# (Max)imilian Puelma Touzel, Canadian/Chilean citizen

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Mila, #200, 6666 rue St. Urbain, Montreal, Quebec H2S 3H1, Canada

Languages spoken: ***English*** (native), ***Spanish*** (fluent), ***French*** (intermediate), ***German*** (intermediate)


## Education

2011-2015 **PhD – Physics**
Physics of Biological and Complex Systems (International Max Planck Research School)
University of Goettingen, Germany
Dissertation: *Cellular dynamics and stable chaos in balanced networks* (link)
Committee: Fred Wolf, Robert Guetig, Joerg Enderlein

2008-2009 **Master of Science – Physics**
Department of Physics, University of Toronto, Canada

2001-2006 **Honours Bachelor of Science – Mathematics & Physics (Double Specialist)**
Department of Physics, University of Toronto, Canada

## Research Experience

2020-present **Research Associate - Canadian Excellence Research Chair funded** Montréal, Canada
Mila*, Université de Montréal*
Advisors: Irina Rish, Yoshua Bengio & Guillaume Lajoie
- Inverse reinforcement learning methods
- Neural representations of value distributions

2018-2020 **Post-Doctoral Fellow - IVADO PDF award** Montréal, Canada
Mila*, Université de Montréal*
Advisors: Yoshua Bengio & Guillaume Lajoie
- Improving training for recurrent neural network models using dynamical systems
- Normative analyses and neural implementations of human and primate decision-making

2015-2018 **Post-Doctoral Fellow - ERC-funded** Paris, France
Laboratoire de physique théorique*, Ecole Normale Supérieure*
Advisors: Aleksandra Walczak & Thierry Mora
- statistical inference of probabilistic models of genetic recombination and selection processes
- model-based inference of repertoire dynamics using high-throughput sequencing

2010-2015 **Doctoral Researcher - IMPRS Excellence stipend award** Goettingen, Germany
Theoretical Neurophysics Group*, Max Planck Institute for Dynamics and Self-Organization*
Advisor: Fred Wolf
- statistical physics of cortical circuit attractor dynamics, response theory for neural ensembles, neural classifiers for sequence discrimination

2009-2010 **Master's Researcher** Toronto, Canada
Systems Biophysics Lab, *Department of Physics, University of Toronto*
Advisor: William Ryu
- thermotaxis assay development and imaging experiments for *C. elegans*

2004-2005 **Undergraduate Researcher** Toronto, Canada
Centre for Quantum Information and Quantum Control, *University of Toronto*
Advisor: Aephraim Steinberg
- optimal measurement theory in quantum state discrimination

## Scholary Awards & Grants

2021 **FRQNT Team grant award** (co-written; 180k/3 years)
2019 **Montreal AI & Neuroscience conference Poster Award**
2018 **IVADO Post-doctoral fellowship award** ($140k over 2 years)
2015 **Sloan-Swartz Travel Fellowship** (1 of 2)
*Swartz Foundation Meeting 2015, HHMI Janelia Farms*
2014 **Summer School Start-up Program grant** (€20k)
*University of Goettingen* (principal writer and coordinator)
2012 **ACCN Award (sole recipient,** €2k)
*Advanced Course in Computational Neuroscience, Organization for Computational Neuroscience*
2012 **CNS 2012 Conference Poster Award**
2011 **Excellence Fellowship, IMPRS PhD** (2 yrs.)
International Max Planck Research School *Physics of Biological and Complex Systems*
2009 **Travel grant, Neural Dynamics Summer School**
*MITACS (Mathematics of Information Technology and Complex Systems)*
2001 **90th Percentile**, Leonardo da Vinci Competition
*Faculty of Applied Science and Engineering, University of Toronto*

## Research Manuscript Bibliography (*equal contribution; ■ peer-reviewed AI conference; ○ pre-print);

- ■ Riemer M, Chandra Raparthy S, Cases I, Subbaraj G, **Puelma Touzel M**, Rish I. Continual Learning In Environments With Polynomial Mixing Times. NeurIPS Workshop on ecological theory of RL (2021)
- ○ Spinney S, Lajoie G, Rish I, Conrod P, **Puelma Touzel M**. Tracking and dissecting reward representations inferred from human adolescent behaviour in a risk-based decision-making task. (manuscript in prep.)
- ○ **Puelma Touzel M**, Cisek P, Lajoie G. Deliberation gated by opportunity cost adapts to context with urgency. Bioarxiv: 2021.07.31.452742 (in revision)
- ○ Koraichi MB, **Puelma Touzel M**, Mora T, Walczak AM. NoisET: Noise learning and Expansion detection of T-cell receptors with Python. arxiv: 2102.03568 (submitted)
- ○ **Puelma Touzel M***, Vogt R*, Schlizerman E, Lajoie, G. On Lyapunov Exponents for RNNs: Understanding Information Propagation Using Dynamical Systems Tools. (submitted) arxiv: 2006.14123
- ■ **Puelma Touzel M**, Cisek P, Lajoie G (2020). Urgency as the opportunity cost of commitment (workshop, NeurIPS).
- **Puelma Touzel M**, Mora T, Walczak A (2019). Inferring the immune response from repertoire sequencing. PLOS Comp Bio 16(4): e1007873.
- ■ Goyette K*, Kerg GC*, **Puelma Touzel M**, Gidel G, Vorontsov E, Bengio Y, Lajoie G (2019). "Non-normal Recurrent Neural Network (nnRNN): learning long time dependencies while improving expressivity with transient dynamics" NeurIPS Proc. 32
- **Puelma Touzel M**, Wolf F (2019). "The statistical mechanics of phase-space partitioning in large-scale spiking neuron circuits." Phys. Rev. E (99)5. 1-16.
- Pogorelyy M, Minervina A, **Puelma Touzel M**, Sycheva A, Komech E, Kovalenko E, Karganova G, Egorov E, Komkov A, Chudakov D, Mamedov I, Mora T, Walczak A, Lebedev Y (2018). Precise tracking of vaccine-responding T-cell clones reveals convergent and personalized response in identical twins. PNAS, 115 (50) 12704-12709.
- Magadan S, Jouneau L, **Puelma Touzel M**, Marillet S, Chara W, Six A, Quillet E, Mora T, Walczak A, Cazals F, Sunyer O, Fillatreau S, Boudinot P (2018). "Origin of Public Memory B Cell Clones in Fish After Antiviral Vaccination". Front. Immuno. (9) 2115.
- Murall CL, Abbate JL, **Puelma Touzel M**, Allen-Vercoe E, Alizon S, Froissart R, McCann K (2016). "Invasions of Host-Associated Microbiome Networks". vol. 56 Networks of Invasion. Editors: Bohane D, Dumbrell A & Massol F. Advances in Ecological Research.
- **Puelma Touzel M**, Wolf F (2015). "Complete Firing-Rate Response of Neurons with Complex Intrinsic Dynamics." PLoS Comput Biol 11(12): e1004636.
- Wolf F, Engelken R, **Touzel MP**, Weidinger JDF, Neef A (2014). "Dynamical models of cortical circuits," *Current Opinion in Neurobiology* (25) 228-36. (Invited article for special issue in computational neuroscience)
- **Touzel MP**, Adamson RBA, Steinberg AM (2007). "Optimal bounded-error strategies for projective measurements in non-orthogonal state discrimination," *Phys. Rev. A*, 76(6), 062314.

## Society membership, Institutional/Research community service

- DBIO member, **American Physical Society**
- Reviewer, **Physical Review X** (Editor's remark: "You clearly put a lot of effort in thinking about the paper and preparing your review. Your help is much appreciated.")
- Reviewer, **COSYNE, NeurIPS**
- Member, **Society for Computational Neuroscience**,
- DPMB member, **Canadian Association of Physicists**
- W2 Professorship hiring committee, **Max Planck Institute for Dynamics and Self-Organization** (2015)
- Board member (Student Representative), **Institute of Nonlinear Dynamics**, Goettingen, Germany (2014-2015)

## Organization of Science Conferences, Workshops, Schools, Reading Groups, Courses

2021 **Reading group Co-organizer** Montréal, Canada
Mila NeuroAI reading group

**Symposium Co-organizer** Montréal, Canada
Symposium on Explanation in Neuroscience & Artificial Intelligence (SENAI)

2020 **Discussion session facilitator** Montréal, Canada
Higher-order cognition *session (UNIQUE Student Symposium 2020)*

2019 **Workshop co-organizer** Montréal, Canada
*Real neurons & hidden units Workshop (NeurIPS NeuroAI Workshop)*
Comprehensive 1-day event, e.g. >50 double-blind review processed papers, live video feed, panel, etc.

**Workshop group discussion activity organizer** Toronto, Canada
*Mathematics of Vision Workshop, Fields Institute*

**Conference co-organizer** Montréal, Canada
*Montreal Physics and AI Workshop*

- >200 participants, lectures, and beginner and advanced workshops

2017 **Symposium co-organizer** Paris, France
*Paris Biological Physics Community Day*

2012-2015 **Summer school lead organizer** Goettingen, Germany
*Goettingen Advanced Course in Computational Neuroscience*

- Managed team, facilitated the event.
- Initiated, acquired funding for, and oversaw a transition to a novel, advanced-content format

2011-2015 **Course co-coordinator/content manager** Goettingen, Germany
Seminar in Biophysics, Seminar in Theoretical Neuroscience

2014 **Summer school co-coordinator (Week 2: Network Neurodynamics)** Valparaiso, Chile
Latin American Summer School in Computational Neuroscience held at Instituto de Sistemas Complejos Valparaiso

## Selected Talks

2021 **Neural Scaling Laws Workshop** Tremblant, Canada

2021 **Reinforcement learning Reading Group (Mila)** Virtual

2020 **Ross Otto Lab (McGill Psychology)** Virtual
Urgency as the opportunity cost of time

**Neural AI Reading Group (Mila)** Montreal, Canada
Inverse Rational Control

2019 ***Soft Matter & Biophysics Seminar*, Simon Fraser University** (invited) Vancouver, Canada
An inference take on urgency in decision-making

***Computational Neuroscience Seminar*, University of Ottawa** (invited) Ottawa, Canada
An inference take on urgency in decision-making

***Quantitative & Computational Biology Seminar*, UdeM** (invited) Montreal, Canada
Inferring repertoire dynamics from repertoire sequencing

2018 ***Spotlight talk*, Rice University, q-bio Conference** Houston, USA
Ensemble response of immune repertoires to vaccination

2018 ***Friday seminar,*** **UCL, Gatsby Theoretical Neuroscience Unit** (invited) London, UK
Understanding the shape of high-dimensional activity in cortex-inspired neural circuits
***Biophysics seminar***, **Emory University, Dept. Physics** (invited) Atlanta, USA
***APS March Meeting*** Los Angeles, USA
Repertoire-based approach to identifying sequence motifs specific to an effective vaccine
***Biophysics seminar***, **McGill University, Dept. Physics** (invited) Montréal, Canada
Inferring contributions of recombination and selection to singly-perturbed repertoires
***Tea talk***, **Montreal Institute for Learning Algorithms** (invited) Montréal, Canada
Don't paint the box black: Using dynamical systems to explain complex phase space geometry
2017 ***Systems Immunology and Vaccine Design Workshop*** Heidelberg, Germany
Repertoire-based approach to identifying sequence motifs specific to an effective vaccine
***Biophysics Seminar,*** **U of T Dept. Physics** Toronto, Canada
Inferring contributions of recombination and selection to singly-perturbed repertoires
2016 ***PhD & PostDoc Seminar,*** **ENS Dept. Physics** Paris, France
The statistical mechanics of phase space partitioning in large scale neuronal circuits
2015 ***Swartz Foundation Meeting*** Janelia Research Campus, USA
A theory for the balanced state that keeps track of each and every spike
***Neuronal Circuits and Computations Group Seminar,*** **Friedrich Miescher Institute** Basel, Switzerland
A theory of precise spike timing in cortical circuits
***American Physical Society March Meeting*** San Antonio, USA
2015 Elements of a finite-size ergodic theory for stable chaos
***ENS Theoretical Neuroscience Seminar*** Paris, France
A theory of precise spike timing in cortical circuits
2014 ***American Physical Society March Meeting*** Denver, USA
Microstate description of stable chaos in networks of spiking neurons
***Tutorial Lecture***, **Summer School in Computational Neuroscience** Valparaiso, Chile
Theory and modelling methodology in biophysics through case studies in computational neuroscience

## Selected Poster Presentations

2021 ***NSF AccelNet meeting*** Virtual
Urgency as the opportunity cost of commitment
2021 ***COSYNE*** Virtual
Urgency as the opportunity cost of commitment
2020 ***Biological and Artificial Reinforcement Learning Workshop NeurIPS*** Virtual
Urgency as the opportunity cost of commitment
2020 ***Neuroscience and Artificial Intelligent Systems (Cold Spring Harbor Labs)*** Virtual
Urgency as the opportunity cost of commitment
2020 ***COSYNE*** Denver, USA
An inference perspective on urgency in decision-making
2019 ***Montréal AI & Neuroscience Conference*** (***Poster Prize Winner***) Montréal, Canada
An inference take on urgency in decision-making
2019 ***Physics & AI Workshop*** Montréal, Canada
Stochastic thermodynamics of aggregate-label learning
2018 ***Montréal AI & Neuroscience Conference*** Montréal, Canada
Transfer properties of multi-spike tempotrons
***q-bio Conference*** Houston, USA
Ensemble response of immune repertoires to vaccination
***Curie-Weizmann Meeting*** Paris, France
Inferring perturbations to immune repertoires using clone size statistics
2017 ***Beg Rohu Summer School on Statistical Physics*** Beg Rohu, France
Inferring perturbations to immune repertoire dynamics
2016 ***Statistical physics methods in biology and computer science*** Paris, France
Antibody repertoires in fish

2016 ***Dynamics and Information in Cells and Tissues Workshop*** Les Houches, France
Inferring antibody generation: VDJ recombination in multiply infected fish

2015 ***International Conference in Mathematical Neuroscience*** Antibes, France
How entropy-producing networks can have precise spike times

2015 ***COSYNE*** Salt Lake City, USA
How entropy-producing networks can have precise spike times

2014 ***Bernstein Conference*** Goettingen, Germany
Stable chaos in balanced networks of spiking neurons with synaptic filtering

2013 ***German Neuroscience Society*** Goettingen, Germany
*Instability and partial synchrony in a balanced network of resonator neurons*

***COSYNE*** Salt Lake City, USA
Controlling the trade-off between categorization and separation via resonance

***Bernstein Conference*** Tuebingen, Germany
*Microstate description of stable chaos in balanced spiking networks*

***Computational Neuroscience Society meeting*** Paris, France
Olfactory bulb network dynamics as a pattern reservoir for adaptive cortical representations

***Mathematical Challenges in Neural Network Dynamics*** Columbus, USA
Stability properties of a balanced network of Type II neuronal oscillators

2012 ***Bernstein Conference*** Munich, Germany
Analyzing chaotic activity in a balanced network of Type II neuronal oscillators

***Computational Neuroscience Society meeting*** (***Poster Prize Winner***) Decatur, USA
Features of Chaotic Activity in a balanced network of Type II neuronal oscillators

2007 ***International Conference on Quantum Information*** Rochester, U.S.A.
Optimal bounded-error strategies for projective measurements in non-orthogonal state discrimination

2006 ***Conference on Quantum Information and Quantum Control*** Toronto, Ontario
Non-orthogonal state discrimination in the presence of error using projective strategies

## Participation in Schools

2017 ***Beg Rohu Summer School on Statistical Physics*** Beg Rohu, France
*Out of Equilibrium Dynamics, Evolution and Genetics*

***Cargese Summer School*** *Theoretical Biophysics* Cargese, France

2016 ***Course on Multiscale Integration in Biological Systems,*** Curie Institute Paris, France
*Physical description of biological systems, from single molecule to organisms*

***L'Ecole de Physique des Houches*** Les Houches, France
*Dynamics and Information in Cells and Tissues*

***Kavli Institute for Theoretical Physics*** Santa Barbara, USA
*Quantitative Immunology*

2015 ***Kavli Institute for Theoretical Physics*** Santa Barbara, USA
*Olfaction*

2014 ***Latin American Summer School in Computational Neuroscience*** Valparaiso, Chile

2013 ***Mathematical Biosciences Institute*** Columbus, USA
*Mathematical Challenges in Neural Network Dynamics*

2012 ***Computational Neuroscience Society*** Bedlewo, Poland
*Advanced Course in Computational Neuroscience (ACCN)*

2009 ***Latin American Summer School in Computational Neuroscience*** Valparaiso, Chile

***Center for Neural Dynamics*** Ottawa, Canada
*Computational Neuroscience Summer School*

2008 ***Instituto de Sistemas Complejos*** Valparaiso, Chile
*Complex Systems Summer School*

***Universidad de Chile*** Santiago, Chile
*Mathematical Modeling of Biological Systems using Matlab*

2007 ***Institute of Physics*** Manchester, England
*Conference and Training Course in Emergent Themes in Biophysics*

## Teaching/Supervision Experience

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|---|---|---|
| 2022 | **MAT1919 development** | Montreal, Canada |
| 2020-present | **Graduate-level dynamical systems lectures (substitute lecturer)** | Montreal, Canada |
| 2020-present | **2 PhD students co-supervision (with Dr. Irina Rish)** | Montreal, Canada |
| 2021-present | **2 PhD student co-supervision (with Guillaume Lajoie)** | Montreal, Canada |
| 2019 | **Physics and AI Workshop tutor** | Montreal, Canada |
| 2018 | **Master's student supervision (with Drs. Aleks Walczak & Thierry Mora)** | Paris, France |
| 2015 | **Master's student supervision (with Dr. Fred Wolf)** | Goettingen, Germany |
| 2014 | **Summer school tutor** | Valparaiso, Chile |
| | • Supervised group projects | |
| | • Lectured on modelling methodology in neuroscience | |
| 2012-2015 | **Summer school group work tutor** | Goettingen, Germany |
| | *Goettingen School for Computational Neuroscience,* | |
| | *Latin American Summer School in Computational Neuroscience* | |
| | • Group work supervision; designed and implemented literature review activity | |
| 2008-2009 | **Teaching assistant** | Toronto, Canada |
| | *Department of Physics*, *University of Toronto* | |
| | • designed and delivered inquiry-based tutorials. | |
| 2006-2007 | **Science educator and content programmer** | Toronto, Canada |
| | *Ontario Science Centre* | |
| | • developed and performed demonstrations on astronomy, robotics, and resonance | |
| 2006 | **Science camp co-ordinator** | Toronto, Canada |
| | *Activity Science Camp With Hispanic Youth* | |
| | • conceived, designed, and implemented activity-focused summer science camp for at-risk youth supported by the *Centre for Spanish-Speaking People* | |
| 2005 | **Professional academic tutor** | Toronto, Canada |
| | • academic (math & science) and language support to newly immigrated youth | |

## Communications Experience

- **Scientific writing and editing**:
  - 2 years professional manuscript and thesis editing for Max Planck Institute (MPIDS)
  - Scientific Advisory Board Report editing 2016, Max Planck Institute for Dynamics and Self-Organization
  - Successful grant/fellowship-writing
- **Effective communication**: completed graduate-level course, *Effective Communication for Physicists*
- **Public-speaking/Event facilitation**: theatre; television interview; conference chair; summer school facilitator
- **Science communication**: talks; course/camp/school teaching; public science center communicator

## Computational Skills

- **High-performance computing experience**:
  - Regular use of >100 cores for distributed calculations on MPIDS 10,000 core cluster (2012-2015).
  - Use of ENS physics cluster multi-threaded program on 48 core machine (2015-2018)
  - Active cloud computing, *Compute Canada* user (2019-present)
- Multi-language proficient (matlab, python, C++, mathematica).
- Extensive version control and notebook-based prototyping
- Python machine learning use (e.g. scipy, scikit-learn, PyTorch)

## Selected Outreach/Media

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|---|---|---|
| 2021 | **Mila blog article,** Recap of NeuroAI reading group | Montreal, Canada |
| 2019 | **ELife Ambassador** | Montreal, Canada |
| | • Contributor to the Statistical Literacy Initiative | |
| 2011 | **History of science journal article** | Goettingen, Germany |
| | "*Joseph Rotblat is Dead: Who will Save the World Now?*", *Peace* magazine vol.24 iss.1 | |
| 2007 | **Canadian Broadcasting Company live on-set, on-air interview** | Toronto, Canada |