CANSSI 2020 Annual Report

Message from the Director

It has been an interesting year. Before the effects of COVID-19 were fully felt, the focus was on organizing the community discussion about the programs that CANSSI will be offering over the next few years. This was in preparation for writing the proposal to the Discovery Institute Support (DIS) Bridge Year program. In addition, we handled a record number of submissions to the Collaborative Research Team (CRT) program, introduced the new Graduate Student Exchange Scholarship (GSES), Rapid Response (RRP, now Research for Social Good (RSG)), and CANSSI Distinguished Postdoctoral Fellowship (CDPF) programs. Additionally, we developed the comprehensive CANSSI Equity, Diversity and Inclusion (EDI) policy and programs. Throughout the year, we also focused on implementing numerous details associated with moving CANSSI operations to Simon Fraser University. But as the year progressed, we spent an increasing amount of effort helping our community deal with the impact of the COVID outbreak, especially with respect to activities receiving CANSSI support.

The travel and human contact restrictions associated with COVID-19 impacted CANSSI programs and supported projects in various ways. CANSSI extended the time frame for every activity running in 2020 by a year. The pandemic had the strongest impact on intermittent events like workshops and conferences. The CRRP had a very strong initial year, but we delayed the GSES program because it is centered around travel and that was not feasible (practically or psychologically) last year. The CRT projects that started in 2020 could not hire the planned HQP nor organize their team-building activities, so started slowly. Other CRT projects encountered a slowdown of months due to the overwhelming nature of the pandemic and the slow conversion to online interaction.

Research

There was an unprecedented number of applications to the Collaborative Research Teams (CRT) program with 15 Letters of Intent from which 7 were invited to submit full proposals. A combination of lower-than-expected spending due to COVID-19 impact and an increase in budget from the DIS Bridge Year award allowed CANSSI to fund 5 new projects. The project titles and universities are listed in Table 1. We list all of the CRT projects in Table 2.

Table 1. CRTs and Canadian Universities of Leads and Collaborators Awarded in 2020
Natural Catastrophes: Are Canadian Insurers Ready for "The Big One", Concordia, Toronto
Statistical machine learning with functional data for assessment and prediction of landscape vulnerability to climate change and land cover development, École de Technologie Supérieure, Montréal, UBC, SFU
Statistical Inference Takes on the Cosmos with CHIME: Big Data, Astrostatistics, and the Fast Radio Burst Enigma, SFU, Toronto
Improving robust high-dimensional causal inference and prediction modelling, Lady Davis Institute for Medical Research, McGill, Toronto, UBC, UQAM, Wilfrid Laurier
CRT In Sports Analytics, Brock, Alberta, Laval, Manitoba, Queen's, SFU, Toronto, UBC, Waterloo

With the selection of the five new projects, we can state in unqualified terms that the Collaborative Research Teams initiative has proved to be a world-leading model for supporting fundamental team-based research in statistical sciences in the context of application. The CRT program provides the infrastructure to seed new interdisciplinary collaborations and train young researchers for future careers.

We report on CRT activities below. We highlight CRT 9, "Statistical Analysis of Large Administrative Health Databases: Emerging Challenges and Strategies," Team Leads: Joan Hu, Robert Platt and Grace Yi, which concluded this year. The project partially supported 4 postdoctoral fellows, 9 Ph.D. students and 1 MSc. student. Five of the trainees accumulated distinctions related to research, including a FRQNT Doctoral Research Scholarship and Thomas O. Pyle Fellowship at Harvard. The project has resulted in 35 manuscripts so far, with 22 published and 3 in revision. Project personnel have given 27 professional talks, including 4 in meetings in other disciplines. The team organized a meeting at Banff that had 39 participants.

Table 2: Collaborative Research Team Projects

	Project	Title
21	2021-2024	Natural Catastrophes: Are Canadian Insurers Ready for "The Big One"
20	2021-2024	Sports Analytics
19	2021-2024	Improving robust high-dimensional causal inference and prediction modelling
18	2021-2024	Statistical Inference Takes on the Cosmos with CHIME: Big Data, Astrostatistics, and the Fast Radio Burst Enigma
17	2021-2024	Statistical machine learning with functional data for assessment and prediction of landscape vulnerability to climate change and land cover development
16	2020-2023	Addressing Spatial and Computational Issues in Integrated Analysis of Modern Ecological Data
15	2020-2023	Modern Techniques for Survey Sampling and Complex Data
14	2019-2022	Statistical methods for the analysis of genetic data with survival outcomes
13	2019-2022	Contingent Capital and Calibration of Capital Structure Models
12	2018-2021	Towards Sustainable Fisheries: State Space Assessment Models for Complex Fisheries and Biological Data
11	2018-2021	Spatial Modeling of Infectious Diseases: Environment and Health
10	2018-2021	Statistical Methods for Challenging Problems in Public Health Microbiology
9	2017-2020	Statistical Analysis of Large Administrative Health Databases: Emerging Challenges and Strategies
8	2016-2019	Joint Analysis of Neuroimaging Data: High-Dimensional Problems, Spatiotemporal Models and Computation
7	2016-2019	Rare DNA Variants and Human Complex Traits: Improving Analyses of Family Studies by Better Modeling the Dependence Structures
6	2015-2018	Evolving Marked Point Processes with Application to Wildland Fire Regime Modeling
5	2015-2018	Statistical Inference for Complex Surveys with Missing Observations
4	2015-2018	Modern Spectrum Methods in Time Series Analysis: Physical Science, Environmental Science and Computer Modeling
3	2014-2017	Statistical Modeling of the World: Computer and Physical Models in Earth, Ocean, and Atmospheric Sciences
2	2014-2017	Advancements to State-Space Models (SSMs) for Fisheries Science
1	2014-2017	Copula Dependence Modeling: Theory and Applications

Training

The great majority of CANSSI's support goes towards training of highly qualified personnel, providing them with the skills and approaches to meet the challenges of research in the future. Young researchers taking part in CANSSI-supported activities have a strong record of success in

finding careers that involve the development and/or the application of research in statistical sciences.

We initiated three new programs that have strong focus on unique training aspects

- CANSSI Distinguished Postdoctoral Fellowship (CDPF)
- Graduate Student Exchange Scholarship (GSES)
- CANSSI Rapid Response Program (CRRP)

The CDPF provides a comprehensive two-year postdoctoral fellowship that will provide young researchers the opportunity to explore potential research careers and to develop the skills needed for future success. GSES scholarships support co-discovery and co-advising, creation of research networks, expansion of research horizons and immersive experience with interdisciplinary research in an academic setting. The RRP (now RSG) program provided trainees with an interest in research that has an impact on society to work closely with people that need high-level statistics research on issues of direct importance to society.

Equity, Diversity and Inclusion (EDI)

CANSSI is committed to accessibility, equity, diversity, and inclusion as the foundation for pursuing excellence and innovation in research and training. EDI is woven through CANSSI operations because diversity is a sine qua non of collaborative and interdisciplinary research. Evolving the CANSSI EDI program was a major topic at the Strategic Retreat held March 2020. Specifically, CANSSI is committed to three goals:

- Improving accessibility of and supporting equitable access to CANSSI support,
- Increasing equitable and inclusive participation in supported activities,
- Integrating activities related to EDI in our programs.

We spent much of the year developing specific plans and mechanisms for pursuing EDI goals that will be rolled out during the coming Bridge Year of the DIS program. The preparation included conducting a systematic survey of the diversity of the people actively involved in CANSSI programs since its inception.

CANSSI EDI will be led by the IDEA (Inclusion, Diversity, Equity, and Accessibility) Committee with membership drawn from across Canada. We will organize townhalls and other mechanisms to ask our community for input into the direction of the program.

CANSSI Programs

Overview

CANSSI is Canada's catalyst for discovery and innovation in the statistical and inferential data sciences. To keep pace with the growing need to extract information from the tremendous amounts of available data, to predict the behavior of complex systems, and to quantify the uncertainty in information and predictions, the demand for statistical and inferential data science research grows daily in many fields. The mission of CANSSI is to support the development, application, and communication of cutting-edge statistical and data science research in the context of tackling engineering, health, scientific, and social challenges.

CANSSI supports a variety of programs designed to build multi-disciplinary research collaborations with a strong statistical foundation and to support new collaborations that link statistical and inferential data sciences to applications. CANSSI is also committed to training the next generation of Highly Qualified Personnel to lead the future development and application of statistical and inferential data science research. Our flagship program of Collaborative Research Teams covers a diverse range of methodology, models, and applications. We support a postdoctoral fellows program and a variety of training opportunities for graduate students. We support a wide array of workshops, conferences and thematic programs. We also support a distinguished visitor program.

Importantly, CANSSI's support is designed to address the challenges of geographic dispersion across Canada and to pursue CANSSI's commitment to equity, diversity, and inclusion.

Collaborative Research Teams

Addressing Spatial and Computational Issues in Integrated Analysis of Modern Ecological Data (2020-2023)

Project leaders: Laura Cowen, Saman Muthukumarana, Simon Bonner
Collaborators: 15 from various disciplines in universities and institutes in Canada and outside Canada.

Notable achievements and activities in 2020 include:

- Mehnaz Jahid, UVic, PhD Student supervised by Cowen, met with Department of Fisheries, obtained sockeye salmon data.
- Hiring of Holly Steeves, Postdoctoral research, October 1, 2020, housed at University of Western Ontario.
- Holly Steeves applied for NSERC postdoctoral funding.
- Mehnaz Jahid, worked on simulation study for stock assessment, sourced covariate data from lighthouse data (sea surface temperature) and from remote sensing data (sea surface temperature, Chloraphyl-a). Studied various ways of combining the time series data through a Bayesian framework, investigated prior parameterizations, and began writing up the manuscript. This work is in collaboration with CRT members Saman Muthukumarana, Wendell Challenger, and collaborator Maycira Costa (Geography, UVic).
- Brittany Halverson-Duncan, UVic, MSc student co-supervised by Cowen and Bonner began exploring N-mixture models and capture-recapture models. She completed a literature review on integrating capture-recapture and chick count data. She began developing the Bayesian model framework.
- Brittany Halverson-Duncan wins 2020 JJEM Graduate Award in Mathematics and Statistics
- Yiran Wang, Waterloo, PhD student supervised by Beliveau, implemented the Bayesian Taku river salmon model. This will be chapter 2 of their thesis.

- Holly Steeves helping to revise two Golden Eagle manuscripts on citizen science and Golden Eagle population trends in the Rocky Mountains with Cowen.
- Wendell Challenger provided the team with anonymized camera trap data collected by several land holders in the Alberta Oil Sands. Holly Steeves began to model this data.
- Saman Muthukumarana applied for adjunct status at UVic (requirement to co-supervise graduate students).
- Johanna de Haan Ward, Western, PhD student supervised by Bonner joined the journal club meetings and will begin working on the Bird Study project in 2021.

Cumulative Project Presentations

	Presenter & co-authors	Talk or poster	Date DD/MM/YY	Meeting	Location	Title
1.	Inesh Munaweera	Talk	20/05/2020	Annual Team Meeting	Virtual	Lake Winnipeg Fish Movement Analysis
2.	Mehnaz Jahid	Talk	20/05/2020	Annual Team Meeting	Virtual	Integrating remote sensing data into fish stock assessment
3.	Jason Fisher	Talk	21/05/2020	Annual Team Meeting	Virtual	Camera traps with hair snag studies
4.	Brittany Halverson-Duncan	Talk	21/05/2020	Annual Team Meeting	Virtual	Ancient Murrelet capture-recapture and count data
5.	Wendell Challenger	Talk	22/05/2020	Annual Team Meeting	Virtual	Open questions and new frameworks for camera trap modelling
6.	Laura Cowen	Talk	22/.5/2021	Annual Team Meeting	Virtual	What does Taku and COVID-19 have in common?

Postdoctoral Fellow

Name	**Supervisor**	**Research Topic**	**Completed**	**Current Position**
Holly Steeves				**Postdoctoral Fellow**

Modern Techniques for Survey Sampling and Complex Data (2020-2023)

Project leaders: David Haziza (University of Ottawa, Canada) and Changbao Wu (University of Waterloo, Canada)
Collaborators: 9 from various disciplines in universities and institutes in Canada, US, China and France.

Notable achievements and activities in 2020 include:

- David Haziza and Song Cai recruited a PhD student Howard He who started at the University of Ottawa in September 2020.
- Changbao Wu recruited two PhD students Qianlin Song and Jingyue Huang who started at the University of Waterloo in September 2020.
- Yilin Chen started a 4 month postdoc on October 1, 2020 under the supervision of Changbao Wu at the University of Waterloo.

Cumulative Project Presentations

	Presenter & co-authors	Talk or poster	Date DD/MM/YY	Meeting	Location	Title
1.	**Mehdi Dagdoug**, Camelia Goga and David Haziza	Talk	21/12/2020	CMStatistics 2020	Virtual	Model-assisted estimation through random forests in finite population sampling
2.	Changbao Wu	Talk	11/09/2020	JJSM 2020	Virtual	Empirical likelihood and estimating equations for survey data analysis
3.	Jae Kwang Kim	Talk	11/09/2020	JJSM 2020	Virtual	Statistical data integration in survey sampling: a review
4.	David Haziza	Talk	11/09/2020	JJSM 2020	Virtual	Variance estimation procedures in the presence of singly imputed survey data: a critical review

Cumulative Project Papers

	Authors (Month/year) Title. *Journal* Volume (Issue), Page numbers. doi
1.	Chen, Y., Li, P. and Wu, C. (2020). Doubly robust inference with non-probability survey samples. *Journal of the American Statistical Association*, 115, 2011-2021.
2.	Dagdoug, M., Goga, C. and Haziza, D. (2021). Imputation procedures in surveys using nonparametric and machine learning methods: an empirical comparison. *To appear in Journal of Survey Statistics and Methodology*.
3.	Wu, C. and Thompson, M.E. (2020). Empirical likelihood and estimating equations for survey data analysis. *Japanese Journal of Statistics and Data Science*, 3, 565-581.

Cumulative HQP

PhD Students

	Authors (Month/year) Title. Etc.
1.	Chen, Y. (2020). Statistical Analysis with Non-probability Survey Samples. PhD Dissertation, Department of Statistics and Actuarial Science, University of Waterloo.
2.	Hellingman, S., Wang, Z and Thompson, M. (2020) *Chosen for Success: Impacts of rule changes on the MLS Superdraft.* Submitted to *Journal of Sports Analytics.*
3.	Hellingman, S., Wang, Z and Thompson, M. (2020). *Generalized multilevel models for analyzing major league soccer superdraft.* In progress.
4.	Dagdoug, M., Goga, C. and Haziza, D. (2020). Model-assisted estimation in high-dimensional settings for survey data. *In revision for Journal of Applied Statistics*.
5.	Dagdoug, M., Goga, C. and Haziza, D. (2020). Model-assisted estimation through random forests in finite population sampling. *In revision for the Journal of the American Statistical Association*.
6.	Kim, J.K., Park, S., Chen, Y. and Wu, C. (2020). Combining non-probability and probability survey samples through mass imputation. *Journal of the Royal Statistical Society, Series A*, revision submitted.

Statistical Analysis of Large Administrative Health Databases: Emerging Challenges and Strategies

Project leaders: Grace Y. Yi (University of Waterloo), Robert Platt (McGill University) and X. Joan Hu (Simon Fraser University)
Collaborators: 7 faculty in universities in Canada

(no report sent in 2020 due to the impact of COVID)

Notable achievements and activities in 2020 include:

- This group continued their weekly Data Science Research Group Meetings online. The group includes 5 PhD students, 2 PDFs, 2 MSc students, 1 undergraduate student, 1 visitor, and 3 faculty members (Grace Yi, Wenqing He and Liqun Diao).
- A 2020 JSM Invited Session included team members from this CRT. It was called Various Challenges and Strategies in Analysis of Real-Life Data; Chair: Wendy Lou; Speakers: Robert Platt, Wenqing He, Grace Yi, Li-Pang Chen, Joan Hu, Yi Xiong, John Braun, Rhonda Rosychuk.

HQP:

Name	**Level**	**Date**	**University**	**Supervisor**	**Title/Description**	**Current Position**

Di Shu	PhD	May-2018	University of Waterloo	Grace Yi	Causal Inference with Measurement Error	Postdoctoral fellow at Harvard Medical School and Harvard Pilgrim Health Care Institute
Li-Pang Chen	PhD	Aug-2019	University of Waterloo	Grace Yi	Survival Analysis of Complex Featured Data with Measurement Error	Postdoctoral fellow at the University of Western Ontario
Xin (Shane) Liu	PDF	Feb-Jul 2018	University of Waterloo	Grace Yi	Ensembling Imbalanced-Spatial-Structured Support Vector Machine	Assistant professor at Shanghai Finance and Economics University, China
Xin (Shane) Liu	PDF	Aug 2018-Jan 2019	Simon Fraser University	Grace Yi and Joan Hu	Using CCHS data to assist prediction for federal election	
Dongdong Li	PhD	Dec-2018	Simon Fraser University	Joan Hu	Statistical Inference Using Large Administrative Data on Multiple Event Times, with Applications to Caner Survivorship Research	Postdoctoral research fellow at Harvard Medical School
Qian (Emma) Wen	MSc	Sep-2019	Simon Fraser University	Joan Hu	Prediction for Canadian Federal Election Aided by Canadian	Instructor at Langara College, Vancouver, BC

					Community Health Survey	
Gabrielle Simoneau	PhD	Sep-2019	McGill University	Robert Platt	Towards an accessible methodology in precision medicine: methods for censored data and non-regular inferences	Senior Biostatistician at Biogen, Montreal, QC
Junhan Fang	PhD	in progress	University of Waterloo	Grace Yi	Matrix-Variate Regression with Measurement Error	to Join Yale University as a postdoctoral fellow in September 2020
Qihuang Zhang	PhD	in progress	University of Waterloo	Grace Yi	Accommodating Measurement Error in Analysis of Genomics Data	PhD student
Menglan Pang	PhD	2020	McGill University	Robert Platt and Michal Abrahamowicz	Flexible Semiparametric Accelerated Failure Time Model for Survival Analysis	Senior Biostatistician at Biogen, Montreal, QC
Steve Ferreira Guerra	PhD	in progress	McGill University	Robert Platt and Michal Abrahamowicz		
Yi Xiong	PhD	Aug-2020	Simon Fraser University	Joan Hu and W. John Braun	Spatio-Temporal Analysis, with Application to Wildfire Management	To join the Data Science Center at Zhejian University as an Assistant Professor
Qi Cui	PDF	Feb 2019 - Jan 2020	Simon Fraser University	Joan Hu	Spatio-Temporal Analysis, with	Assistant Professor at Changchun

					Application to MHED	Technology University
Asad Haris	PDF	in progress	McGill University	Robert Platt and Grace Yi		

Talks

Title	**Journal**	**Date**	**Author 1**	**Author 2**
R Package for Analysis of Data with Mixed Measurement Error and Misclassification in Covariates: augSIMEX	Journal of Statistical Computation and Simulation, 89, 2293-2315	May-2019	Qihuang Zhang	Grace Yi
Multiclass Analysis and Prediction with Network Structured Covariates	Journal of Statistical Distributions and Applications, 6:6	Jun-2019	Li-Pang Chen	Grace Yi
ipwErrorY: An R Package for Estimating Average Treatment Effects with Outcome Misclassification	The R Journal, 11:1, pages 337-351	Aug-2019	Di Shu	Grace Yi
Support Vector Machine with Graphical Network Structures in Features	The 15th International Conference on Machine Learning and Data Mining (MLDM 2019)	Jul-2019	Wenqing He	Grace Yi
Weighted Causal Inference Methods with Mismeasured Covariates and Misclassified Outcomes	Statistics in Medicine, 38, 1835-1854	May-2019	Di Shu	Grace Yi
Inverse-Probability-of-Treatment Weighted Estimation of Causal Parameters in the Presence of Error-Contaminated and Time-Dependent Confounders	The Biometrical Journal, 61,1507-1525	Aug-2019	Di Shu	Grace Yi
Estimation of Causal Risk Measures in the Presence of Measurement Error in Confounders	Statistics in Biosciences, Springer;International Chinese Statistical Association, vol. 10(1), pages 233-254	Apr-2018	Di Shu	Grace Yi
Causal inference with noisy data: Bias analysis and estimation approaches	Statistics in Medicine, 39(4), 456-468	Dec-2019	Di Shu	Grace Yi

to simultaneously addressing missingness and misclassification in binary outcomes				
Multiple event times in the presence of informative censoring: modeling and analysis by copulas	Lifetime Data Analysis, 26, 573–602	Nov-2019	Dongdong Li	Joan Hu
Cox Regression of Clustered Event Times with Covariates Missing Not at Random	Scandinavian Journal of Statistics, 46(4), 1315-1346	Aug-2019	Li Liu	Yanyan Liu
Estimation under Cox Cure Model with Covariates Missing Not at Random, with Application to Disease Screening/Prediction	Canadian Journal of Statistics, Online Version of Record before inclusion in an issue	Apr-2020	Lisha Guo	Yi Xiong
Non-regular inference for dynamic weighted ordinary least squares: understanding the impact of solid food intake in infancy on childhood weight	Biostatistics, 19(2),233-246	Apr-2018	Gabrielle Simoneau	Erica Moodie
Estimating optimal dynamic treatment regimes with survival outcomes	Journal of the American Statistical Association	Jul-2019	Gabrielle Simoneau	Erica Moodie
Adaptive Treatment Strategies with Survival Outcomes: An Application to the Treatment of Type 2 Diabetes using a Large Observational Database	American Journal of Epidemiology, Volume 189, Issue 5, May 2020, Pages 461–469	Jan-2020	Gabrielle Simoneau	Erica Moodie
Ensembling Imbalanced-Spatial-Structured Support Vector Machine	Econometrics and Statistics, In Press, Corrected Proof	May-2020	Xin Liu	Grace Yi
Matrix-variate Logistic Regression with Measurement Error	Biometrika, Accepted Manuscript	Jul-2020	Junhan Fang	Grace Yi
Semiparametric Methods for Left-Truncated and Right-Censored Survival Data with Covariate Measurement Error	Annals of the Institute of Statistical Mathematics	Jun-2020	Li-Pang Chen	Grace Yi

Towards Sustainable Fisheries: State Space Assessment Models (SSAMs) for Complex Fisheries and Biological Data

Project leader: Joanna Mills Flemming (Dalhousie University)
Collaborators:

- William Aeberhard (WA)-Swiss Data Science Center, ETH Zurich, Switzerland.
- Chris Field (CF) -DAL.
- Marie Auger-Methe (MAM)-University of British Columbia, British Columbia, Canada.
- Eva Cantoni (EC}-University of Geneva, Geneva, Switzerland.
- Anders Nielsen (AN)-Technical University of Denmark (DTU), Copenhagen, Denmark.
- Louis-Paul Rivest (LPR)- Universite Laval (UL), Quebec, Canada.

2020 began with PhD student trainee Jonathan Babyn (JB) returning to DAL from the Northwest Atlantic Fisheries Centre (DFO) in St. John's where he successfully contributed to the framework review for the cod stock off the south coast of Newfoundland (3Ps cod). This stock had been assessed with a survey based (SURBA) model, and JB was tasked with helping to develop a state-space assessment model (SSAM) to better deal with catch uncertainty and integrate more of the available data.

Notable achievements and activities in 2020 include:

- PhD student trainee JB, along with WA, NC, EC and JMF participated in a workshop on the "Review and Future of State Space Stock Assessment Models in ICES" which took place January 21st-23rd at The International Council for the Exploration of the Seas (ICES) in Copenhagen, Denmark. JMF had originally planned to attend in person alongside NC but it proved too difficult to get there (and back) efficiently. JB and EC also attended remotely. WA gave a talk and participated in subsequent reporting.
- On February 25th and 26th, JMF served as a reviewer of a framework for the assessment of snow crab in the Maritimes Region of Canada. She was invited by DFO Maritimes Region Centre for Science Advice (CSAM). The meetings were held at Northwest Atlantic Fisheries Organization (NAFO) Headquarters in Nova Scotia. Yihao Yin (Research Assistant from our previous CRT) was also in attendance.
- Notably, Yihao Yin is now employed full time by DFO. He works closely with collaborators DK and JS to develop SSAMs for select Atlantic Canadian fish stocks.
- During the first quarter of 2020 JMF revised her proposal to establish CANSSI Atlantic at DAL. These revisions reflected input from the Vice President of Research and Innovation at DAL.
- Regular in-person meetings of student trainees and their supervisory committees occurred until the middle of March. The arrival of COVID-19 sent all CRT members scrambling to setup home offices.
- PhD student trainees Ethan Lawler and JB, as well as PDF Yuan Yan, all gained valuable teaching experience during this period by offering undergraduate statistics courses online for DAL.
- MSc student trainee Raphael McDonald successfully defended his thesis on July 27th• It was titled "Developing a new spatio-temporal framework for assessment of the Nova Scotia inshore sea scallop (Placopecten Magellanicus) fishery." Shortly thereafter he

commenced a term position at the BIO in Dartmouth, NS. Raphael submitted one paper coming out of his thesis and has another in preparation.

- PhD student trainee JB successfully defended his thesis proposal on September 29th. It proposed the development of new statistical methods to expand the statistical tools available to fisheries researchers for increased precision, better use of available data and new insights. JB completed two manuscripts, the first of which was written in collaboration with his supervisors at the Northwest Atlantic Fisheries Centre. The second manuscript proposed a novel approach to developing spatial age-length keys and is currently in revision with Fisheries Research.
- MSc student trainee Jiaxin Luo successfully defended her thesis on December 8th• It was titled "Novel statistical analyses of longline survey data for improved indices of Atlantic Halibut abundance." Jiaxin was offered a three-month contract with the Northwest Atlantic Fisheries Centre (DFO) which will begin in January 2021. She is concurrently preparing one paper that reflects the contributions of her thesis.
- On December 5th, PDF Yuan Yan learned that the Canadian Journal of Fisheries and Aquatic Sciences had requested a revision of her manuscript titled "Spatiotemporal modeling of bycatch data: methods and a practical guide through a case study in a Canadian Arctic fishery." Yuan Yan continues to work with Margaret Treble, and more recently HB, to develop a data aggregation approach for mature-at-length data derived from fishery surveys in the Canadian Arctic.
- During this time all student trainees associated with this project continued to have regular meetings with their supervisory committees via Zoom or Skype. The limited number of cases of COVID-19 in Nova Scotia during this time window also allowed for outside, in person meetings of DAL based CRT members.
- On the west coast of Canada, MAM saw her PhD student trainee Joe Watson successfully defend his thesis in December. He is continuing work on this project with AE and will likely commence a PDF with DFO in early 2022.
- LPR hired an undergraduate student, Ariane Boivin. She was awarded an NSERC undergraduate scholarship and was supervised by LPR and HB.

Presentations and publications (cumulative)

C1: Presentations of team members related to the project (cumulative)

	Presenter & co-authors	Talk or poster	Date DD/MM/YY	Meeting	Location	Title
	William Aeberhard	Invited Talk	22/01/20	ICES Workshop on the Review and Future of State Space Stock Assessment Models	Copenhagen, Denmark	Flexibility and Robustness Considerations in Building State Space Assessment Models
1.	Kim Whoriskey	Contributed Talk	23/06/20	International Statistical Ecology Conference	Sydney, Australia (virtual)	Iteratively fitting switching state-space models to animal tracking via maximum likelihood estimation
2.	Ethan Lawler	Contributed Talk	22/03/20	ENAR Spring Meeting	Nashville, Tennessee, USA (virtual)	Where did all the fish go? Spatio-temporal modelling of research vessel data with R
3.	Joanna Mills Flemming	Invited Talk	23/10/20	Faculty of Science Seminar Series, University of Manitoba	Winnipeg, Manitoba, Canada (virtual)	Using genetic information to estimate the size of Brook Trout populations
4.	Joanna Mills Flemming	Invited Talk	27/10/20	Department of Statistics Seminar Series, University of Notre Dame	Notre Dame, Indiana, USA (virtual)	A new approach to estimating population size for marine species
5.	Yuan Yan	Invited e-Poster	20/11/19	KAUST Statistics and Data Science Workshop	Saudi Arabia	Spatial Analysis of Bycatch in a Canadian Arctic Fishery
6.	Noel Cadigan & Andrea Perrault	Invited Talk	15/11/19	ICES Workshop to develop guidelines for addressing catch forecasts from biased Assessments.	Woods Hole, MA, USA	Accounting for retrospective patterns in state-space stock assessment models
7.	Jonathan Babyn	Invited Talk	04/11/19	The Center for the Advancement of Population Assessment Methodology (CAPAM)	Wellington, New Zealand	A New Approach to Generating Spatial Age-Length Keys Based on Using

Publications of team members related to the project (cumulative)

	Authors (Month/year) Title. Journal Volume (Issue), Page numbers. doi
1.	William Aeberhard, Eva Cantoni , Chris Field, Hans Kuensch, and Joanna Mills Flemming. (2020). Robust estimation for discrete-time state space models, Scandinavian Journal of Statistics. URL: https://doi.org/10.1111 /sjos.1 248 2.
2.	Nan Zheng, Noel Cadigan , and Joanne Morgan. (20 20). A Spatiotemporal Von Bertalanffy Growth Model and Its Estimation When Data are Collected Through Length-Stratified Sampling. Environmental and Ecological Statistics. In press. https://doi.org/10.1007/s106 51-0 20-00 4 50-8 .
3.	Rajeev Zumar, Noel Cadigan, Nan Zheng, Divya Varkey, and Joanne Morgan. (2020). A state- space spatial survey-based stock assessment (SSURBA) model to inform spatial variation in relative stock trends and performance. Canadian Journal of Fisheries and Aquatic Sciences. In press.
4.	Nan Zheng , George Robertson, Noel Cadigan, Fan Zhang , Laura Wheeland , and Joanne Morgan. (2020). Spatiotemporal variation in maturation: A case study with American plaice (Hippoglossoides platessoides) on the Grand Bank of Newfoundland. Canadian Journal of Fisheries and Aquatic Sciences. In press.
5.	Andrea Perreault, Laura Wheeland , Joanne Morgan , and Noel Cadigan. (20 20). A state-space stock assessment model for American plaice on the Grand Bank of Newfoundland. Journal of Northwest Atlantic. Fishery Science. htt ps:/ /doi.org/ 10.29 60 /J.v5 1.m727 .
6.	Benia Nowak, Don Bowen, Kim Whoriskey, Damian Lidgard, Joanna Mills Flemming, and Sara Iverson. (2020). Foraging behaviour of a continental shelf marine predator, the grey seal (Halichoerus grypus), is associated with in situ, subsurface oceanographic conditions. Movement Ecology, 8:41.
7.	Paul Regular, Gregory Robertson, Keith Lewis, Jonathan Babyn, Brian Healey and Fran Mowbray. (20 20). SimSurvey: An R package for comparing the design and analysis of surveys by simulating spatially correlated populations. PLOS ONE htt ps:/ /doi.org/ 10.137 1/journal.pone.0 2 328 22.
8.	Yuan Yan , Margaret Treble, Eva Cantoni , Chris Field and Joanna Mills Flemming. (20 20). Spatiotemporal modeling of bycatch data: methods and a practical guide through a case study in a Canadian Arctic fishery. In revision with The Canadian Journal of Fisheries and Aquatic Sciences.
9 .	Jonathan Babyn, Divya Varkey, Paul Regular, Joanna Mills Flemming. (20 20). Gaussian Field Approach to Generating Spatial Age Length Keys. In revision with Fisheries Research.
10.	Andrea Perreault, Nan Zheng , and Noel Cadigan. (2020). Estimation of growth parameters based on length-stratified age samples. Canadian Journal of Fisheries and Aquatic Sciences. In press.

11 .	Fan Zhang, Rick Rideout, and Noel Cadigan. (2020). Spatiotemporal variation in juvenile mortality and cohort strength of Atlantic cod (Gadus morhua) off Newfoundland and Labrador. Canadian Journal of Fisheries and Aquatic Sciences. In press.
12.	Kim Whoriskey, Eduardo Martins, Marie Auger- Methe, Lee Gustowsky, Rob Lennox, Steve Cooke , Matt Power, and Joanna Mills Flemming. (20 19). Current and emerging statistical techniques for aquatic telemetry data: A guide to analyzing spatially discrete animal detections . Methods in Ecology and Evolution.
13.	Ethan Lawler, Kim Whoriskey , Chris Field, and Joanna Mills Flemming. (20 19). The conditionally autoregressive hidden Markov model (CarHMM): Inferring behavioural states from animal tracking data exhibiting conditional autocorrelation. Journal of Agricultural, Biological and Environmental Statistics.
14.	Yihao Yin , William Aeberhard , Stephen Smith, and Joanna Mills Flemming. (20 18). Identifiable state-space models: A case study of the Bay of Fundy sea scallop fishery. Canadian Journal of Statistics, doi: 10.100 2/cjs.114 70
15.	William Aeberhard , Joanna Mills Flemming, and Anders Nielsen. (2018). Review of State- Space Models for Fisheries Science. Annual Review of Statistics and Its Application 5, 21 5-235. doi: 10.1146/ annurev-statistics-031017-100427

Other writing of team members related to the project: (reports, papers submitt ed, papers in progress) (updated)

	Authors (Month/year) Title. Etc.
1.	Jiaxin Luo , Nell den Heyer, Bruce Smith , Brenda Wringe, Yuan Yan, Joanna Mills Flemming. (2021). Novel Statistical Analyses of Longline Survey Data for Improved Indices of Atlantic Halibut Abundance . In preparation.
2.	Kim Whoriskey , Chris Field, Don Bowen, Ethan Lawler , Jonathan Babyn, Mike Hammil, Nell den Heyer, and Joanna Mills Flemming. (2021). Concurrent prediction of location and behavioural states reveals colony-specific foraging tactics of adult female grey seals. To be submitted to *Ecological Monographs.*
3.	Kim Whoriskey, Baktoft, Chris Field, Rob Lennox, Jonathan Babyn, Ethan Lawler, and Joanna Mills Flemming. (2021). Predicting aquatic animal movements and behavioural states in continuous-time from acoustic detections. To be submitted to *Methods inEcology and Evolution.*

4.	Ethan Lawler, Chris Field and Joanna Mills Flemming. (2021). staRVe: An R package for analyzing spatio-temporal point-referenced data. To be submitted to the Journal of Statistical Software.
5 .	Raphael McDonald, David Keith, Jessica Sameoto , Jeffrey Hutchings, and Joanna Mills Flemming. (2021). Incorporating intra-annual variability in stock assessment models to better capture population dynamics. To be submitted to Fisheries Research.
6.	Raphael McDonald, David Keith , Jessica Sameoto , Jeffrey Hutchings, and Joanna Mills Flemming. (2021). Applying a new spatio-temporal state-space stock assessment model for the Nova Scotia Inshore Sea Scallop (Placopecten magellanicus) Fishery. To be submitted to the ICES Journal of Marine Science.
7.	I Hurley, Dan Boyce, J Bl anchard, E Nicholson, Raphael McDonald , Boris Worm , and Derek Titt ensor. (2021). Evaluating the utility of the IUCN's ecosystem risk assessment framework or open water ecosystems. To be submitted to Conservation Letters.
8.	Yihao Yin, David Keith, Jessica Sameoto and Joanna Mills Flemming. (2021) A Spatiotemporal Model of the Shell Height-Meat Weight Relationship for Bay of Fundy Sea Scallops. To be submitted to the Canadian Journal of Fisheries and Aquatic Sciences.
9 .	Hugues Benoit, and Noel Cadigan . (2021). Model-based estimation of commercial-sized snow crab (Chionoecetes opilio) abundance in the southern Gulf of St. Lawrence, 1980- 2012, using data from two bottom trawl surveys. In preparation.
1O.	Benoit Ariane and Louis-Paul Rivest. (2021). A spatio-temporal investigation of a cod stock in the Gulf of St-Lawrence. In preparation.

Spatial Modeling of Infectious Diseases: Environment and Health

Project leader: Mahmoud Torabi (University of Manitoba)
Collaborators: Charmaine Dean (University of Waterloo), Mike Pickles (University of Manitoba), Rob Deardon (University of Calgary), Rhonda Rosychuk (University of Calgary), Cindy Feng (University of Saskatchewan), Subhash Lele (University of Alberta), and Erin Rees (Université de Montréal)

This project began in 2018. The team so far has recruited four highly qualified personnel and plans to recruit more postdoctoral fellows and graduate students. They have given five talks and published two peer-reviewed papers. In 2020, the team successfully got two prestigious grants related to the COVID-19 pandemic:

- Torabi M (PI), Deardon R, Ogden N, Loeppky C, Guidolin L, Dean C, Rosychuk R, Rees E, Feng C. Modeling of COVID-19 Pandemic in Canada: Projection and Interventions, NSERC Alliance COVID-19, 2020-2021, $50,000.
- Torabi M (PI), Deardon R, Loeppky C, Guidolin L. Projection of COVID-19 Pandemic and Possible Interventions in Manitoba, Research Manitoba COVID-19 Rapid Response Grant, 2020-2021, $68,500.

Notable achievements and activities in 2020 include:

- Dr. Torabi is now an Elected Member of ISI (International Statistical Institute) and Dr. Dean is now a member of PHAC Covid-19 Expert Modelling Group.
- They had a very successful workshop from June 8-12, 2020 remotely. We had more than 25 invited speakers from all around the world and with more than 400 participants.
- They organized an invited session at the Joint Statistical Meetings (JSM) in Philadelphia, USA (Aug 1-6, 2020) entitled "Recent Advances in Statistical Modeling of Infectious Diseases" with speakers from our team (Drs. Deardon, Dean, Feng, and Amiri (post-doc)).
- They organized an invited session at the SSC in Ottawa (May 31-June 3, 2020) entitled "Recent Advances in Statistical Modeling of Infectious Diseases", however, it was cancelled due to the COVID-19 pandemic.
- Leila Amiri is continuing her postdoctoral fellowship at the University of Manitoba
- Georges Bucyiburata began his postdoctoral fellowship at the University of Waterloo.
- Md Mahsin continues his PhD student at the University of Calgary
- Tingxuan Wu began work towards a PhD at the University of Saskatchewan.
- The team met in 2019 for a workshop at the University of Calgary during the SSC Meetings and they are planning a 5-day workshop at the Fields Institute (FI) in Toronto from June 8-12, 2020. Their workshop application to the FI was successful and the FI will provide $21,500 for the workshop costs in addition to the venue. They are planning to invite 34 world-renowned speakers for this event.
- Notable talks given by team members include:
  - *Advancing Knowledge about Spatial Modeling, Infectious Diseases, Environment and Health* by Torabi in March in Winnipeg
  - *A New Class of Spatiotemporal Individual-Level Models for Infectious Diseases Transmission* by Mahsin and Deardon in May in Calgary
  - *Geographically-Dependent Individual-Level Models for Infectious Diseases Transmission* by Mahsin and Deardon in August, September and December in Glasgow (Scotland), Calgary, and Dhaka (Bangladesh)

Publications of team members related to the project (cumulative)

	Authors (Month/year) Title. *Journal* Volume (Issue), Page numbers. doi

1.	Amiri L, Torabi M, Deardon R, and Pickles M (2020). Spatial modeling of individual-level infectious disease transmission: tuberculosis data in Manitoba, Canada, *Statistics in Medicine*, to appear.
2.	Mahsin MD, Deardon R, and Brown P (2020). Geographically dependent individual-level models for infectious diseases transmission. *Biostatistics*; doi:10.1093/biostatistics/kxaa009.

Other writing of team members related to the project: (reports, papers submitted, papers in progress) (updated)

	Authors (Month/year) Title. Etc.
1.	Amiri L, Torabi M, and Deardon R (2020). Spatial modeling of infectious diseases with covariates measurement error, submitted.
2.	Dean, Renouf, Feng, Zhang, Zhang, Wang (2020). A logistic growth model with logistically varying carrying capacity for Covid-19 deaths using data from Ontario, Canada, under revision in Springer Proceedings for Fields Covid-19 Seminars.
3	Dean, Renouf, Feng, Zhang, Zhang, Wang (2020). Joint Modeling of Hospitalization and Mortality of Ontario Covid-19 cases, under revision in Springer Proceedings for Fields Covid-19 Seminars.

Statistical Methods for Challenging Problems in Public Health Microbiology

Project leaders: Leonid Chindelevitch (Simon Fraser University), Alexandre Bouchard-Côté (University of British Columbia), and Liangliang Wang (Simon Fraser University)

Collaborators: Art Poon, Department of Pathology and Laboratory Medicine, University of Western Ontario, Jesse Shapiro, Department of Biological Sciences, Université de Montréal, Shijia Wang, Nankai University

This project has not proceeded as anticipated due to the personal situations of the three leads. Project lead Chindelevitch is on an extended sabbatical lead that has diminished his engagement with the project. Project co-leads Bouchard-Côté and Wang have been on parental leave during the past year. This has prevented the project from becoming fully operational, especially with regards to recruiting the complete team of HQP proposed for the project. Unfortunately, with the NSERC funding for institutes during the current cycle ending, we could not be flexible about extension of expenditure deadlines. Therefore, we have

implemented the CANSSI policy about expenditures and re-captured some of the project funding for use on other activities and this project ended.

So far, the project team members have given 14 presentations at professional meetings related to the CRT project and have published three papers in peer-reviewed journals and proceedings. The team has involved eight highly qualified personnel in research related to the project.

Notable achievements and activities in 2020 include:

Session organizer at BayesComp 2020, to be held January 7--10 2020 in Gainesville, Florida
CFI Innovation Grant (currently under embargo; Bouchard-Côté as co-applicant, Single Cell Dynamics Observatory, $5,992,026)
Regular bi-weekly Zoom meetings (L. Wang, A. Bouchard-Côté, S. Wang)

- PIMS-UBC Mathematical Sciences Young Faculty Award (Bouchard-Côté)
- Early tenure awarded, with promotion to Associate Professor (Leonid Chindelevitch)
- Newly established collaboration with Dr. Mark Brockman, joint CIHR grant (Leonid Chindelevitch): Harnessing cross-reactive T cells to eliminate latent HIV reservoirs.
- Participation in the CANSSI CRT Workshop. March 30-March 31, 2019. SFU
- HQP recruited and involved with the project include
    - Kevin Chern (MSc),
    - Miguel Biron (PhD),
    - Vittorio Romaniello (PhD),
    - Doig (MSc),
    - Jingxue Feng (PhD),
    - Jiarui Zhang (PhD),
    - Mohammad Hossein Rezaie (MSc),
    - Amir-Hosein Safari (MSc)

Presentations of team members related to the project (cumulative)

	Presenter & co-authors	Talk or poster	Date	Meeting	Location	Title
1.	Alexandre Bouchard-Côté	Talk	11/2019	Rutgers University Statistics Seminar	Neward, USA	Scalable approximation of integrals using non-reversible methods
2.	Alexandre Bouchard-Côté	Talk	12/2019	VanML	Vancouver, Canada	Large-scale single-cell tree reconstruction

3.	Alexandre Bouchard-Côté	Talk	2/2019	Phyloseminars	Vancouver, Canada	Advances in computational Bayesian methods and their use in large-scale single-cell tree reconstruction
4.	Alexandre Bouchard-Côté	Talk	11/2018	BIRS	Banff, Canada	Non-reversible parallel tempering
5.	Alexandre Bouchard-Côté	Talk	6/2018	International Symposium on Bayesian Analysis	Edinburgh, UK	Non-Reversible Monte Carlo methods
6.	Liangliang Wang	Talk	01/2020	Bayes Comp 2020	Gainesville, US	Sequential Monte Carlo methods for Bayesian phylogenetics
7.	Liangliang Wang	Talk	12/2019	Research School of Finance, Actuarial Studies and Statistics 2019 Summer Research Camp	Canberra, Australia	An annealed sequential Monte Carlo method and its applications
8.	Liangliang Wang	Talk	07/2019	The 12th International Conference on Monte Carlo Methods and Applications	Sydney, Australia	An Annealed Sequential Monte Carlo Method for Bayesian Phylogenetics
9.	Liangliang Wang	Talk	08/2018	JSM	Vancouver, Canada	Bayesian inference for phylogenetic trees and networks

10.	Alexandre Bouchard-Côté	Talk	11/11/20	BIRS	Virtual	Phylogenetic inference with a distribution continuum
11	Alexandre Bouchard-Côté	Talk	21/9/20	BC CHR epidemiology Workshop	Virtual/BC CHR	Real-time phylogenetic inference
12	Leonid Chindelevitch	Talk + Poster	10/11/18	Wellcome Trust workshop: Antimicrobial Resistance – Genomes, Big Data and Emerging Technologies	Hinxton, UK	Analysis of Machine Learning Methods in Predicting Drug Resistance of *Mycobacterium Tuberculosis*
13	Leonid Chindelevitch	Talk	12/11/20	BIRS Workshop: Mathematics and Statistics of Genomic Epidemiology	Virtual	Interpretable machine learning methods for predicting drug resistance
14	Leonid Chindelevitch	Talk + Poster	6/11/20	Wellcome Trust workshop: Antimicrobial Resistance – Genomes, Big Data and Emerging Technologies	Virtual	Predicting drug resistance from whole-genome sequence data using interpretable or deep machine learning
15	Leonid Chindelevitch	Talk	5/11/20	Seminar of the MRC London Institute of Medical Sciences	Virtual	Computational analysis of bacterial diversity

16	Liangliang Wang	Talk	16/10/20	Algorithms & Computationally Intensive Inference Seminars, University of Warwick	Virtual	Sequential Monte Carlo for estimating parameters of differential equations
17	Liangliang Wang	Talk	9/11/20	BIRS	Virtual	Bayesian inference of parameters in transmission models

Publications of team members related to the project (cumulative)

	Authors (Month/year) Title. *Journal* Volume (Issue), Page numbers. doi
1.	**Liangliang Wang**, Shijia Wang, **Alexandre Bouchard-Côté**. An Annealed Sequential Monte Carlo Method for Bayesian Phylogenetics. Systematic Biology. Volume 69 (1). 155–183. https://doi.org/10.1093/sysbio/syz028
2.	Shijia Wang, **Liangliang Wang** (2020) Particle Gibbs sampling for Bayesian phylogenetic inference, *Bioinformatics*, https://doi.org/10.1093/bioinformatics/btaa867
3.	Hooman Zabeti, Nick Dexter, Amir Hosein Safari, Nafiseh Sedaghat, Maxwell Libbrecht, **Leonid Chindelevitch** (2020). An interpretable classification method for predicting drug resistance in M. tuberculosis. WABI, 2:1-18. https://doi.org/10.1101/2020.05.31.115741
4.	Guo Liang Gan, Elijah Willie, Cedric Chauve, **Leonid Chindelevitch** (2020). Deconvoluting the diversity of within-host pathogen strains in a Multi-Locus Sequence Typing framework. BMC Bioinformatics, 20:637. 10.1186/s12859-019-3204-8

Other writing of team members related to the project: (reports, papers submitted, papers in progress) (updated)

	Authors (Month/year) Title. Etc.

1.	Submitted: Blang: Bayesian Declarative Modelling of General Data Structures and Inference via Distribution Continua. Journal of Statistical Software. Bouchard-Côté et al.
2.	Submitted: Adaptive semiparametric Bayesian differential equations via sequential Monte Carlo. Journal of Computational and Graphical Statistics. L Wang et al.
3.	Submitted: Geographic heterogeneity impacts drug resistance predictions in Mycobacterium tuberculosis. L. Chindelevitch et al.
4.	Submitted: Predicting drug resistance in M. tuberculosis using a Long-term Recurrent Convolutional Networks architecture. L. Chindelevitch et al.

Statistical Methods for the Analysis of Genetic Data with Survival Outcomes

Project Leaders: Lajmi Lakhal-Chaieb (Université Laval), Richard Cook (University of Waterloo), and Laurent Briollais (Lunenfeld Tanenbaum Research Institute of Mount Sinai Hospital, Toronto)
Collaborators: Shelley Bull (Lunenfeld Tanenbaum Research Institute of Mount Sinai Hospital, Toronto), Yun-Hee Choi (Western University), and Yildiz Yilmaz (Memorial University of Newfoundland)

This team began in 2019. The team's research brings together individuals who published seven papers on research related to this project and are now collaborating on joint papers which will be submitted in 2020. They have collectively made six presentations on research related to the project.

Notable achievements and activities in 2020 include:

- Richard Cook devoted a great deal of time with Jerry Lawless to understanding the public health reporting system to work towards a refinement of the daily reported case counts to account for reporting delays in COVID19 cases. He also designed a COVID19 trial investigating the therapeutic effects of convalescent plasma (plasma donated by a patient who had recovered from COVID19) on the prevention of the need to ventilate patients in hospital requiring oxygen support.
- Richard Cook was named "University Professor" at the University of Waterloo. https://uwaterloo.ca/provost/university-professor
- Briollais and Choi have worked on the implementation of time-varying covariates to assess prophylactic surgical interventions in hereditary breast ovarian cancer families. This work has given rise a submitted paper to Statistical Methods in Medical Research and an applied paper to JAMA Oncology.
- Richard Cook presenting the 2019 Scandinavian Journal of Statistics Keynote Lecture at the Nordic-Baltic Meeting of the International Biometrics Society.
- Richard Cook was awarded the Faculty of Mathematics Research Chair for his Statistical Methods for Health Research, July 1, 2019 – June 31, 2024 in the Statistics and Actuarial Science Department at the University of Waterloo.
- Notable talks/presentations made by team members in 2019:

- *Joint Modeling of Multivariate Longitudinal and Time-to-Event Phenotypes in Genetic Association Studies of Complex Traits* by Myriam Brossard, AD Paterson, O Espin-Garcia, Radu Craiu, and Shelley Bull in May and June in Calgary and Montebello (Canada)
- *Improving Mixture Cure Modelling of Molecular Genetic Biomarkers in Cancer Prognosis* by Penalized Maximum Likelihood by C Xu and Shelley Bull in May in Calgary
- *Revealing the Complex Genetic Architecture of Type 1 Diabetes Complications: Joint Modeling of Multivariate Longitudinal and Time-to-Event Traits* by Myriam Brossard, AD Paterson, O Espin-Garcia, Radu Craiu, and Shelley Bull in October in Houston, TX

Publications of team members related to the project (cumulative)

Zhong, Y., & Cook, R. J. (2021). Selection models for efficient two-phase design of family studies. Statistics in Medicine, 40(2), 254-270. This was published on-line in October, 2020.

Choi YH, **Briollais L**, He W, Kopciuk K. FamEvent: An *R* Package for Generating and Modeling Time-to-Event Data in Family Designs. *Journal of Statistical Software, In Press.*

Rustand D, **Briollais L**, Tournigang C, Rondeau V. Two-part joint model for a longitudinal semicontinuous marker and a terminal event with application to metastatic colorectal cancer data. Biostatistics. 2020 Apr 13: kxaa012. doi: 10.1093/biostatistics/kxaa012.

Choi YH, Jacqmin-Gadda H, Król A, Parfrey P, Briollais L, Rondeau V. Joint nested frailty models for clustered recurrent and terminal events: An application to colonoscopy screening visits and colorectal cancer risks in Lynch Syndrome families. Stat Methods Med Res. 2020 May;29(5):1466-1479. doi: 10.1177/0962280219863076. Epub 2019 Jul 26. PMID: 31347460.

Choi YH, Terry MBT, MacInnis RJ, Hopper JL, Colonna S, Buys SS, Daly MB, Andrulis IL, Kurian AW, John EM, **Briollais L**. Risk-Reducing Salpingo Oophorectomy in Reducing Breast Cancer Risk in Women with BRCA1/2 mutations. Accepted in *JAMA Oncology*, Dec. 2020.

Other writing of team members related to the project: (reports, papers submitted, papers in progress) (updated)

	Authors (Month/year) Title. Etc.
1.	Zhong, Y. And Cook, R.J. (January, 2021). Analysis of secondary outcomes in family studies. Manuscript in preparation.
2.	Choi YH, Jung H, Buys S, Daly M, John E, Hopper J, Andrulis I, Terry MB, Briollais

	L. A Competing Risks Model with Binary Time Varying Covariates for Estimation of Breast Cancer Risks in *BRCA1* Families. Submitted to Stat Methods Med Res., Sept. 2020.
3.	Rustand D, Briollais L, Rondeau V. A marginal two-part joint model for a longitudinal biomarker and a terminal event with application to advanced head and neck cancers. Submitted to *Biometrics*, Jan. 2021.
4.	Rustand D, Rue H, Van Niekerk J, Tournigand C, Rondeau V, Briollais L. Bayesian Estimation of Two-Part Joint Models for a Longitudinal Semicontinuous Biomarker and a Terminal Event with R-INLA: Interests for Cancer Clinical Trial Evaluation. To be submitted in Feb 2021.

Contingent Capital and Calibration of Capital Structure Models

Project Leaders: Mark Reesor (Wilfrid Laurier University), Adam Metzler (Wilfrid Laurier University) and Hatem Ben-Ameur (HEC Montréal)
Collaborators: Joe Campolieti (Wilfrid Laurier University), Rim Chérif (HEC Montréal) and Malek Ben-Abdellatif (HEC Montréal)

This team began their collaboration in 2019. Collaborators include HQP in this team consists of the following individuals: **(no Report sent in 2020)**

- Fortuné Edong: MSc student, HEC Montréal, registered since spring 2019, co-directed by Hatem Ben-Ameur and Rim Chérif
- Di Meng: PhD student in the Department of Mathematics at Wilfrid Laurier University, began in Fall 2018
- Bolade Ewarawon: PhD student in the Department of Mathematics at Wilfrid Laurier University, began in Winter 2020
- Hanchao Liu: MSc student in the Department of Mathematics at Wilfrid Laurier University, began in Fall 2019

So far, the team has made five presentations on research related to the project and authored and submitted 7 papers in peer-reviewed venues.

Notable activities on the project include:

- Ben-Ameur, Ben-Abdellatif, and Chérif are working to extend the models of Ayadi, Ben-Ameur, and Fakhfakh (2016) and Ben-Ameur, Fakhfakh, and Roch (2018) in modeling the call and the conversion options embedded in corporate bonds. These authors propose an extended structural setting that accommodates an arbitrary debt structure, several seniority classes and multiple intangible assets, including illiquidity costs. This part of their project is ongoing and still at the theoretical level.
- Ben-Ameur, Ben-Abdellatif, Chérif, and Fakhfakh have been working on extending the maximum-likelihood (ML) procedure of Duan (1994), which uses the closed-form

solution of Merton (1974). We propose a quasi-maximum likelihood (QML) procedure, which builds on approximate value functions of corporate securities for the model estimation step. Both ML and QML make use of the stock-price time series of the underlying public company. This part of the team's project is already very advanced.

- Ben-Ameur, Chérif, and Edong are collaborating on an ML procedure that is perfectly aligned with the second part of the project except that the QML procedure capitalizes on CDS premiums written on the underlying public company. This part is ongoing and is at the algorithm-design level.

Once those three parts of the team's research are completed, the team will start on the financial industry and the potential added value of the conversion option as a risk management tool. This portion of the research agenda is expected to happen during the third year of their research project.

CANSSI Postdoctoral Fellows

Started in 2019

Dengdeng Yu
Supervisor name: Dehan Kong
Title of project: Integrating different modalities of baseline imaging data to predict the risk of Alzheimer's disease progression
Location/University: University of Toronto

Haolun Shi
Supervisor name: Jiguo Cao
Title of project: High Dimensional Functional Data Analysis
Location/University: Simon Fraser University

Mamadou Yauck
Supervisor name: Erica Moodie
Title of project: Causal inference for network data
Location/University: McGill University

Eric Rose
Supervisor name: Erica Moodie
Title of project: Design of data analyses of optimal dynamic treatment regimes from observational data, and the development of sensitivity analyses to investigate violations of the typical assumptions required for such analyses.
Location/University: McGill University

Shirou Wang
Supervisor name: Yingfei Yi
Title of project: Synchronization in Markov random networks
Location/University: University of Alberta

Seoncheol Park
Supervisor name: Francis Zwiers
Title of project: Research on the statistics of climate-related extremes.
Location/University: University of Victoria, Pacific Climate Impacts Consortium

Started in 2020

Seoncheol Park – Year 2
Supervisor name: Francis Zwiers
Title of project: Research on the statistics of climate-related extremes.
Location/University: University of Victoria, Pacific Climate Impacts Consortium

Asad Haris
Supervisor Name: Robert Platt
Location/University: McGill University

CANSSI Distinguished Postdoctoral Fellows

Selected in 2020, terms start in 2021

Caitlin Ward
Supervisor name: Rob Deardon and Alexandra Schmidt
Title of project: Behavioural Change in Infectious Disease Systems
Location/University: University of Calgary

Cedric Beaulac
Supervisor name: Mirza Faisal Beg and Farouk Nathoo
Title of project: Genetic Correlates of Alzheimer's Disease Subtypes
Location/University: Simon Fraser University

Kaiqiong Zhao

Supervisor name: Linglong Kong and Dehan Kong
Title of project: Novel statistical modeling of neuroimaging and genetic data with an application to Alzheimer's risk prediction
Location/University: University of Alberta

Conferences and Workshops

Title, organizers, universities, dates Postponed or not, number of participants if held

Title**: Canadian Statistics Student Conference (CSSC) 2020 – May 30th, 2020**

Organizers: Steve FERREIRA GUERRA (Co-chair) Thai-Son TANG (Co-chair)

Event Location: Virtual

The keynote speaker was Dr. David Haziza from Universite de Montreal and consultant at Statistics Canada. Dr. Haziza is also the recipient of the 2019 CRM-SSC Prize, which continues the lineage of usually inviting an SSC awardee for the keynote speech. He gave a talk on applications of machine learning in survey sampling.

Number of participants : 244 participants attended the virtual conference at some point during the event. The fact that the conference was online allowed participants to join from all over the world, namely Canada
(89.9%), U.S. (4.9%), China (1.6%), UK (0.8%), Mexico (0.8%), Taiwan (0.8%), India (0.4%), France (0.4%), and Albania (0.4%).

Title: **Distinguished Lecture Series in Statistical Sciences**

Organizers: The Fields Institute for Research in Mathematical Sciences
Event Location: Virtual

The Fields Institute annually hosts the prestigious Distinguished Lecture Series in Statistical Science (DLSS). This lecture series has been held annually since 2000, and consists of one general lecture and one more specialized lecture by an internationally prominent statistical scientist.

- Monday, September 28th, 2020: Navier-Stokes, spatial-temporal kriging and combustion stability: a prominent example of physics-based analytics
- Tuesday, September 29th, 2020: Cmenet: a new method for bi-level variable selection of conditional main effects

Number of participants: 391 attendees

Title: **HEC Data Challenge 2021**

Organizers: Data Science Committee of HEC Montréal

Event Location: Virtual

The HEC Data Challenge brought valuable discussion to the 2 cultural organizations (Museum of Fine Arts of Montreal and Orchestre Symphonique de Montréal) which were hoping for innovative and concrete solutions from participants to face issues brought by the COVID-19 pandemic.

This competition was introduced by a conference on big data and its link with cultural events and management. Thanks to this talk, participants had the chance to hear perspectives from

Hervé Mensah, the director of Data Integration at La Presse and co-founder of Quotient Social, a non-for-profit organization which helps cultural organizations deal with their data. In addition, an expert from Synapse C shared its experience of working for hundreds of cultural events and handling their data. This talk brought value as participants discovered real-world issues related data science and computer science in the cultural landscape

Number of participants: 90 participants

Title: Data Science Bootcamp
Event Location: University of Saskatchewan (class rooms will be provided by the University at no cost)
Organizers: Shahedul Khan, University of Saskatchewan

Date: June 08-19, 2020 (2 weeks; Monday – Friday in each week – dates may need to change)

Data science is an interdisciplinary field that combines perspectives from mathematics, statistics and computer science. The focus is to extract and communicate meaningful information from complex data using techniques that fall under the umbrella of these three disciplines. The scope of the field is expanding, as learning from data is common practice in all disciplines. With the increasing availability of data with wide ranging characteristics, there is now a high demand for data scientists.
A successful summer school in data science was held at the University of Saskatchewan in 2019 with supports from CANSSI, PIMS, SSC and University of Saskatchewan. It had a major impact on the visibility of data science, University of Saskatchewan, CANSSI, PIMS and SSC, and helped an outstanding pool of participants gain knowledge and practical skills in data science. Building on this year's success, we propose to hold a new summer school in 2020. The 2020 summer school will go beyond that of 2019 by exposing participants to more core areas of data science, including real data analysis and hand-on training in software. The proposed speakers are all accomplished data science researchers and while their mini courses will be focused on introducing the basics, they will also include exposure to leading-edge research in the field. New topics and case studies will be introduced and more focus will be placed on hands-on training in software so that 2019 participants will still benefit from the 2020 bootcamp.

Postponed June 2021

Title: Statistical Methods for Precision Medicine
Event Location: Virtual (Zoom)

Organizers: Karen A. Kopciuk, University of Calgary
Date: December 8, 2020

Statisticians need to understand how to implement methods for precision medicine. This workshop will appeal to practitioners and researchers from a variety of disciplines including

medicine, veterinary medicine, biostatistics and health services. We will advertise the event widely across Canada and encourage circulation within other institutions' relevant faculties.

Number of participants: 238

Title: Turing-CANSSI Workshop on Statistical Machine Learning

Event Location:

Organizers: Marina Riabiz (Turing), Dan Roy, Murat Erdogdu (Toronto)
Date: June-July 2020

UK and Canada based researchers present distinct expertise in statistical machine learning. For example, the UK hosts a strong community of Stein's method researchers, while Canada hosts a solid group of researchers in PAC learning theory and deep learning. Since the two communities share a common goal, both groups can benefit from sharing their respective insights. This workshop provides an excellent venue for UK and Canada based researchers to combine their strengths, and work towards solving fundamental problems in statistical machine learning.

Number of participants: Postponed

Title: The UBC/SFU Joint Seminar
Event Location: Harbour Centre, SFU Vancouver Campus
Date: February 29, 2020
Organizer: Kenny Chiu, Shuxian Fan, Rachel Lobay

The graduate students of the UBC Department of Statistics and the SFU Department of Statistics and Actuarial Science jointly organize and host one event per term at a central location in Vancouver. The event offers Statistics and Actuarial Science graduate students an opportunity to attend seminars with accessible talks that provide them with an introduction to the state-of-art and active research areas in the field. The event allows three students from each university to present their work and provides them with an opportunity to develop and enhance their presentation skills with their peers. There will also be a talk given by a guest faculty speaker from UBC. There will be time dedicated to traditional important social components - there is an intermission between talks for discussion and the opportunity to have morning coffee and lunch together where students get great opportunities to network and to foster a mutually beneficial relationship between the two departments. This is a traditional all-day event that we have organized over a decade.

Number of participants: Postponed

Title: Vancouver Datajam 2020
Event Location: Virtual (via WebEx Meetings and Slack)
Date: September 4, 11 &12, 2020

Organizer: Lucia Darrow, Srishti Yadav, Jasmine Lai, Raissa Philibert, Meghan Halton, Sheia Duchesne, Laura Gutierrez Funderburk, Lisa Cao

The Vancouver Datajam occurred on September 12th with an unconference and several Python and R workshops preceding the full day hackathon and career panel.
The Unconference kickstarted the event a week before by bringing participants together to discuss various topics in the technology sector via moderated discussion rooms. Discussion topics included diversity in the data science community, the state of data science and the various coding languages used. This served as an icebreaker and networking opportunity for our participants as it provided a relaxed environment to explore ideas related around data science and technology.

Number of participants: 125

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