Dario **Prandi**

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Professional experience

Chargé de Recherche CNRS, Université Paris-Saclay, CentraleSupélec, L2S 2016–now
Researcher in Section 07.

Post-doc, CEREMADE, Université Paris-Dauphine, Paris 2015–2016
Supervisors: G. Peyré and J.-M. Mirebeau.

Post-doc, LSIS, Université de Toulon, Toulon 2014–2015
Grant of the LabEx Archimede (Aix-Marseille Université). Supervisor: J.-P. Gauthier.

Education

Philosophiae Doctor (Ph.D.), École Polytechnique, Palaiseau 2010–2013
Geometry and analysis of control-affine systems: motion planning, heat and Schrödinger evolution.
Supervisors: Ugo Boscain, Fréderic Jean, and Mario Sigalotti.

Master of Science (M.Sc.), Dep. of Mathematics, Univ. di Padova, Italy 2008 – 2010
Final grade 110/110 *cum laude*. Specialised curriculum in mathematical analysis.
Subject of the dissertation: Rearrangements in Metric Spaces. Supervisor: Roberto Monti.

Bachelor of Science (B.Sc.), Dep. of Mathematics, Univ. di Modena e Reggio Emilia, Italy 2005 – 2008
Final grade 110/110 *cum laude*. General curriculum in mathematics.
Subject of the dissertation: Area and coarea formulae. Supervisor: Gian Paolo Leonardi.

Grants and awards

80 prime, "A bio-inspired geometric model for speech sound reconstruction" 2023–2024
Financing for 20k€ and a Ph.D thesis. In collaboration with U. Boscain and G. Turco.

ANR JCJC, "Redundancy-free neuro-biological design of visual and auditory sensing" 2021–2024
Financing for 160k€. PI of the project.

Dispositif de Soutien aux Collaborations avec l'Afrique Subsaharienne (DSCA), "Neural dynamics via mean-field models" 2021-2022
Financing for 17k€. PI of the project.

Emergence en Recherche de Idex Université de Paris, "BioSpeech" 2019
Financing for 20k€. Principal investigator: Giuseppina Turco, in collaboration with U. Boscain

Financing from iCODE institut, "Control theoretical modelling of contrast perception" 2019
Financing for 12k€. "Porteur" of the project, in collaboration with V. Franceschi and L. Calatroni

PEPS INS2I, "Lifting approaches for cortical inspired methods in imaging (LiftME)" 2018
Financing for 10k€. "Porteur" of the project, in collaboration with V. Franceschi and L. Calatroni

PEPS INS2I, "Cortical Inspired Non-holonomic Control for Imaging (CINCIN)" 2017
Financing for 8k€. "Porteur" of the project, in collaboration with J.-P. Gauthier, V. Franceschi, L. Calatroni.

ERC Proof of Concept, "An artificial visual cortex for image processing (ARTIV1)" 2016
Financing for 150k€. Principal investigator: Ugo Boscain. In collaboration with J.-P. Gauthier and M. Sigalotti.

Organization

NFW 23: Neural fields equations, from Wilson-Cowan to neural engineering, LJLL, Paris. 19-20 jun 2023
Website: https://nfwparis2023.sciencesconf.org/registration.

Geometry and Control in Cortona, Cortona, Italy 27-31 mar 2023
Website: https://indico.math.cnrs.fr/event/7106/.

Séminaire d'Automatique du Plateau de Saclay, L2S, CentraleSupélec, Gif-sur-Yvette. oct 2016 – now
Website: https://icode-seminars.github.io. Co-organised with N. Amini.

Cortical models for visual perception and imaging applications, LJLL, Paris. 22 nov 2018
Website: https://liftme.sciencesconf.org/. Co-organised with L. Calatroni, V. Franceschi, and B. Franceschiello.

Cortical Inspired Non-holonomic Control for Imaging, Institut Henri Poincaré, Paris. 28 nov 2017
Co-organised with L. Calatroni and V. Franceschi.

A day in control theory, CMAP, École Polytechnique, Palaiseau. 2 may 2017
Thematic day in honour of A. Agrachev 65th birthday. Co-organised with F. Chittaro and R. Ghezzi.

INDAM meeting on Geometric Control and sub-Riemannian Geometry, Cortona, Italy. may 2012
Website: http://www.cmap.polytechnique.fr/geometric-control-srg/.

Teaching

Lecturer, Geometric Control Theory (CM, 30h). 2024
Master course, Institut de Mathématiques et de Sciences Physiques (Porto-Novo, Benin).

Lecturer, Geometric Control Theory (CM, 18h). 2018 – now
Master course, Université Paris-Sud Orsay / ENSTA.

Lecturer, Analyse et Topologie / Calcul Differentiel / Méthodes Mathématiques (∼80h/y). 2015 – now
Bachelor level courses (L2/L3). PSL Research University, Paris.

Teaching assistant, Contrôle Géométrique (TD, 10h). 2013 & 2016
Master course, Université Paris-Sud Orsay.

Teaching assistant, Outils Logiciels (TP, 50h). 2014
Bachelor course, IUT de Toulon.

Supervision

- Post-doc supervisions:
  - Virginia Bolelli (2023-prés.). Subject: "Flicker-induced visual illusions".
  - Ilias Rentzeperis (2021-2022). Subject: "Sparse coding for V1 receptive fields".
- Ongoing PhD thesis supervision:
  - Pierre-Jean Ménabé (2021–prés.).
    Co-supervised with Y. Chitour. Title: "Regularity of optimal trajectories for control-affine systems".
  - Roman Vanlaere (2022–prés.).
    Co-supervised with P. Lissy. Title: "Controllability of the heat equation on sub-Riemannian manifolds".
  - Adel Annabi (2022–prés.).
    Co-supervised with J.-B. Pomet and L. Sacchelli. Title: "Observability and observer synthesis for Wilson-Cowan equations".
  - Xiangyu Ma (2023-prés.).
    Thesis financed by the CNRS 80 prime interdisciplinary project.
    Co-supervised with U. Boscain and G. Turco. Title: "A bio-inspired geometric model for speech sound reconstruction".
- Completed PhD thesis supervision:
  - Amine Bohi (2014–2017). Co-supervised with F. Bouchara, J.-P. Gauthier, V. Guis.
    Title: "Descripteurs de Fourier inspirès de la structure du cortex visuel primaire humain. Application á la reconnaissance de navires dans le cadre de la surveillance maritime"
  - Cyprien Tamekue (2020–2023). Thesis financed by the "Financement Jean-Pierre Aguilar".
    Co-supervised with Y. Chitour. Title: "Controllability, visual illusions and perception".
- Supervised 10 "stage de master" since 2018.
- Supervised a student in the "parcours recherche" of CentraleSupèlec (2017–2020)

Publications

Books and edited proceedings

[1] A semidiscrete version of the Petitot model as a plausible model for anthropomorphic image reconstruction and pattern recognition
Dario Prandi, Jean-Paul Gauthier,
SpringerBriefs in Mathematics (2018), Springer International Publishing, DOI: 10.1007/978-3-319-78482-3

Peer-reviewed journals

[1] On the mathematical replication of the MacKay effect from redundant stimulation
Cyprien Tamekue, Dario Prandi, Yacine Chitour
SIAM Journal on Applied Dynamical Systems (to appear), arXiv: 2311.07338 [math.OC]

[2] Weyl's law for singular Riemannian manifolds
Y. Chitour, D. Prandi, L. Rizzi
Journal de Mathématiques Pures et Appliquées (2024), DOI: https://doi.org/10.1016/j.matpur.2023.10.004

[3] Beyond ℓ1 sparse coding in V1
Ilias Rentzeperis, Luca Calatroni, Laurent U. Perrinet, Dario Prandi
PLOS Computational Biology (2023), DOI: 10.1371/journal.pcbi.1011459

[4] Horizontal magnetic fields and improved Hardy inequalities in the Heisenberg group
David Krejčiřík Biagio Cassano, Dario Prandi
Communications in Partial Differential Equations (2023), DOI: 10.1080/03605302.2023.2191326

[5] Worst Exponential Decay Rate for Degenerate Gradient Flows Subject to Persistent Excitation
Paolo Mason, Yacine Chitour, Dario Prandi
SIAM Journal on Control and Optimization (2021), DOI: 10.1137/20M1343427

[6] A Cortical-Inspired Sub-Riemannian Model for Poggendorff-Type Visual Illusions
Emre Baspinar, Luca Calatroni, Valentina Franceschi, Dario Prandi
Journal of Imaging 7.3 (2021), DOI: 10.3390/jimaging7030041

[7] A bio-inspired geometric model for sound reconstruction
Ugo Boscain, Dario Prandi, Ludovic Sacchelli, Giuseppina Turco
The Journal of Mathematical Neurosciences (2021), DOI: 10.1186/s13408-020-00099-4

[8] Point interactions for 3D sub-Laplacians
Riccardo Adami, Ugo Boscain, Valentina Franceschi, Dario Prandi
Annales de l'Institut Henri Poincaré C, Analyse non linéaire (2020), DOI: 10.1016/j.anihpc.2020.10.007

[9] Cortical-inspired Wilson-Cowan-type equations for orientation-dependent contrast perception modelling
Marcelo Bertalmío, Luca Calatroni, Valentina Franceschi, Benedetta Franceschiello, Dario Prand i
J. Math. Imaging Vision (2020), DOI: 10.1007/s10851-020-00960-x

[10] Visual illusions via neural dynamics: Wilson-Cowan-type models and the efficient representation principle
Marcelo Bertalmío, Luca Calatroni, Valentina Franceschi, Benedetta Franceschiello, Alexander Gomez-Villa, Dario Prandi
Journal of Neurophysiology (2020), DOI: 10.1152/jn.00488.2019

[11] Hardy-Type Inequalities for the Carnot–Carathéodory Distance in the Heisenberg Group
Valentina Franceschi, Dario Prandi
The Journal of Geometric Analysis (2020), DOI: 10.1007/s12220-020-00360-y

[12] On the regularity of abnormal minimizers for rank 2 sub-Riemannian structures
Davide Barilari, Yacine Chitour, Fréderic Jean, Dario Prandi, Mario Sigalotti
Journal de Mathématiques Pures et Appliquées (2018), DOI: 10.1016/j.matpur.2019.04.008

[13] A sub-Riemannian Santaló formula with applications to isoperimetric inequalities and first Dirichlet eigenvalue of hypoelliptic operators
Dario Prandi, Luca Rizzi, Marcello Seri
J. Differential Geom. (2019), Lehigh University, DOI: 10.4310/jdg/1549422105

[14] On the Essential Self-Adjointness of Singular Sub-Laplacians
Valentina Franceschi, Dario Prandi, Luca Rizzi
Potential Analysis (2019), DOI: 10.1007/s11118-018-09760-w

[15] Quantum confinement on non-complete Riemannian manifolds
Dario Prandi, Luca Rizzi, Marcello Seri

J. Spectr. Theory (2018), DOI: 10.4171/JST/226

[16] Highly Corrupted Image Inpainting Through Hypoelliptic Diffusion
Ugo V. Boscain, Roman Chertovskih, Jean-Paul Gauthier, Dario Prandi, Alexey Remizov
J. Math. Imaging Vision (2018), DOI: 10.1007/s10851-018-0810-4

[17] Self-adjoint extensions and stochastic completeness of the Laplace-Beltrami operator on conic and anti-conic surfaces
Ugo Boscain, Dario Prandi
J. Differential Equations (2016), DOI: 10.1016/j.jde.2015.10.011

[18] Spectral analysis and the Aharonov-Bohm effect on certain almost-Riemannian manifolds
U. Boscain, D. Prandi, M. Seri
Comm. Partial Differential Equations (2016), DOI: 10.1080/03605302.2015.1095766

[19] Fourier descriptors based on the structure of the human primary visual cortex with applications to object recognition
Amine Bohi, Dario Prandi, Vincente Guis, Frédéric Bouchara, Jean-Paul Gauthier
J. Math. Imaging Vision 57.1 (2017), pp. 117–133, DOI: 10.1007/s10851-016-0669-1

[20] Complexity of control-affine motion planning
F. Jean, D. Prandi
SIAM J. Control Optim. (2015), DOI: 10.1137/130950793

[21] Hölder equivalence of the value function for control-affine systems
Dario Prandi
ESAIM: COCV (2014), DOI: 10.1051/cocv/2014014

Peer-reviewed conferences and workshops

[1] Cortical origins of MacKay-type visual illusions. A case for the non-linearity
Cyprien Tamekue, Dario Prandi, Yacine Chitour
21st IFAC World Congress, 2023

, [2] Reproducing Sensory Induced Hallucinations via Neural Fields
Cyprien Tamekue, Dario Prandi, Yacine Chitour
2022 IEEE International Conference on Image Processing (ICIP), 2022, DOI: 10.1109/ICIP46576.2022.9898022

[3] An Auditory Cortex Model for Sound Processing
Rand Asswad, Ugo Boscain, Giuseppina Turco, Dario Prandi, Ludovic Sacchelli
Geometric Science of Information, 2021, Springer International Publishing, DOI: 10.1007/978-3-030-80209-7_7

[4] On the decay rate for degenerate gradient flows subject to persistent excitation
Yacine Chitour, Paolo Mason, Dario Prandi
IFAC-PapersOnLine 53.2 (2020), pp. 1709–1714, DOI: 10.1016/j.ifacol.2020.12.2246

[5] A bio-inspired geometric model for sound reconstruction (Extended Abstract)
Ugo Boscain, Ludovic Sacchelli, Dario Prandi, Giuseppina Turco
20th IFAC World Congress, 2020

, [6] A Cortical-Inspired Model for Orientation-Dependent Contrast Perception: A Link with Wilson-Cowan Equations
Marcelo Bertalmío, Luca Calatroni, Valentina Franceschi, Benedetta Franceschiello, Dario Prandi
Scale Space and Variational Methods in Computer Vision, 2019, Springer International Publishing

, [7] Cortical-inspired image reconstruction via sub-Riemannian geometry and hypoelliptic diffusion
Boscain, Ugo, Chertovskih, Roman, Gauthier, Jean-Paul, Prandi, Dario, Remizov, Alexey
SMAI 2017 – ESAIM: ProcS 64 (2018), pp. 37–53, DOI: 10.1051/proc/201864037

[8] Image inpainting via a control-theoretical model of human vision
Ugo V. Boscain, Jean-Paul Gauthier, Dario Prandi
2018 14th IEEE International Conference on Control Automation (ICCA), 2018, DOI: 10.1109/ICCA.2018.8444289

[9] Recent results on the essential self-adjointness of sub-Laplacians, with some remarks on the presence of characteristic points
Dario Prandi Valentina Franceschi, Luca Rizzi
Séminaire de Théorie spectrale et géométrie (Grenoble), 33, 2015-2016, DOI: 10.5802/tsg.311

[10] Image processing in the semidiscrete group of rototranslations
Dario Prandi, Ugo Boscain, Jean-Paul Gauthier

Geometric science of information, 2015, Springer, Cham, DOI: 10.1007/978-3-319-25040-3_67

[11] Image reconstruction via non-isotropic diffusion in Dubins/Reed-Shepp-like control systems
U. Boscain, J. P. Gauthier, D. Prandi, A. Remizov
53rd IEEE Conference on Decision and Control, 2014, DOI: 10.1109/CDC.2014.7040056

Preprints

[1] A neural model for V1 that incorporates dendritic nonlinearities and back-propagating action potentials
Ilias Rentzeperis, Dario Prandi, Marcelo Bertalmío
eprint: https://www.biorxiv.org/content/early/2024/09/17/2024.09.17.613420.full.pdf

[2] Neural field equations with time-periodic external inputs and some applications to visual processing
Maria Virginia Bolelli, Dario Prandi
arXiv: 2407.17294 [q-bio.NC]

[3] Activity estimation via distributed measurements in an orientation sensitive neural fields model of the visual cortex
Adel Malik Annabi, Dario Prandi, Jean-Baptiste Pomet, Ludovic Sacchelli
arXiv: 2403.01906 [math.OC]

[4] Reproducibility via neural fields of visual illusions induced by localized stimuli
Cyprien Tamekue, Dario Prandi, Yacine Chitour
arXiv: 2401.09108 [q-bio.NC]

[5] Generalized Fourier-Bessel operator and almost-periodic interpolation and approximation
J.-P. Gauthier, D. Prandi
arXiv: 1612.00056 [math.NA]

Talks in international conferences

[1] Magnetic Hardy inequalities in the Heisenberg group
Dispersion and Geometry in Padova. Padova, Italy. 7 May 2024

[2] Reproducing sensory induced visual hallucinations via neural fields, a case for the non- linearity
SIAM Conference on Control and Its Applications (CT23). Philadelphia, USA. 26 July 2023

[3] Magnetic fields in the Heisenberg group
Hypoelliptic Operators in Geometry. MFO, Oberwolfach. 25 May 2023

[4] On the decay rate for degenerate gradient flows subject to persistent excitation
Congrés SMAI 2021 - 10ième Biennale Française des Mathématiques Appliquées et Industrielles. La Grande Motte, France. 24 June 2021

[5] On the essential self-adjointness of singular sub-Laplacians
Mini-workshop "Self-adjoint extensions in new settings", MFO, Obserwolfach, Germany. 10 October 2019.

[6] Weyl law for singular Laplace-Beltrami operators
Asymptotic Analysis & Spectral Theory, University Paris-Sud, Orsay, France. 02 October 2019.

[7] Weyl law for singular Riemannian manifolds
EquaDiff2019, Leiden, The Netherlands. 08 July 2019.

[8] Weyl law for singular Riemannian manifolds
Journées sous-riemanniennes, Grenoble, France. 16 October 2018.

[9] Weyl law for singular elliptic operators
A sub-Riemannian day in Padova, Italy. 14 September 2018.

[10] Cortical-inspired functional lifting for image inpainting
SIAM conference on Imaging Science, Bologna, Italy. 5 June 2018.

[11] Anthropomorphic image reconstruction via sub-Riemannian geometry and hypoelliptic diffusion
Delays and constraints in distributed parameter systems, Gif-sur-Yvette, France. 24 November 2017.

[12] Quantum confinement and spectral analysis of degenerate operators on Riemannian manifolds
VII Partial differential equations, optimal design and numerics, Benasque, Spain. 22 August 2017.

[13] A variational formulation of the sub-Riemannian model of the primary visual cortex
Geometric Analysis in Control and Vision Theory, Voss, Norway. 11 May 2016.

[14] Image processing in the semidiscrete group of rototranslations
2nd Conference on Geometric Science of Information, École Polytechnique. 20 October 2015.

[15] A sub-Riemannian Santaló formula with applications to isoperimetric inequalities and Dirichlet spectral gap of hypoelliptic operators
PGMO Days 2015, ENSTA ParisTech, Palaiseau. 28 October 2015.

[16] Self-adjointness of intrinsic diffusions in almost-Riemannian structures
Thematic day on Analysis and geometry of almost-Riemannian manifolds, IHP, Paris. 03 December 2014.

[17] Intrinsic hypoelliptic diffusions in sub-Riemannian and almost-Riemannian geometry
Thematic day on Hypoelliptic diffusion: analysis and control, IHP, Paris. 06 November 2014.

[18] Spectral properties and Aharonov-Bohm effect on Grushin-like structures
First International Joint Meeting, Bilbao, Spain. 02 July 2014.

[19] The Laplace-Beltrami operator on conic and anti-conic surfaces
Geometry and Control, Steklov Institute, Moscow, Russia. 17 April 2014.

[20] Heat and Schrödinger equation on conical and anticonical-type manifolds
Control of PDEs, CNAM, Paris. 02 April 2014.

[21] Complexity in control-affine systems
Mathematical Control in Trieste, SISSA, Trieste, Italy. 05 December 2013.

[22] Dynamics of a quantum particle on a conical-like surface
Conical Intersections in Mathematical Physics, IHP, Paris. 31 May 2013.

[23] The Laplace-Beltrami operator on conic-type surfaces
Non Linear Control: Geometric Methods and Applications, Firenze, Italy. 19 April 2013

Other talks

[1] Weyl's law for singular Riemannian manifolds
Analysis seminar, University of Warwick. 2 November 2023.

[2] Neural fields equations for visual illusions
Séminaire d'automatique du plateau de Saclay, Université Paris-Saclay, Gif-sur-Yvette. 12 October 2023.

[3] Reproducing sensory induced visual hallucinations via neural fields
Imaging in Paris Seminar, IHP, Paris. 15 December 2022.

[4] Reproducing sensory induced visual hallucinations via neural fields
S´eminaire McTAO, INRIA Sophia-Antipolis. 25 May 2022.

[5] A sub-Riemannian Santaĺ o formula with applications to isoperimetric inequalities and Dirichlet spectral gap of hypoelliptic operators
Floris Takens Seminar, University of Groningen, Netherlands. 25 January 2022.

[6] Cortical-inspired Wilson-Cowan-type equations for orientation-dependent contrast perception modellin
Université de l'Artois, Lens. 16 Decembre 2021.

[7] On the regularity of abnormal minimizers for rank 2 sub-Riemannian structures
Moscow seminar on geometric theory of optimal control. 14 April 2021.

[8] Point interactions for 3D sub-Laplacians
Oberseminar Analysis/Numerik, Universität Oldenburg. 14 January 2021.

[9] Point interactions for 3D sub-Laplacians
Sub-riemannian international online seminar. 08 January 2021.

[10] Self-adjointness e teoria spettrale per (sub-)laplaciani singolari
Seminario FIM, Universitá di Modena e Reggio Emilia, Italy. 25 January 2018.

[11] Loi de Weyl avec reste et estimés du noyau de la chaleur sur varietés riemanniennes non-completes
Séminaire de Théorie spectrale et géométrie, Institut Fourier, Grenoble. 30 November 2017.

[12] Sur le caractère auto-adjoint et la théorie spectrale des opérateurs de type Hörmander singuliers
Séminaire d'Analyse, Université de Tours. 09 November 2017.

[13] Quantum confinement and spectral theory of (sub-)Laplacians
Séminaire de Géométrie sous-riemannienne, IHP, Paris. 04 October 2017.

[14] Quantum confinement in non-complete Riemannian manifolds
25e colloque Jeunes Chercheurs Alain Bouyssy, Orsay, Paris. 02 March 2017.

[15] Neuro-geometry of vision and applications to image processing
Seminario FIM, Universitá di Modena e Reggio Emilia, Italy. 11 February 2016.

[16] A variational formulation of the sub-Riemannian model for the primary visual cortex
Séminaire "Analyse numérique et EDP", Université Paris Sud-Orsay. 26 November 2015.

[17] Reconstruction and pattern recognition via the Citti-Petitot-Sarti model
Séminaire "Statistique et imagerie", Université Paris-Dauphine. 19 January 2015.

[18] Complexity of control-affine motion planning
Séminaire de Théorie du Contrôle de Toulon, Université de Toulon. 30 January 2014.

[19] The heat and Schrödinger equations on conic and anticonic-type
Gdt Problémes spectraux et physisque mathématique, Université Paris Sud-Orsay. 18 December 2013.

[20] Complexity of control-affine motion planning
Séminaire de Géométrie sous-riemannienne, IHP, Paris. 02 October 2013.

[21] The heat and Schrödinger equations on conic and anticonic-type surfaces
A geometry day in Bicocca, Milan, Italy. 27 September 2013.

[22] Complexity in affine control systems
Journée GECO, UPMC, Paris. 25 June 2012.

[23] Complexity in affine control systems
Functional Analysis sector's seminar, SISSA, Trieste, Italy. 19 April 2012.

Posters

[1] Hardy-type inequalities and spectral bounds for hypoelliptic operators of Hörmander type
Contrôle des EDP et applications, CIRM, Marseille. 10 November 2015

[2] Highly corrupted image inpainting through hypoelliptic diffusion
Workshop on Geometrical Models in Vision, IHP, Paris. 23 October 2014.

Languages

Mothertongue: **Italian**, Fluent: **English, French**