

Joan Bruna

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CITIZENSHIP Spain (USA Permanent Resident).

RESEARCH INTERESTS Machine Learning, Deep Learning, High-Dimensional Statistics, Inverse Problems, Optimization.

PROFESSIONAL EXPERIENCE

Institute of Advanced Study, Princeton, NJ

Visiting Scholar, School of Mathematics, Year on Optimization and ML, **Fall 2019-Spring 2020**

Courant Institute of Mathematical Sciences and Center for Data Science, NYU, New York, NY

Assistant Professor, Department of Computer Science and Center for Data Science,
Department of Mathematics (affiliated) , **Fall 2016-Now**

UC Berkeley, Berkeley, CA

Assistant Professor, Dept of Statistics, **Jan 2015 - Aug 2016**

Facebook AI Research,

Visiting Scientist, Paris, **May-Aug 2018**

Post Doctoral Fellow, New York, NY, **Oct-Dec 2014**

Courant Institute, NYU, New York, NY

Postdoctoral Researcher **Oct 2012 - Sep 2014**

CSR, Malakoff, France

Senior Reseach Consultant **Oct 2010 - July 2012**

Zoran, Malakoff, France

Senior Reseach Engineer **June 2008 - Sep 2010**

Let it Wave, Palaiseau and Malakoff, France.

Research Engineer **April 2005 to June 2008**

EDUCATION

Ecole Polytechnique, Palaiseau, France

Ph.D. in Applied Mathematics, “Scattering Representations for Recognition”, 2008-2013.

- Thesis Topics: *Invariant signal representations, classification, pattern recognition, stochastic processes, invariance learning, differential geometry.*
- Adviser: Professor Stéphane Mallat.

Ecole Normale Supérieure, Cachan, France

MSc “Mathématiques, Vision, Apprentissage” in Applied Mathematics, 2004-2005.

- Image, audio and video processing, Harmonic analysis, Machine Learning, Wavelet theory.
- *Mention Très bien.*

Universitat Politècnica de Catalunya, Barcelona, Spain

BS, MSc Telecommunications Engineering, 1999-2004,

- Master Thesis developed in Nokia Denmark (Aalborg), 2003-2004.
- Title: “New Modeling techniques for HSDPA/WCDMA” (*A with honors*).

BS Mathematics, 1998-2002.

- *With Honors, Ranked 2nd.*

AWARDS

- NSF CAREER Award, 2019.
- Alfred P. Sloan Research Fellowship, 2018.
- Best Paper Award, ICMLA, 2018
- Honors Mention in Spanish Physics Olympiad, 1998
- ENS Cachan Scholarship, 2004-2005
- 2nd national place in Cangur Mathematical Contest, 1996

1. Chen, L., Chen, Z. Bronstein, M, **Bruna, J**, “Attributed Random Walk as Matrix Factorization: An Adaptive Unsupervised Graph Embedding”, *submitted*.
2. Brandfonbrener, D., **Bruna, J**, “On the Expected Dynamics of Nonlinear TD Learning”, *submitted*, 2019.
3. Gama, F, **Bruna, J**, Ribeiro, A, “Stability Properties of Graph Neural Networks”, *submitted*, 2019.
4. Lacroix, T. Obozinski, G., **Bruna J**, Usunier, N. “Smaller Embeddings for Large Scale Knowledge Base Completion”, *preprint*, 2019.
5. Domingo, C, Jelassi, S., Mensch, A., Scieur, D., **Bruna, J**, “Extra-Gradient with Player Sampling for Provable Fast Convergence in n-player games”, *preprint*.
6. Williams, F, Trager, M, Silva, C., Panozzo, D., Zorin, D. **Bruna, J**, “Gradient Dynamics of Univariate ReLU Networks”, *NeurIPS*, 2019.
7. d’Ascoli, S, Sagun, L, Biroli, G, **Bruna, J**, “Finding the Needle in the Haystack with Convolutions: on the benefits of architectural Bias”, *NeurIPS*, 2019.
8. Gama, F, **Bruna, J**, Ribeiro, A. , “Stability of Graph Scattering Transforms”, *NeurIPS*, 2019.
9. Chen, Z, Villar, S., Chen, L., **Bruna, J**, “On the Equivalence between Graph Isomorphism Testing and Function Approximation with GNNs”, *NeurIPS*, 2019.
10. Kileel, J, Trager, M, **Bruna, J**, “On the expressive Power of Deep Polynomial Neural Networks”, *NeurIPS*, 2019.
11. Frerix, Th., **Bruna J.**, “Approximating Unitary Matrices with Effective Givens Factorization”, *ICML*, 2019.
12. Rotskoff, G., Jelassi, S., **Bruna J.**, Vanden-Eijnden, E. “Global Convergence of Neuron Birth-Death Dynamics” *ICML*, 2019.
13. **Bruna, J.**, Mallat, S. “Sparse Multiscale Microcanonical Models”, *Mathematics, Statistics and Learning*, 2019.
14. Venturi, L. Bandeira, A. **Bruna, J.**, “Spurious Valleys in two-layer Neural Network Optimization Landscapes”, *JMLR*, 2019.
15. Resnick, C. Raileanu, R. , Kapoor, S. Peysakhovich, A. Cho, K, **Bruna J**. “Backplay: ”Man muss immer umkehren”, *preprint*, 2018.
16. Williams, F. Schneider, T. Silva C, Zorin, D. **Bruna, J** and Panozzo, D, “Geometric Deep Prior for Surface Reconstruction”, *CVPR* 19.
17. Gama, F. Ribeiro, A. **Bruna, J**, “Diffusion Scattering Transforms on Graphs”, *ICLR* 19.
18. Chen, Z. Li, Lisha, **Bruna, J.**, “Supervised Community Detection with Line Graph Neural Networks”, *ICLR*, 2019.
19. Choma, N. Monti, F. Gerhardt, L., Palczewski, T, Ronaghi, Z, Prabhat, Bhimji, W., Bronstein, M., Klein, S., **Bruna, J**, “Graph Neural Networks for IceCube Signal Classification” *ICMLA (Oral presentation)* 2018, **Best Paper Award**.
20. Resnick, C., Eldridge, W. Ha, D, Britz, D., Foerster, J., Togelius, J. Cho, K. and **Bruna, J**, “Pommerman: A multi-agent playground”, *Marlo AIIDE Workshop (Oral)* 2018.
21. Folque, D. Sukhbaatar, S. , Szlam, A, **Bruna, J**, “Planning with Structured Attributes”, *ICML Workshop* 18.
22. Kostrikov, I. , Panozzo, D. , Zorin, D, **Bruna, J**, “Surface Networks”, *CVPR 18 (oral presentation)*.
23. Garcia, V. and **Bruna, J.**, “Few-Shot Learning with Graph Neural Networks”, *ICLR* 2018.
24. Nowak, A. Folque, D., **Bruna, J** , “Divide and Conquer Networks”, *ICLR’18*.
25. Henrion, I. Brehmer, J. **Bruna, J.** , Cho, K., Cranmer, K., Louppe, G, Rochette, G. , “Neural Message Passing for Jet Physics”, *NIPS’17 Deep Learning for Physical Sciences Workshop*.
26. Nowak, A. Villar, S. Bandeira, A, **Bruna, J** , “A Note on Learning Algorithms for Quadratic Assignment with Graph Neural Networks ”, *ICML PADL Workshop*, 2017.
27. Vidal, R. **Bruna, J**, Giryes, R. Soatto, S, “Mathematics of Deep Learning”, *CDC*, 2017.
28. Bronstein, M., **Bruna, J.**, Szlam, A. LeCun, Y, Vandergyst, P. “Geometric Deep Learning: going beyond Euclidean data”, *IEEE Sig Processing Magazine*, 2016.
29. Freeman, D., **Bruna, J**, “Topology and Geometry of Deep Rectified network optimization landscapes”, *ICLR* 2017, *arxiv 1611.01540*.
30. Moreau, T. and **Bruna, J.**, “Understanding Neural Sparse Coding with Matrix Factorization”, *ICLR* 2017 *arxiv 1609.00285* .
31. Dokmanic, I. , **Bruna, J**. Mallat, S. De Hoop, M. “Inverse Problems with Invariant Multiscale Statistics”, *SPARS 2017*, 2016.

32. **Bruna, J**, Sprechmann, P and Y. Lecun, “Super-Resolution with Deep Convolutional Sufficient Statistics”, *Proceedings of ICLR*, 2016.
33. Tygert, M, **Bruna, J**, Chintala, S., Piantino, S., Szlam, A. and Lecun, Y. “A theoretical argument for complex-valued convolutional networks”, *Neural Computation*, 2016.
34. P. Sprechmann, **Bruna J.** and Y. LeCun. “Audio Source Separation with Discriminative Scattering Networks”, *LVAICA*, 2015.
35. M. Henaff, **Bruna J.** and Y. LeCun. “Deep Convolutional Networks on Graph-Structured Data”, *preprint*, 2015.
36. Ranzato, M.A., Szlam, A., **Bruna, J.**, Mathieu, M., Collobert, R. and Chopra, S., “Video (language) modeling: a baseline for generative models of natural videos”, *preprint*, 2015.
37. Sukhbaatar, S., **Bruna, J.**, Paluri, M. Bourdev, L. Fergus, R., “Training Convolutional Networks with Noisy Labels”, *ICLR Workshop*, 2015.
38. Goroshin, R, **Bruna, J.**, Thomson, J. Eigen, D and Lecun, Y, “Unsupervised Learning of Spatiotemporally Coherent Metrics”, *ICCV*, 2015.
39. **Bruna, J.**, Sprechmann, P., LeCun, Y, “Audio Source Separation with NMF Scattering”, *ICASSP*, 2015.
40. Denton, E. Zaremba, W. **Bruna, J**, Fergus, R. LeCun, Y, “Exploiting Linear Structure Within Convolutional Networks for Efficient Evaluation”, *NIPS*, 2014.
41. Krishnan, D., **Bruna, J.**, and Fergus, R., “Blind Deconvolution with Re-weighted Sparsity Promotion”, 2013.
42. **Bruna, J.**, Mallat, S., “Audio Texture Synthesis with Scattering Moments”, *preprint* 2013.
43. **Bruna, J.**, Szlam, A., LeCun, Y. “Signal Recovery from ℓ_p Pooling Representations”, *ICML*, 2014.
44. Szegedy, C. Zaremba, W., Sutskever, I. **Bruna, J**, Erhan, D, Goodfellow, I, Fergus, R., “Intriguing Properties of Neural Networks”, *ICLR*, 2014.
45. **Bruna, J.**, Zaremba, W., Szlam, A and LeCun, Y, “Spectral Networks and Locally connected networks on Graphs”, *ICLR*, Jan 2014.
46. **Bruna, J.**, Mallat, S., Muzy, J-F and Bacry, E., “Intermittent Process Analysis with Scattering Moments”, *Annals of Statistics*, 2013.
47. **Bruna, J.**, Szlam, A., LeCun, Y. “Learning Stable Group Invariant Representations with Convolutional Networks”, *ICLR*, 2013.
48. **Bruna, J.**, Mallat, S. “Invariant Scattering Convolution networks”, *IEEE trans of PAMI*, 2012.
49. **Bruna, J.**, Mallat, S., “Classification with Scattering Operators”, *CVPR*, 2011.
50. **Bruna, J.**, Mallat, S. “Classification with Invariant Scattering Representation”, *IVMSP*, 2011.
51. **Bruna, J.**, Mallat, S., “Geometric Models with Co-occurrence Groups”, *ESANN*, 2010, Brugge.
52. **Bruna, J.**, Mallat, S., “Super-Resolution Bandlet Upconversion for HDTV”, *SMPTE*, Los Angeles, 2006.

INVITED TALKS

1. Samsung Korea, Seoul, AI Forum, Nov’19.
2. IPAM, UCLA, Physics of Machine Learning Workshop, Nov’19.
3. John Hopkins University, Plenary Lecture MINDS Symposium, Nov’19.
4. UPenn, Applied Mathematics Seminar, Oct’19.
5. IAS, Oct’19.
6. Duke University, Oct’19.
7. UC Berkeley, Mathematics Departmental Seminar, Sep’19.
8. MSRI Summer School, Mathematics of Deep Learning, Seattle, August’19.
9. SAMPTA, Bordeaux, July’2019
10. BCN Analysis, Keynote, June’19.
11. IPAM, UCLA, Geometry Workshop, Apr’19.
12. Harvard University, Mar’19.
13. Georgia Tech, Applied Math Seminar, Mar’19.
14. NYU, ML for Network Data Workshop, Jan’19.
15. MIT MiFods workshop, Jan’19.
16. Rice University, CS Colloquium, Jan’19.
17. Aspen Center for Physics, ML and Physics Conference, Jan’19.
18. NeurIPS “Relational Data” Workshop, Montreal, Dec’18.

19. NeurIPS “ML for Physical Sciences” Workshop, Montreal, Dec’18.
20. Physics Next Meeting, Long Island, NY, Oct’18.
21. Reinssalaer, Applied Math Seminar, Oct’18.
22. Samsung Research, Seoul, Sep’18.
23. UAB Barcelona, Keynote, July’18.
24. Beg Rohu Summer School (France), June’18.
25. ENS (Paris) Data Science Colloquium, June’18.
26. CISS Princeton University, Mar’18.
27. Caltech, Feb’18.
28. IPAM, UCLA LA, “New Deep Learning Techniques”, Feb’18.
29. Rice University, Simons Math+ symposium, Jan’18.
30. NeurIPS “Geometric Deep Learning” Tutorial, Dec’17.
31. Stanford University, Nov’17.
32. MIT, Statistics Seminar, Nov’17.
33. Newton Institute, Cambridge, UK, Oct’17.
34. Deep Learning Summit, Montreal, Oct’17.
35. Allerton Conference, Urbana, Oct’17.
36. Dagstuhl, Germany, Sep’17.
37. Weizmann Institute, “Hammers and Nails, Physics and ML”, Jul’17.
38. FOCM, Barcelona, Jul’17.
39. University of Montreal, June’17.
40. CMU, “Graph Signal Processing School”, June’17.
41. UMD, Maryland, May’17.
42. SIAM Optimization Conference, Vancouver, May’17.
43. Edinburgh University, Mar’17.
44. Princeton University, Statistics Seminar, Mar’17.
45. Barcelona Graduate School of Mathematics, Feb’17.
46. University of Amsterdam, Oct’16.
47. University of Tübingen, Oct’16.
48. EPFL, Lausanne, Oct’16.
49. Rice University, Sep’16.
50. Cubist, New York, Sep’16.
51. Harvard University, Aug’16.
52. JSM (Joint Statistical Meetings), Chicago, Aug’16.
53. UPC Barcelona, May’16.
54. UC Davis, Apr’16.
55. Cambridge University, Mar’16.
56. Google DeepMind, Mar’16.
57. Gatsby Center, UCL, London, Mar’16.
58. Bonn HIM Institute, Mar’16.
59. UC Berkeley, Statistics Seminar, Jan’15.
60. ICCV ‘Mathematics of Deep Learning’ Tutorial, Dec’15.
61. John’s Hopkins University, Nov’15.
62. University of North-Carolina, Oct’15.
63. Facebook, June’15.
64. Google, Mar’15.
65. Santa Fe, Mar’15.
66. Columbia Univ. Dec’14.
67. Yale University, Sep’14.
68. Peking University, June’14.
69. Telecom Paris, June’14.
70. Curves and Surfaces, Paris, June’14.
71. Banff MultiFractal Workshop, Feb’14.
72. UC Berkeley, Aug’13.
73. Duke University, Jul’13.

PATENTS

EP10703636: Video sequence analysis for robust motion estimation.

EP10703637: Temporal video interpolation method with 2-frame occlusion handling.

US 20110096227: Frame Rate Conversion with Motion estimation in a plurality of resolution levels.

US 20110058106, with M.Shand: Sparse Geometry for super-resolution video processing.

EP2010/068133: Cadence Detection for Interlaced Video Based on Temporal Regularity.

US 20100104210, with S.Mallat, N.Laveau, C.Bernard: Method and apparatus for spatio-temporal subband video enhancement with small time-delay.

US 20090278981, with S.Mallat: Method and apparatus for robust super-resolution video scaling.

COLLEGIAL

- Program Committee of ‘Mathematical and Scientific Machine Learning (MSML)’ Conference, June 20, Princeton.
- Organiser of Inverse Problems and Deep Learning Workshop, NeurIPS’19.
- Organiser of Mathematics of Deep Learning (DeepMath), Oct’19.
- Organiser of IAS Workshop on Theory of Deep Learning, Oct’19
- Organizer of MIFODS “Deep Learning and Non-convex Optimization” Workshop, MIT, Jan 2019
- Organizer of “Space Exploration, Inverse Problems and Deep Learning” Symposium, Rice, Simons Foundation Math+X, jan 2019.
- Organizer of “Machine Learning for Network Data” Workshop, New York, Jan 2019.
- Co-organizer of “Representation Learning on Graphs and Manifolds”, ICLR 19.
- Program Chair KDD DL Day 18, Aug 18, London.
- Co-organizer of Machine Learning Summer School, Cadiz, 2016.
- Co-organizer of “Mathematics of Deep Learning” tutorial: ICCV, 2015, CVPR 2016, ECCV 2016, CVPR 2017, ICCV 2017.
- Co-organizer of “Geometric Deep Learning” tutorial: CVPR 2017, NIPS 2017.
- Program committee AISTATS 2016-2017, ICLR 2017-18-19, ICML 17-18-19, NIPS 2017-18-19.
- Senior Program committee AAAI 2018, AISTATS-2019.
- Science, JMLR, ACHA, NIPS, EECV, IEEE TPAMI, Annals of Statistics, IEEE TIT, ICLR, CVPR, PNAS reviewer (2013-present).

UNIVERSITY SERVICE

- Faculty Search Committee: Courant-CDS, 2018-2019.
- Faculty Search Committee: CS NYUAD 2018.
- Faculty Search Committee: Courant CS-ML: 2017-present.
- Faculty Search Committee: Tandon ECE-CDS, 2017-2018.
- Faculty Search Committee: Steinhardt Stats-CDS, 2016-2017.
- PhD Admissions Committee, Courant, 2016-present.
- PhD Admissions Committee, CDS, 2016-present.
- Math and Data Group, CDS. Co-founder and MaD seminar organiser, 2017-present.
- MsC Admissions Committee: Stats Dept. UC Berkeley, 2016.
- Computing Center Committee, Stats Dept., UC Berkeley, 2015.

MENTORING

PhD students:

- Cinjon Resnik (CS, co-advised with Kyunghyun Cho). Sep 2017-
- Luca Venuri (Math, co-advised with Afonso Bandeira). Sep 2017-
- Zhengdao Chen (Math). Sep 2018-
- David Branfonbrener (CS). Sep 2018-
- Aaron Zweig (CS). Sep 2018-
- Min Jae Song (CS, co-advised with Oded Regev). Sep 2018-
- Samy Jelassi (Princeton ORFE). Sep 2018-
- Francis Williams (CS, co-advised with Daniele Panozzo). Sep 2018-
- Carles Domingo (CS). Sep 2019-

- Karl Otness (CS,co-advised with Benjamin Peherstorfer). Sep 2019-

Postdocs:

- Matthew Trager (CDS). Sep 2018-
- Yossi Arjevani (CDS). Sep 2019-

Fellow co-advising:

- Soledad Villar (Fellow). Sep 2017-
- Leo Miolaine (Fellow/Postdoc). Sep 2019-
- Ilias Zadik (Fellow). Sep 2019-

FUNDING

- MURI-ONR THEORINETs (Pending): Amount: 975k, PI.
- NSF CHS Medium: Geometric Deep Learning for Accurate and Efficient Physics Simulation, Amount: 1.2M , period: 8/19 - 7/23. Lead PI.
- NSF CCF CAREER *Theory and Applications of Geometric Deep Learning*: Amount 500k, period 2019/2024. Sole PI
- Capital One. Period: 1/19, 1/21. Amount 450k. “Semi-Supervised Learning in dynamic networks via Recurrent Graph Neural Networks”, PI: Joan Bruna, Co-PI: Carlos Fernandez-Granda.
- NSF IIS-1816753 *Computational and Statistical Tradeoffs in Inverse Problems using Deep Learning* Sole PI. Amount 500k, Period 9/1/18, 8/31/21.
- Alfred P. Sloan Fellowship. Unrestricted funds. Amount: 65k. Period 9/1/18 -.
- Title: NERSC Big Data Center Source: Department of Energy Location: Lawrence Berkeley Lab/ New York University Amount: 220k Period: 3/1/17 - 2/28/20. Commitment: 8.3%
- GRP Deep Learning Phase 2. Source: Samsung. Amount: 1.6M, Period, 11/1/16 - 10/31/19. PI: Kyunghyun Cho, Co-PIs: Joan Bruna, Rob Fergus, Yann LeCun.
- Geometric and Graph Structures in Information Characterization and Extraction. Source: Department of Army. Amount: 299k, Period: 7/1/17- 8/31/20. PI: Alejandro Ribeiro (UPENN), Co-PI: Joan Bruna
- Improving Deep Learning using Latent Structure. Source: Samsung Electronics. Amount: 2.23M, Period: 9/1/17 - 8/31/20. PIs: Joan Bruna, Sam Bowman, Kyunghyun Cho.
- NYU-PSL Global Alliance Fund. Amount 10k, 5/18 to 5/19. PIs: Joan Bruna, Daniele Panozzo, Laurent Cohen (PSL).

TEACHING

- Spring 2015: Stat 135 (UC Berkeley): Mathematical Statistics.
- Fall 2015: Stat 153 (UC Berkeley): Time Series.
- Spring 2016: Stat 212b (UC Berkeley): Topics in Deep Learning.
- Fall 2016: DS-GA 1005 (NYU): Inference and Representation.
- Fall 2017: DS-GA 1005 (NYU): Inference and Representation.
- Spring 2018: CSCI-GA-3033-020 (NYU): Mathematics of Deep Learning
- Fall 2018: DS-GA 1005 (NYU): Inference and Representation.
- Spring 2019: CSCI-GA-3033-020 (NYU): Mathematics of Deep Learning