

# Aaron Berk

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Canadian citizen

Aaron Berk

McGill University, Dept Math & Stats

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## Education

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### University of British Columbia

*Ph.D. Applied Mathematics*

Vancouver, BC

*Sep 2015 – Aug 2021*

- On [LASSO](#) parameter sensitivity
- Principal Supervisors: [Dr. Özgür Yilmaz](#) and [Dr. Yaniv Plan](#)
- Also supervised by [Dr. Ipek Oruc](#)
- Awarded Four-Year Fellowship (institutional)
- Awarded NSERC CGS-D (national)
- Member of IAM Student Committee and Mathematics Grad Student Committee

### University of Toronto

*M.Sc. Mathematics*

Toronto, ON

*Sep 2013 – Aug 2014*

- On [multiscale analysis and PDE methods on graphs in image processing](#)
- Supervisor: [Dr. Adrian Nachman](#)
- 90% cumulative average
- Math rep to UT Graduate Students Union

### McMaster University

*B.Sc. Hon. Maths & Stats*

Hamilton, ON

*Sep 2009 – Aug 2013*

- Dean's Honours List (2009 - 2013)
- The McMaster Honour Award, Level 3 (2009)
- The University (Senate) Scholarship (2010, 2012)
- NSERC USRA (2012, 2013)
- 11.5 cumulative average (3.95 GPA)

## Selected Research Experience

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### Postdoctoral Fellow — Concordia University; McGill University

Sept 2021 – Apr 2022; May 2022 –

*Drs. [Simone Brugiapaglia](#) (Concordia) & [Tim Hoheisel](#) (McGill)*

Montréal, QC

- Realistic sampling strategies for deep generative inverse problems in medical imaging
- Sensitivity and uniqueness of LASSO programs

### Intern — Learning for Inverse Problems & Dynamical Systems

May – Sept 2021

*Mitsubishi Electric Research Laboratories*

Boston, MA, USA

- Researched deep proximal gradient methods for learned convex regularizers.

### Graduate Researcher — Compressed Sensing & Machine Learning

Sept 2015 – Aug 2021

*Drs. [Özgür Yilmaz](#), [Yaniv Plan](#) & [Ipek Oruc](#), UBC*

Vancouver, BC

- Researching convex methods for compression and recovery of structured high-dimensional data using geometric functional analysis and high-dimensional probability.
- Researching deep learning methods for medical imaging with applications to ophthalmology and the automated investigation of patient health.
- Experienced user of PyTorch for training deep neural networks.

### Data Scientist — Feature Selection & Signal Processing

Oct 2016 – Feb 2017

*Andrea Palmer, Paul Fijal*

Awake Labs, Vancouver, BC

- Mitacs Accelerate internship: affective computing R&D for quality of life improvement in children on the autism spectrum.
- Researched optimization & feature selection methods for structured time series analysis.

- Graduate Researcher** — Medical Imaging Algorithms May – Aug 2014  
*Supervisor: Dr. Adrian Nachman, University of Toronto* Toronto, ON
- Researched variational methods in image processing to develop fast computational methods with applications to medical imaging.
  - Relied heavily on wavelet methods, numerical methods for PDE (gradient descent, spectral methods, convex splitting), eigenvalue problems (the Nyström Extension), matrix conditioning.
- Undergraduate Research Assistant** — Computational Fluid Dynamics May – Aug 2013  
*Supervisor: Dr. Nicholas Kevlahan, McMaster University* Hamilton, ON
- Researched adaptive wavelet methods for solving PDEs on irregular and spherical domains; examined efficacy of these methods in solving shallow water equations subject to realistic bottom bathymetry and coastline data.
  - Wrote a software library in MATLAB to process and visualize geophysical images and data, using level set methods to morphologically alter real data according to its geometric properties.
- Undergraduate Research Assistant** — Computational Stats, Math Ecology May – Aug 2012  
*Supervisor: Dr. Benjamin Bolker, McMaster University* Hamilton, ON
- Optimized and analyzed GLM models for heteroskedastic pine seed and pine seedling spatial population distributions (using `nlme`, `stats`, and `RandomFields` in R).
  - Created protocols in R to retrieve, analyze and visualize large-scale bibliometric data.
- Summer Research Assistant** — Computational Mathematical Biology May – Aug 2011  
*Supervisor: Dr. Diamandis, SLRI, Mt. Sinai Hospital* Toronto, ON
- Developed and simulated a mathematical model to simulate the effect of chemotactic enzyme gradients on tumour morphology and tumour cell movement (using R) (Karagiannis, *et al.*, 2013)
  - Assisted lab members with data processing and statistical analysis using Microsoft Excel and R

## Articles & Preprints

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- [1] **AB**, Yanting Ma, Petros Boufounos, Pu Wang, and Hassan Mansour. Deep proximal gradient method for learned convex regularizers. Submitted to *ICASSP 2023-2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE, October 2022.
- [2] **AB**, Simone Brugiapaglia, Babhru Joshi, Yaniv Plan, Matthew Scott, and Özgür Yilmaz. A coherence parameter characterizing generative compressed sensing with Fourier measurements. Accepted to *IEEE Journal on Selected Areas in Information Theory (JSAIT)* [arXiv:2207.09340](#), July 2022. doi:10.1109/JSAIT.2022.3220196.
- [3] **AB**, Gulcenur Ozturan, Parsa Delavari, David Maberley, Özgür Yilmaz, and Ipek Oruc. Learning from few examples: Classifying sex from retinal images via deep learning. Submitted to *PLOS One* [arXiv:2207.09624](#), July 2022.
- [4] **AB**, Simone Brugiapaglia, and Tim Hoheisel. LASSO reloaded: A variational analysis perspective with applications to compressed sensing. Submitted to *SIAM Journal on Mathematics of Data Science (SIMODS)* [arXiv:2205.06872](#), May 2022.
- [5] **AB**. Deep generative demixing: Error bounds for demixing subgaussian mixtures of Lipschitz signals. In *IEEE ICASSP 2021*, pages 4010–4014, 2021. doi:10.1109/ICASSP39728.2021.9413573.
- [6] **AB**, Yaniv Plan, and Özgür Yilmaz. On the best choice of LASSO program given data parameters. *IEEE Transactions on Information Theory*, 68(4):2573–2603, 2021. doi:10.1109/TIT.2021.3138772.
- [7] **AB**. Deep generative demixing: Recovering Lipschitz signals from noisy subgaussian mixtures. [arXiv:2010.06652](#), 2020.
- [8] **AB**, Gulcenur Ozturan, David Maberley, Özgür Yilmaz, and Ipek Oruc. Learning from few examples: Classifying sex from retinal images. *Journal of Vision*, 20(11):255–255, 2020.
- [9] **AB**, Yaniv Plan, and Özgür Yilmaz. Sensitivity of  $\ell_1$  minimization to parameter choice. *Information and Inference: A Journal of the IMA*, 2020. doi:10.1093/imaiai/iaaa014.

- [10] **AB**, Yaniv Plan, and Özgür Yilmaz. Parameter instability regimes in sparse proximal denoising programs. In *SampTA*, 2019. doi:10.1109/SampTA45681.2019.9030982.
- [11] **AB** and Ethan White. Up in the air: The mathematics of juggling. *Crux Mathematicorum*, 45(8):471–475, 2019. (link to pdf).
- [12] George S Karagiannis, **AB**, Apostolos Dimitromanolakis, and Eleftherios P Diamandis. Enrichment map profiling of the cancer invasion front suggests regulation of colorectal cancer progression by the bone morphogenetic protein antagonist, gremlin-1. *Molecular oncology*, 7(4):826–839, 2013. doi:10.1016/j.molonc.2013.04.002.

## Selected Research Talks

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- Compressed Sensing meets Statistical Inverse Learning** Applied Inverse Problems 2023  
*“Provable guarantees for generative compressed sensing with Fourier measurements”* (upcoming) Sept 2023  
 • Invited research talk.
- Mathematics of Machine Learning** CMS W22 Meeting  
*“Sensitivity and uniqueness for square-root LASSO”* (upcoming) Dec 2022  
 • Invited research talk.
- DeepMath 2022** San Diego, CA, USA  
*“Theoretical guarantees for generative compressed sensing with subsampled isometries”* (upcoming) Nov 2022  
 • Accepted contributed research poster.
- Applied Harmonic Analysis and Machine Learning 2022** Machine Learning Genoa Center (MalGa)  
*“Theoretical guarantees for compressed sensing with subsampled isometries”* Sept 2022  
 • Accepted contributed research talk.
- Scientific Machine Learning** CMS S22 Meeting  
*“On Lipschitzness of solution mappings for LASSO”* June 2022  
 • Invited research talk on variational analytic tools for analyzing LASSO solution sensitivity.
- Mathematical Foundations of Scientific Machine Learning** AARMS CRG 2022  
*“Towards generative compressed sensing via random sampling in bounded orthonormal systems”* June 2022  
 • Contributed research talk on generative compressed sensing with subsampled isometries.
- Mathematical Foundations of Machine Learning** CMS W21 Meeting  
*“Sensitivity to parameter selection for LASSO programs”* Dec 2021  
 • Invited research talk on probabilistic tools for analyzing LASSO parameter sensitivity.
- CRM Applied Math Lab seminar**  
*“Parameter sensitivity in  $\ell_1$  minimization”* Oct 2021  
 • Invited research talk on probabilistic tools for analyzing LASSO parameter sensitivity.
- The Mathematics of Sparse Recovery and Machine Learning** CAIMS-SIAM AN20  
*“Parameter sensitivity in  $\ell_1$  minimization”* Jul 2020  
 • Invited research talk on probabilistic tools for analyzing LASSO parameter sensitivity.
- Virtual Vision Sciences Society 2020** Vision Sciences Society  
*“Learning from few examples: Classifying sex from retinal images”* Jun 2020  
 • Accepted research poster on deep learning performance for ophthalmology applications.  
 • doi:10.1167/jov.20.11.255
- PIMS CRG Summer School** Simon Fraser University  
*PIMS CRG Summer School: Deep Learning for Computational Mathematics* Jul 2019  
 • Invited research talk on deep learning applications to medical imaging in ophthalmology.
- SampTA 2019** Université Bordeaux  
*13th International Conference on Sampling Theory and Applications* Jul 2019  
 • Accepted research talk on sensitivity of  $\ell_1$  minimization to parameter choice.
- UBC Department of Ophthalmology & Visual Sciences** VGH/UBC Eye Care Centre  
*35th Annual O&VS Research Day* April 2019

- Research talk on a deep learning approach to understanding retinal fundus images.
- Winner of Graduate Student Presentation Award.

#### **PIMS Mathematical Education Circles**

University of British Columbia

*“The mathematics of juggling”*

March 2019

- Talk on the “lighter side of mathematics”.
- Introduced high school teachers, teaching faculty and research faculty to the mathematics underlying juggling.
- Facilitated a mini-workshop in which participants learned to juggle in “ten minutes or less”.

#### **SFU Computational Math Seminar**

Simon Fraser University

*“Program selection for sparse proximal denoising”*

March 2019

- Invited research talk on parameter instability in sparse proximal denoising programs.

#### **Banff International Research Station**

Banff International Research Station

*Intersection of Information Theory and Signal Processing*

October 2018

- Invited research talk on parameter instability in proximal denoising programs.

#### **PIMS High Dimensional Data Analysis**

University of British Columbia

*Mathematical Foundations of Data Science*

August 2018

- Invited research talk on parameter instability in compressed sensing programs.

#### **International Matheon Conference**

Technische Universität Berlin

*Compressed Sensing and its Applications*

December 2017

- Contributed research poster on sensitivity in sparse proximal denoising programs.

### **Selected Honours & Awards**

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#### **IVADO Postdoctoral Fellowship**

Institut de valorisation des données (Montréal, QC)

\$60 000 *p.a.*

May 2022

#### **CRM Applied Math Lab Postdoctoral Fellowship**

Centre de recherches mathématiques (Montréal, QC)

\$50 000 *p.a.*

Sept 2021

#### **British Columbia Graduate Scholarship**

Province of BC, UBC

\$15 000

Jan 2021

#### **MDS TA Award**

UBC Master's of Data Science

\$100

Jun 2020

#### **Margaret L. Adamson Award**

UBC Ophthalmology and Visual Sciences

\$2 000

Dec 2019

#### **Accelerate internship**

Mitacs, Awake Labs

\$15 000

Oct 2016

#### **Canada Graduate Scholarship—Doctoral (CGS-D)**

NSERC, UBC

\$35 000 *p.a.*

Sept 2016

#### **Four Year Fellowship**

University of British Columbia

\$18 000 *p.a.*

Spring 2015

#### **Canada Graduate Scholarship (Master's level)**

NSERC, University of Toronto

\$17 500 [*declined*]

Fall 2014

#### **Blythe Fellowship**

University of Toronto

\$16 500

Fall 2013

#### **Ontario Graduate Scholarship**

McMaster University

\$15 000 [*declined*]

Spring 2013

#### **NSERC Undergraduate Student Research Award**

McMaster University

\$6 500

Summer 2012, 2013

**Samuel Lunenfeld Research Award**  
Mt. Sinai Hospital, Toronto, ON

\$6 500  
Summer 2011

## Supervisory Experience

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**The Minh Nguyen** (Concordia Undergraduate Student Research Award)  
Visualizing the expressivity of deep learning: Low-dimensional journeys in high-dimensional worlds

Concordia University  
May – Aug 2022

## Facilitation & Teaching Experience

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### Sessional Instructor

*MATH 315 Ordinary Differential Equations*

Dept Math & Stats, McGill, Montréal QC  
Sep 2022 – Dec 2022

- Lecturer for Ordinary Differential Equations
- Created lecture material, weekly assignments, midterms and exam; focuses on: separable and linear equations, higher-order systems, series solutions, in/homogeneous systems, Laplace transforms.

### Sessional Instructor

*MATH 387 Honours Numerical Analysis*

Dept Math & Stats, McGill, Montréal QC  
Jan 2022 – Apr 2022

- Lecturer for Honours Numerical Analysis
- Created lecture material, weekly assignments, midterms and exam; focuses on: iterative methods, interpolation, approximation methods, numerical integration and differentiation.

### Sessional Instructor

*UBC Masters of Data Science program*

Dept Statistics, UBC, Vancouver BC  
Sep 2020 – October 2020

- Lecture and lab instructor for the 1-block course [DSCI 551: Probability & Descriptive Statistics](#)
- Created weekly lab assignments, bi-weekly quizzes and twice-weekly lectures, with focuses on: dependence, simulation, and conditional probability, contextualized for professional data science.

### TA Trainer & Facilitator

*UBC Mathematics TA Training*

Dept Mathematics, UBC, Vancouver BC  
Sep 2018, 2019, 2020

- Developed, led content delivery for and facilitated small-group activities for new graduate student TAs in the Department, focusing on Facilitative Teaching, Marking, online coursewares, Expectations, Communication, and Diversity.
- Developed a web-based Canvas module on Expectations & Diversity, as these topics pertain to being a Canada-based teaching assistant, mathematician and academic in the international academe.

### Mathematics Host

*Future Science Leaders*

Science World, Vancouver BC  
Jan 2019 & Jan 2020

- Outreach program for engaged, highly motivated high school students interested in STEM fields.
- Led content delivery and facilitated small-group activities.
- Developed modules for self-guided learning for cryptography with Python.

### Workshop Organizer and TA

*BC Data Science Workshop*

PIMS, UBC IAM  
Jan – Jun 2017, 2018

- Served as co-organizer for the [2017](#) and [2018](#) BC Data Science Workshop.
- Coordinated with industry mentors to develop projects of suitable scope.
- Mentored student teams through facilitation of research ideas and background knowledge.
- Designed and led 2017 [mini-project sessions](#).

### Participant

*Instructional Skills Workshop*

UBC Dept. Mathematics  
May 2016

- Three day intensive workshop developing effective teaching and facilitation practices, with a focus on teaching and learning in a mathematics settings.

## Teaching Assistant Experience

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### Master of Data Science program

University of British Columbia

*Teaching Assistant*

*Sept 2017 – May 2020*

- UBC's professional Master of Data Science program is a year-long intensive, cut into 6 blocks of courses and a capstone project.
- Facilitated course labs. Hosted office hours and problem solving sessions. Developed detailed assignment solutions. Marked and provided detailed feedback for students' assignment submissions. Provided feedback and review of draft assignments before they were released to students.
- Detailed course descriptions [available here](#). A list of courses for which I've served as TA are included below.
- 2017: Descriptive Statistics and Probability for Data Science, Communication and Argumentation, Data Wrangling, Supervised Learning I, Feature and Model Selection, Statistical Inference and Computation II, Experimentation and Causal Inference
- 2018: Communication & Argumentation, Data Wrangling, Databases and Data Retrieval, Unsupervised Learning, Spatial & Temporal Models, Web and Cloud Computing
- 2019: Descriptive Statistics and Probability for Data Science, Statistical Inference and Computation I, Supervised Learning I, Supervised Learning II, Spatial and Temporal Models, Advanced Machine Learning
- 2020: Supervised Learning II, Unsupervised Learning, Advanced Machine Learning

### Master of Data Science program

University of British Columbia

*Courseware developer*

*Summer 2020*

- Developed and adapted all lecture and lab learning resources for Supervised Learning II and Advanced Machine Learning from [Tensorflow](#) to [PyTorch](#).

### Multivariable and Vector Calculus

University of British Columbia

*Teaching Assistant*

*Jan 2015 – Apr 2015*

- Second year calculus for electrical engineers; co-syllabus with the electrical engineering electrodynamics course.
- Graded students' midterms and biweekly assignments; required knowledge of electrodynamics, multivariable calculus, linear algebra.

### Math Learning Centre

University of British Columbia

*Teaching Assistant*

*Sep 2015 – Dec 2016*

- Served in several roles for a drop-in help centre run by the Math Department.
- "Quick-help TA": given a strict two minute duration in which to respond to student questions. Peak hours popularity demand high energy, on-the-spot ingenuity, concise clarity
- "TA in-charge": ensure TAs evenly distribute among students; collect regular data on number of students, TAs; help students when other TAs are indisposed.
- "TA": create novel explanations for class-learned concepts to address student questions.

### Biology, Models and Mathematics

University of Toronto

*Teaching Assistant*

*Sept 2013– Apr 2014*

- First year math course for Biology students, requiring instruction to be delivered in a way that is relevant and appropriate for Biology students.
- Graded students' weekly assignments and provided feedback to students' instructor.
- Held two weekly hour-long office hours that were well-attended.

### Engineering Mathematics IV

McMaster University

*Undergraduate Teaching Assistant*

*Jan – Apr 2013*

*Jul – Aug 2012*

- Second-year second-term Engineering Mathematics course covering vector calculus, Fourier series, linear algebra, graphical visualization and MATLAB.
- Graded students' midterms, weekly lab assignments.
- Led two twice-weekly labs to review course content using slides I created in  $\text{\LaTeX}$
- Responded to students' questions via e-mail and during office hours.

**Calculus for Math and Stats I**  
*Undergraduate Teaching Assistant*

McMaster University  
*Sept – Dec 2012*

- Designed and conducted weekly one-hour tutorial; supervised in-tutorial quizzes.
- Prepared creative, rigorous examples to stimulate students' interest, develop intuition and mathematical insight.
- Answered students questions via e-mail and in the Math Help Centre.

**Undergraduate mathematics**  
*Private Tutor*

Ontario, Canada  
*Jan 2012 – Aug 2014*

- Tutor for calculus, statistics, differential equations, computer science, complex analysis
- Create study curriculum tailored to student's needs
- Experience with language barriers, mature students, students with disabilities and destination-not-the-journey type students

## Other Outreach & Service

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**Tutor**  
*UBC Longhouse drop-in tutoring*

UBC First Nations House of Learning  
*Sept 2020 – May 2021*

- Drop-in tutoring sessions for (typically first-year) indigenous students at UBC.
- Primary focus on calculus, word problems and problem solving skills.

**Convener**  
*BC Data Colloquium*

UBC IAM, UBC DSI, PIMS, CANSSI  
*Jan 2017 – Aug 2018*

- Organized speakers for a monthly colloquium.
- Talk descriptions available at [bcdata.ca](https://bcdata.ca).

**CMS Student Committee (STUDC)**  
*Co-Chair, Student Director*

Canadian Mathematical Society  
*Jun 2015 – Jun 2018*

- Coordinated and directed operations of the (national scale) CMS student committee and its members.
- Managed the largest budget of any CMS committee.
- Served as representative of Canadian math students and as liaison with CMS leadership.
- Reviewed student conference funding proposals, and awarded student prizes for academic achievement in the form of poster printing subsidies and conference bursaries.

## Other Skills

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**Language**

- **Native:** English
- **Intermediate:** French

**Programming and software skills**

- **Expert:** Python and PyTorch, R, MATLAB,  $\text{\LaTeX}$ , HTML, CSS, Markdown
- **Intermediate:** C, Java, Unix bash, zsh
- **Beginner:** Common Lisp, elisp, sed, awk