer school and AARMS' first Industrial Problem Solving Workshop. As a result, Dr. Hong Gu has been granted an NSERC ENGAGE grant with EhEye. The CRG is planning to partially sponsor the HQP to participate in the 2019 SSC in Calgary and the ICSA- Canada Chapter 2019 Symposium in Kingston.

3.1.2.2.6 New CRG members

In the first year three new members joined the CRG:

- Henrik Stryhn (UPEI)
- Connie Stewart (UNB)
- Wenjiang Jiang (Yunnan Normal University, China)

3.2 AARMS Postdoctoral Fellowship Program

Each year AARMS conducts a competition to award Postdoctoral Fellowships to highly qualified personnel who received their PhD within the last 4 years. AARMS provides a portion of the funding for these positions, which must be at least matched by other research funding from the host university. The program is successful in attracting highly qualified young researchers to universities in New Brunswick and the rest of the Atlantic region. Starting in autumn 2018 we have also made available a travel grant of \$1500/year for each postdoc.

3.2.1 Postdoctoral Fellow Biographies

The following postdoctoral fellows have been supported by AARMS in the past year:



Marzieh Bayeh received her PhD in 2016 from the University of Regina. Her research interests include homotopy theory, topological invariants and category theory. She was working at Dalhousie University under the supervision of Dorette Pronk.



Rosalinde Cameron is currently a postdoctoral fellow at Memorial University of Newfoundland, working with David Pike. She received her PhD from Monash University in 2017 and her research interests include graph theory and combinatorial design theory.

Jonathan Gallagher (biography to come)



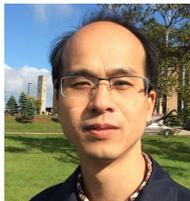
Nathan Grieve received his PhD (2013) from Queen's University. His research interests include algebraic, complex, and differential geometry and was working at the University of New Brunswick under the supervision of Colin Ingalls.



Suzanne Lanéry received her PhD in 2015 from the University of Erlangen–Nuremberg, Germany, and is currently a postdoctoral fellow at the University of New Brunswick. Her research interests lie in the mathematical foundations of Quantum Field Theory, especially the topics of coarse-graining, refinement and renormalization, as well as their applications to quantum gravity.



Rory Lucyshyn-Wright received his PhD from York University in 2013 and was an NSERC Postdoctoral Fellow at the University of Ottawa and the University of Cambridge from 2013 to 2015. As an AARMS Postdoctoral Fellow, he was working at Mount Allison University under the supervision of Geoffrey Cruttwell and Robert Rosebrugh.



Shuaibing Luo graduate from the University of Tennessee-Knoxville with a PhD in Operator Theory and Complex Analysis. He is working as a postdoctoral fellow at Memorial University under the supervision of Jie Xiao.



Viraj Sanghai received his PhD from the University of London on the topic of Using the Post-Newtonian formalism to understand general relativity and its alternatives on cosmological scales. He was based as an AARMS postdoc, at Dalhousie University doing research on theoretical cosmology under the supervision of Dr. Alan Coley.



Daniele Turchetti completed his doctoral studies at the University of Versailles and the Institut de Mathématiques de Jussieu. He held positions at Leiden University, the Max-Planck-Institute for Mathematics, and the University of Caen. He is currently pursuing his research in arithmetic geometry at Dalhousie University and his math communication interests in the framework of AARMS outreach initiatives.



Edward Wilson-Ewing received his PhD from the Pennsylvania State University in 2011. His research interests are in the fields of quantum gravity and cosmology, and he was working with the gravity research group at the University of New Brunswick.

We held our annual postdoctoral fellowship competition in the autumn of 2018. Awards will be made in early spring 2019 and the new postdocs will start in September 2019.

3.3 AARMS Summer School

Summer School
University of Prince Edward Island
June 4 to 29 2018

AARMS

Data Analytics

Functional Analysis for Big Data
Jiguo Cao (Simon Fraser) June 7 to 20

Statistical Analysis for High Dimensional Data
Wenqing He (U Western Ontario) June 18 to 29

Machine Learning and Data Mining
Mark Schmidt (U British Columbia) June 4 to 15

Foundations in Data Science and Applications
Osmar Zaiane (U Alberta) June 4 to 15

**CANSSI
INCASS**

**UNIVERSITY
of Prince Edward
ISLAND**

aarms.math.ca/school2018

The seventeenth AARMS Summer School took place at UPEI in Charlottetown June 4-29, 2018 on the theme of Data Analytics. The Canadian Statistical Sciences Institute (CANSSI) sponsored the participation of five students in the summer school.

Four courses at the beginning graduate level were offered:

Functional Data Analysis for Big Data

Instructor: **Dr. Jiguo Cao (SFU)**

Machine Learning and Data Mining

Instructor: Dr. Mark Schmidt (UBC).

Statistical Learning for High Dimensional Data

Instructor: Dr. Wenqing He (UWO).

Foundations in Data Science and Applications

Instructor: Dr. Osmar Zalane (U of Alberta).

40 students and 4 professionals were admitted. Social activities included an orientation on the first day, a 4-hour bus tour to Borden-Carleton, near the Confederation Bridge and lunch on June 26. After lunch, we took the students on a second four-hour bus tour to North Rustico and Cavendish. Course certificates were sent to students who successfully completed the courses.

3.3.1 Summer School Students

Name	University or home country
Alice Masmontel	Acadia
Ali Farrokhtala	MUN
Clemonell B-Biakana	Ottawa
Chuqio Dong	USA
Di Wang	Acadia
Elham Karimi	MUN
Emile Nadeau	UQAM
Fatemeh Taghdisi	MUN
Gulnara Shavelieva	Sweden
Hanieh Khorasami	MUN
Hoda Rafieipour	MUN
Hamza Qureshi	Calgary
Jabun Nasa	Acadia
Jacob Morehouse	UNB

Jared Keown	Victoria
Jun Wang	MUN
Justin Kamerman	UNB
Jinying Wu	Calgary
Leila Valehzaghard	Dalhousie
Mei Dong	Saskatchewan
Mathew Larade	UPEI
Majid Afshar	MUN
Nafiseh yekta	UNB
Neghmah Shargh	UNB
Ni Zehao	China
Parima Sattari	UNBC
Peng Tang	Victoria
Rebecca Ryan	Dalhousie
Rasoul Shahsavarifar	UNB
Satish Pichika	Windsor
Shahla Ahmadi	UNB
Tushita Patel	Saskatchewan
Trevor Profitt	UPEI
Uyen Thi Banh	Manitoba
Victoria Gaidar	Ukraine
Xin Bian	USA
Youssof Cisskho	Ottawa
Yirong Weng	Waterloo
Yingqi Wang	Calgary
Yuxuan Liu	Carleton
Zachary MacDonald	Toronto

3.4 Workshops and Conferences

3.4.1 Complete Listing

In 2018 AARMS has funded or partially funded the following workshops conferences and events, or has made a commitment to do so.

Canadian Mathematics Society Winter Meeting 2018

Vancouver

December 7, 2018 - December 10, 2018

Science Atlantic Mathematics, Statistics, and Computer Science Conference

Université de Moncton

October 12, 2018 - October 13, 2018

AAC minicourse by Professor Matej Bresar

Memorial University (St. John's Campus)

September 9, 2018 - September 15, 2018

Diversity in Mathematics

Pacific Institute of Mathematical Sciences, Vancouver

August 7, 2018 - August 17, 2018

23rd International Conference on Implementation and Applications of Automata

University of Prince Edward Island

July 30, 2018 - August 8, 2018

20th International Conference on Descriptive Complexity of Formal Systems (DCFS)

St. Mary's University

July 25, 2018 - July 28, 2018

25th International Domain Decomposition Conference

Memorial University (St. John's Campus)

July 22, 2018 - July 27, 2018

Canadian Undergraduate Math Conference 2018

University of Saskatchewan

July 11, 2018 - July 15, 2018

AARMS Industrial Problem Solving Workshop 2018

Dalhousie University
July 3, 2018 - July 6, 2018

18th International Conference on Fibonacci Numbers and Applications

Dalhousie University
July 1, 2018 - July 7, 2018

Theory Canada 13

St. Francis Xavier University
June 7, 2018 - June 9, 2018

Mathematical Foundations of Programming Semantics

Dalhousie University
June 6, 2018 - June 9, 2018

Atlantic General Relativity Workshop and Conference

St. Francis Xavier University
June 5, 2018 - June 7, 2018

Quantum Physics and Logic

Dalhousie University
June 3, 2018 - June 7, 2018

2018 CMS Summer Meeting

University of New Brunswick (Fredericton Campus)
June 1, 2018 - June 4, 2018

26th Foundational Methods in Computer Science Workshop

Mount Allison University
May 31, 2018 - June 2, 2018

AARMS CRG Annual Meeting: Dynamical Systems and Spatial Models in Ecology

University of New Brunswick (Fredericton Campus)
May 31, 2018 - June 1, 2018

Calculus Instruction in Atlantic Canada

Acadia University

May 29, 2018 - May 30, 2018

East Coast Combinatorics Conference

Dalhousie University

May 7, 2018 - May 9, 2018

Tensor Categories and Topological Field Theory

Memorial University (St. John's Campus)

March 5, 2018 - March 9, 2018

3.4.2 AARMS Industrial Problem Solving Workshop



Special mention should be made of the first AARMS Industrial Problem Solving Workshop (IPSW) held at Dalhousie University July 3-6, 2018. The four-day workshop was a great success with over 45 participants (6 industry reps, 28 students, 11 faculty) from across Atlantic Canada and 4 students from outside the region as well! At the start of the workshop, five companies presented mathematical challenges connected to their business. Over the following three days, the participants worked in teams of 5-10 to find solutions to these challenges.

The problems, and the solutions found, spanned a wide range of mathematical, statistical, and computational approaches. The Black Arcs presented an interesting geometric problem of representing the street map of Sackville NB in an accurate but more readable format. The team presented two different solutions, one based on continuous optimization of the location of the

nodes of the graph and another on discrete linear programming. Both hinged on the definition of appropriate fitness functions.

EhEye presented a problem of identifying violent behaviour in surveillance videos. Once again, two approaches were explored. One tracked objects in the video and looked for increases in the velocity of the objects. The second used an array of statistical measures of the video and trained a regression model to detect violence.

A different type of problem was presented by the Fundy Ocean Research Centre for Energy (FORCE). The FORCE problem was focussed on understanding the wake behind an island in Minas Passage, a site being considered for tidal energy development. Students used principal component analysis and image processing techniques to find the bounds of the wake and compare radar observations of the wake to numerical simulations.

QRA's problem drew on methods from what would typically be called pure mathematics, mathematical logic and theoretical computer science. QRA's problem involved improving systems testing their software which uses Satisfiability Modulo Theories (SMT) solvers. The workshop team used a proof-by-induction to establish that one aspect of the software was not performing as expected. "These bugs weren't found by random chance, but rather by the students attempting to prove things about our software, and probing the software when difficulties with the proof were encountered -- proof-directed bug finding!" As a result, QRA "will be making immediate changes to our software as a direct result of what the students found at the workshop" making "our software both more robust, and more capable."

Finally, Stepscan challenged the students to track individuals as they walked across their pressure sensitive floor panels. Students used a variety of metrics based on normal walking patterns and a



probabilistic model to predict the most likely candidate for the subsequent step.

The response from those involved in the workshop was extremely positive. The industry reps commented on the importance of establishing "new connections made with instructors and interested students for future collaborations" and pursuing "an Engage grant to further explore

the problem.” While students commented that: “ The IPSW was a great experience and helped me identify skills that I can contribute in an industrial setting“ and “This was an excellent workshop! Definitely the most useful/interesting one I've attended in all of my academic career.” Based on the post workshop survey results, students were significantly more interested in academic-industry collaborations and were more likely to consider a career outside of academia. Students also recognized the important contribution of our sponsors, NSERC, PIMS and AARMS, noting that “If the workshop was not funded, I would not have been able to attend.” As well, MITACS provided a \$1500 voucher towards an Accelerate Fellowship that was awarded to the EhEye team.

Along with the workshop, AARMS held its first Math/Stats Networking Event called “Formulating Success” in collaboration with Springboard Atlantic and NSERC. At the event, 6 companies and 7 researchers gave presentations on their research and experience with industry-academic collaborations; ACENET described how its resources can support research; and Acadia’s Office of Industry & Community Engagement outlined the many funding programs that support industry-academic research. Over 60 people attended and enjoyed wide-ranging discussions while networking after the presentations.

Overall, the first AARMS IPSW was a busy, productive and successful week. So successful, that planning has already begun for the next one to be held at the University of New Brunswick in May 2019. The workshop will be a full five days, with more time for student training and solution formulation. Keep an eye on the AARMS webpage for more details.

3.4.3 Special Sessions at the CMS Summer Meeting

These events also deserve special mention. The Canadian Mathematical Society (CMS) hosted 14 sessions on specialist topics at their summer meeting in Fredericton between June 1-4, 2018. These sessions were largely made possible by the provision of funding from AARMS to help defray the travel costs associated with the attendance of experts, students and postdocs from across Canada. Sessions were funded with strong links to Atlantic Canada (e.g. organizers or a large number of speakers from the region). The titles of each of the funded sessions were:

- Ergodic Theory, Dynamical Systems, Fractals and Applications
- Geometric Potential Theory
- Combinatorial Game Theory
- Mathematical Epidemiology
- Algebraic Groups and related topics
- Representation Theory of Algebras and Related Topics
- Mathematical Aspects of Quantum Information Theory
- Noncommutative geometry
- Categories and Topology
- Active Learning
- Dynamical systems in Ecology
- PDEs and Variational Problems
- Singularities and Phase Transitions

- Computational and Diophantine Number Theory

3.5 Outreach

In 2018, AARMS has supported the outreach activities described below.

3.5.1 Ongoing Activities

3.5.1.1 Big Data for the Mi'qmaq Elementary and High school Students

An extracurricular program in Big Data for 13 First nations schools in Nova Scotia. Sponsored jointly by Uloonweg, AARMS and CANSSI, the program will deliver 12 hrs of training in 4 sessions to two groups of children, aged 9-10 and 15-17, respectively. A total of 180 First Nations students will be involved and trained. A pilot program for the younger group has been developed and tested with a group of students in May, 2018. Curriculum for the older children has been developed with the assistance of an expert group from University of Toronto and from the Oceans of Data Institute at UCLA, including hands on experience with prepared software and data (CODAP and GapMinder). The Uloonweg project sponsors the development and partial delivery of the program in the schools; funding from AARMS is used to complete the training and delivery.

3.5.1.2 Connecting Math to Our Lives and Communities

A focused after school, in-community mathematics outreach program created for and reaching 200 Mi'kmaw and African Nova Scotian youth annually. The program is built on community relationships and run in full partnership with four Mi'kmaw and three African Nova Scotian communities. Throughout the academic year, St. Francis Xavier University (StFX) students travel to local communities to engage youth in meaningful, hands-on investigations of mathematics related to their everyday lives. A final celebration day provides a culminating experience for all participants on campus at St.FX. The goal of the program is to have students see the role mathematics plays in reading and writing the world, and identify themselves as mathematicians in a way that also honors their ways of being.

3.5.1.3 Enhancing Our Appreciation of Mathematics Through Intentional Community Outreach



An ongoing program for developing public appreciation of mathematics: by creating a recreational mathematics exhibit, displayed in libraries; by implementing a public lecture series in the Fredericton Library; and by interactive visits to schools. Organized by John McLoughlin (staffed by volunteers from the UNB Faculty of Education, UNB).

McLoughlin is also the recipient of the **2013 Adrien Pouliot Award** from the Canadian Mathematical Society in recognition of his outstanding contributions to mathematics education in Canada:

“What is significant about John is his deep humanity and his mentorship of both students and teachers, those with strong ability in the subject as well as those who approach mathematics with caution and nervousness,” said Keith Taylor, President of the Canadian Mathematical Society. “As a professional he is an effective bridge between the worlds of Mathematics and Math Education.”

3.5.1.4 Nova Scotia Math League

Designed to stimulate and challenge high school students across the province, the NSML is based on the very successful Newfoundland Math League which has been running since 1987. The first game was run in Halifax in 2002 by Richard Hoshino and Sarah McCurdy. Since then there has been no looking back.

3.5.1.5 The Math Challenge Club

The club meets once a week at Dalhousie University to have fun with challenging math problems, specifically, teaching the techniques needed to solve math contest problems and work on problems as a group. We hope to see more students from Halifax participating in the international math competitions, such as the APMO (the Asian Pacific Math Olympiad), the European or Asian Girls Math Olympiad, and the IMO (the International Math Olympiad).

3.5.1.6 Acadia Math Outreach with the Annapolis Valley Regional School Board

Based on the Math Circles format and also including groups interested in participating in the Nova Scotia Math League this initiative comprised a variety of outreach activities involving faculty members from Acadia University and school children from different age groups.

3.5.2 Outreach Events

Integration Tournament and Boolean Bash at UPEI

University of Prince Edward Island
March 14, 2018 - March 16, 2018

NB Math League

University of New Brunswick (Fredericton Campus)
March 28, 2018

CMS/UPEI Math Camp

University of Prince Edward Island
May 4, 2018 - May 6, 2018

AARMS-Girl Guides STEM Camp

University of New Brunswick (Fredericton Campus)
May 12, 2018 - May 13, 2018

Blundon Seminar Math Camp

Memorial University (St. John's Campus)
May 16, 2018 - May 18, 2018

StFX Math Camp

St. Francis Xavier University
May 18, 2018 - May 20, 2018

Dalhousie Math Camp for High School Students

Dalhousie University
July 15, 2018 - July 20, 2018

The Ken Ireland Public Lecture: What is a Smart Village?

University of New Brunswick (Fredericton Campus)
September 26, 2018

3.5.3 AARMS-Girl Guides STEM Camp

On May 12-13, 2018, AARMS hosted a camp for over 500 Girl Guides from New Brunswick and Prince Edward Island at the University of New Brunswick's Fredericton campus. The goal of the camp was to expose girls aged 9-17 to the Mathematical Sciences research undertaken at Atlantic Canadian universities such as UNB, as well as to inspire them to consider pursuing careers in STEM (Science-Technology-Engineering-Mathematics).



In addition to the the 500 Guides, Rangers and Pathfinders, around 150 adult volunteers from the Girl Guides of Canada participated. The core of the camp was the 46 unique mini-workshop sessions organizes by 64 University faculty, postdocs and students that covered virtually all of the STEM sub-disciplines. Sessions included "Amateur Radio", "Calendar mathematics and the date of Easter", "Coding with Drones", "Landslides", "Sprucebud worms", and many more.

One of the highlights of the camp was the evening panel discussion, which featured a diverse group of women working in STEM. The panelists included academics of all career stages (undergraduates to professors) as well as women working as industrial scientists in aquaculture

and education. The girls provided an endless supply of questions and seemed to be truly inspired and engaged by the answers from the experts.

Feedback from the event was very positive, with comments such as “this was the best Guiding event I’ve ever attended”, “[we] can’t wait to do this again”, and “the instructors were very passionate about their field of study and were able to relate it to the girls that attended the sessions; they made learning fun!”.



The camp was featured in the [Daily Gleaner and Telegraph-Journal](#) newspapers, in the [Journal-Pioneer](#), and on [Rogers TV](#). The sponsors and partners of the event included the Cyberlaunch Academy, Engineers and Geoscientists of New Brunswick, Let’s Talk Science, NSERC, the Osco

Construction Group, the Quartermain Earth Science Centre, UNB, and Worlds UNBound. Next spring, the camp will move to Dalhousie University.



Income and Expenditure Account 2018

Income (1)

	\$	<u>2017</u>	\$
Carried forward from previous year	354,905		325,478
Mathematical Institutes	71,766		105,000
Universities	89,000		102,000
Provinces	51,000		150,744
NSERC other grants	50,000		0
Other Revenue	3,140		<u>2,131</u>
Total Income	619,811		685,353

Expenditure

Summer School	62,025		96,163
Workshops and Events (2)	82,340		35,624
Outreach (3)	87,617		38,113
PDF Program (4)	55,476		84,316
Collaborative Research Groups (5)	20,000		20,000
Distinguished Lecturers	0		0
Administrator Salary	33,211		31,753
AARMS Online system (6)	5,915		5,962
Travel	3,674		4,435
Office Expenses	2,020		1,083
Dalhousie Overheads	<u>13,000</u>		<u>13,000</u>
Total Expenditure	365,278		330,449
Surplus: Income Less Expenditure	254,533		354,905

Notes

1. For a breakdown see Appendix 1
2. See Appendix 2
3. See Appendix 2

4. See Appendix 3
5. See Appendix 4
6. See Appendix 5



Balance Sheet

31/12/2018

<u>Assets</u>	\$	\$
Surplus from Operations (Income less expenditure)		254,533
Accounts Receivable ¹		
2018 University support	22,000	
2018 Institutes support	30,000	
2018 Provinces support	5,000	
2018 Other	3,225	
2019 University support	106,000	
2019 Institutes Support	90,000	
2019 Provinces support	75,000	
2019 Other	30,000	
	<hr/>	361,225
Total Assets		615,758
<u>Liabilities</u>		
Accounts Payable ²		
2016 Conferences & Workshops	8,500	
2016 CRG in Numerical Analysis	18,000	
2017 Postdocs	17,500	
2017 Conferences & Workshops	4,069	
2017 CRGs	11,929	
2018 Postdocs	70,000	
2018 Conferences & Workshops	14,290	
2018 Outreach	10,710	
2018 CRGs	20,000	
2019 Postdocs	135,550	
2019 Conferences & Workshops	55,820	
2019 Outreach	47,010	
2019 CRGs	40,000	
2019 Summer School	80,000	
2019 Administrator	32,000	
2019 Dal overheads	13,000	
2019 Travel, office, poster expenses	5,000	
2019 Online systems expenses	6,000	
	<hr/>	589,377
Unallocated funds - for AARMS activities		26,381
Total Liabilities		615,758

Notes

1. Fees due to be collected in 2019
2. Funding Commitments in 2019



Annual Accounts 2018

Appendix 1

Revenue Breakdown

Provinces			
New Brunswick	50,000		
Newfoundland (1)	1,000		
Nova Scotia	0		
		<hr/>	51,000
Mathematical Institutes			
CRM	0		
Fields	30,000		
PIMS	37,653		
CANSSI (for Summer School)	4,113		
		<hr/>	71,766
NSERC other grants			
PromoScience	37,500		
Odyssey	5,000		
IPSW support	7,500		
			50,000
Universities			
Acadia	5,000		
Cape Breton	1,000		
Dalhousie	30,000		
Memorial	30,000		
Moncton	0		
Mount Allison	1,000		
Mount Saint Vincent	0		
Saint Francis Xavier	1,000		
Saint Mary's	1,000		
UNB	15,000		
UPEI	5,000		
		<hr/>	89,000
Other Revenue			
book royalties	241		
Girl Guides	2,899		
		<hr/>	3,140
		<hr/>	261,766
	total:		261,766

Notes

1. accounting revision to previous payments from RDC



Annual Accounts 2018

Appendix 2

Workshops and Scientific Events

2016 Combinatorial Algebra / Algebraic Combinatorics	1,000
2017 CAIMS public lecture	4,468
2018 CMS Poster Prize	1,000
2018 Special sessions at CMS Summer meeting	14,343
2018 East Coast Combinatorics Conference	2,842
2018 Theory Canada 13	500
2018 MSRI annual fee	6,266
2018 Diversity in Mathematics	5,000
2018 CIAA	3,000
2018 Atlantic General Relativity	4,600
2018 Dynamical Systems and Spatial Models in Ecology	4,869
2018 DCFS	4,165
2018 Science Atlantic	4,000
2018 Foundational Methods in CS	5,000
2018 IPSW	21,286
total	82,340

Outreach

2017 Annapolis Valley Outreach	533
2017 John McLoughlin Outreach	3,750
2017 NB Math League	485
2018 Girl Guides camp	45,010
2018 AARMS Outreach Coordinator	10,000
2018 Blundon Seminar camp	3,000
2018 Connecting Math to our Lives and Communities	10,000
2018 STFX Math camp	4,247
2018 Dal Math camp	3,200
2018 AARMS Outreach day	2,400
2018 Acadia outreach	2,967
2018 John McLoughlin Outreach	2,025
	87,617



Annual Accounts 2018

Appendix 3

Postdoctoral Fellowships

Viraj Sanghai	9,750
Daniele Gregoris	2,917
Joep Evers	4,375
Chris Duffy	5,100
Marzia Bayeh	17,500
Daniele Turchetti	7,084
Marco de Cesare	8,750
total	55,476

Appendix 4

Collaborative Research Groups

Statistical Learning for Dependent Data	20,000
Dynamical Systems and Spatial Models in Ecology (1)	0
total	20,000

Notes

1. Due to lengthy administrative delays at MUN this cash has not yet been transferred.
but these postdocs and the CRG are up and running



Annual Accounts 2018

Appendix 5

Online System Expenditures

MathJobs Fee	836
Survey Monkey annual fee	264
AARMS website license	30
Wizehive annual fee	4784
total	5,915