Juan Pablo Vigneaux Ariztía

Education

Université Paris Diderot, Paris, France.
Doctorate, Mathematics, 2019.
Dissertation: "Topology of Statistical Systems: A Cohomological Approach to Information Theory" Supervisor: Daniel Bennequin.

Université Pierre et Marie Curie (UPMC), Paris, France.
Master, Fundamental Mathematics, *mention très bien* (highest honours), 2015.

Pontificia Universidad Católica de Chile (PUC), Santiago, Chile.
Industrial Engineer with specialization in Mathematical Engineering, *distinción máxima* (highest honours), 2014.
BS, Science of Engineering, 2013.

Research interests

1. The development of algebraic, topological and categorical techniques adapted to information theory, probability, and statistics.
2. The algebro-geometric characterizations of information functions and related quantities.
3. Probabilistic and combinatorial applications of information theory (central limit theorem, asymptotic equipartition property, sumset inequalities...).
4. Information bottleneck principle and its applications in machine learning.
5. The relation between information theory and statistical mechanics (free energy minimization, belief propagation); applications of the free energy principle in machine learning and neuroscience.

Publications

Peer-reviewed

J.P. Vigneaux, "Information structures and their cohomology," in *Theory and Applications of Categories*, vol. 35, no. 38, pp. 1476-1529, 2020.

D. Bennequin and J.P. Vigneaux, "A functional equation related to generalized entropies and the modular group," *Aequationes Mathematicae*, vol. 94, pp. 1201–1212, 2020.

J.P. Vigneaux, "Information theory with finite vector spaces," in *IEEE Transactions on Information Theory*, vol. 65, no. 9, pp. 5674-5687, Sept. 2019.

J.P. Vigneaux, "Entropy under disintegrations," to appear in F. Nielsen, F. Barbaresco (eds.), *Geometric Science of Information - 5th International Conference, GSI 2021, Paris, France, 2021, Proceedings.* Lecture Notes in Computer Science 12829, Springer 2021.

J.P. Vigneaux, "Information cohomology of classical vector-valued observables," to appear in F. Nielsen, F. Barbaresco (eds.), *Geometric Science of Information - 5th International Conference, GSI 2021, Paris, France, 2021, Proceedings.* Lecture Notes in Computer Science 12829, Springer 2021.

Preprints

D. Bennequin, O. Peltre, G. Sergeant-Perthuis, and J.P. Vigneaux, "Extra-fine sheaves and interaction decompositions", arXiv:2009.12646, 2020.

J.P. Vigneaux, "A homological characterization of generalized multinomial coefficients related to the entropic chain rule", arXiv:2003.02021, 2020.

Research experience

Max-Planck-Institut für Mathematik in den Naturwissenschaften, Leipzig, Germany.
Post-doctoral associate, September 2019—August 2020.
Adviser: Nihat Ay. Group: Information Theory of Cognitive Systems.

IMJ-PRG: Institut de Mathématiques de Jussieu-Paris Rive Gauche, Paris, France.
Doctoral researcher, 2015—August 2019.
Adviser: Daniel Bennequin.

ANESTOC: Center for Stochastic Analysis and Applications, Santiago, Chile.
Research assistant, 2012–14.
Adviser: Rolando Rebolledo.

INRIA, Paris, France.
Research intern, January—March, 2013.
Adviser: Nicolas Broutin. Group: RAP (Networks, Algorithms and Probabilities).

Presentations

Invited talk "Functors on posets, extra-fine sheaves, and interaction decompositions" at the seminar *Algebraic and Combinatorial Perspectives in the Mathematical Sciences* (online), October 30, 2020.

Invited talk "Cohomology of statistical systems" at the Robert Ghrist's seminar, University of Pennsylvania, Philadelphia, PA, USA, October 23, 2019.

Invited talk "Cohomology of statistical systems" at the *Category Theory Seminar*, Johns Hopkins University, Baltimore, MD, USA, October 22, 2019.

Invited talk "Information cohomology: an overview" at *OASIS: The Oxford Advanced Seminar on Informatic Structures*, Oxford, England, January 25, 2019.

Invited talk "Une introduction à la topologie de l'information" at the seminar *Higher categories, polygraphs and homotopy*, Université Paris Diderot, Paris, France, September 28, 2018.

Contributed talk "Information theory associated to Tsallis' 2-entropy" at the conference *Latin American Week on Coding and Information*, Campinas, Brazil, July 26, 2018.

Contributed talk "Information topology and probabilistic graphical models" at the conference *Applied Algebraic Topology*, Sapporo, Japan, August 8, 2017.

Invited talk "Cohomologie de l'information" at the seminar *Geometry and mathematical physics*, Université Paris Diderot, Paris, France, November 4, 2016.

Teaching experience

Department of Mathematics, Université Paris Diderot – Paris 7, Paris, France.
Temporary Lecturer (ATER), 2018—2019.
Teaching Assistant, 2015–18.

- Lecturer: *Elementary algebra and analysis I*, Fall 2017.
- Teaching assistant:
  Elementary algebra and analysis I, Fall 2018 and Spring 2016.
  Elementary algebra and analysis II, Spring 2019 and Spring 2015.

Faculty of Engineering, Pontificia Universidad Católica de Chile (PUC), Santiago, Chile.
Teaching assistant, 2011–14.

- Teaching assistant and course coordinator:

Introduction to Mathematical Engineering, Spring 2014.
Stochastic models, Fall 2011.
- Teaching assistant:
Numerical Modeling in Engineering, Fall 2012.
Mathematical Modeling in Engineering, Spring 2012.

Faculty of Mathematics, Pontificia Universidad Católica de Chile (PUC), Santiago, Chile.
Teaching assistant, 2009–12.

- Teaching assistant: *Calculus I* (single variable calculus), *Calculus III* (vector calculus) and *Probability and Statistics*, several times each.

Awards and scholarships

PGSM Masters Scholarship, Fondation Sciences Mathématiques de Paris, France, 2014.
An international academic scholarship that covered the full cost of studying one year in Paris.

Padre Hurtado award, Pontificia Universidad Católica de Chile, Chile, 2008.
A university-wide academic scholarship that covered the tuition fees of undergraduate education.

Additional training

European Talbot Workshop: "Topological aspects of quantum field theories,"
Winterberg, Germany, 2016.

Course "Disruptive technologies and public policies,"
Master 2 École d'Affaires Publiques, Sciences Po, Paris, France, Fall 2015.

Complex Systems Summer School - Chile,
Santa Fe Institute – Universidad del Desarrollo, Zapallar, Chile, 2013.

Skills and competences

First language: Spanish

Other languages: French (full professional proficiency), English (full professional proficiency), German (limited working proficiency)

Programming: advanced level in C# and LaTeX; intermediate level in Java, Python (including scikit-learn, numpy, tensorflow, and keras), AMPL, and Mathematica.

Additional information

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References

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