Gabriella Contardo

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Research Interests: My current research is at the interface between Machine Learning, Data Mining and Astrophysics. My goal is to develop ML and data-mining methods that can help us deepen our understanding of the data, and discover unexplained or unexpected aspects within it. Most recently, I've worked on the detection of 'gaps' (i.e. 'missing' data) in datasets, as a way to discover new types of anomalies, framed as regions of the data-space instead of global outliers data-points. I'm also interested in (weakly supervised) representation-learning for complex data (e.g. time-series, sets), especially for anomaly detection and class-discovery, as well as applications in other scientific fields (e.g. structural biology, healthcare, neuroscience).

Appointment

Flatiron Research Fellow — July 2018 - now
Center for Computational Astrophysics (CCA), Flatiron Institute — New York, USA

Education

Ph.D in Computer Science / Machine Learning — 2013 –2017
Sorbonne University - Pierre et Marie Curie (UPMC) — Paris, France

- Title: Machine Learning Under Budget Constraints
- Advisors: Ludovic Denoyer (UPMC / now Facebook), Thierry Artieres (Centrale Marseille).
- Grant from French Ministry of Research

MSc. Computer Science - Artificial Intelligence — 2011–2013
Sorbonne University - Pierre et Marie Curie - Major in "Intelligent Agents, Learning and Decision."

BSc. Computer Science — 2008–2011
Sorbonne University - Pierre et Marie Curie - Final semester at Université de Montreal, Canada.

Teaching

Teaching Assistant — 2013 –2016
Sorbonne University Pierre et Marie Curie, Paris, France

- BSc. level courses (150h lab class total): Python and Java project-oriented classes with Introduction to A.I. – Task automation – Web Technologies – A.I and Data Science – Computer Science and Statistics.
- MSc. level courses: Machine Learning courses for the 'Big Data Certificate' in Mathematics' Master Program (28h lab class) – Data Science and ML courses at ICS Summer School (Bsc / Msc students in Biology, Mathematics and Computer-Science) (15h lecture).

Mentoring

- **Pa Chia Thao** - Astronomy Grad Student at UNC Chapel Hill - CCA Pre-doctoral Program — Jan 2021 - now
  Machine Learning methods for detrending light-curves data
  Co-advised with Trevor J. David and Dan Foreman-Mackey.

- **Malena Rice** - Astronomy Grad Student at Yale — July 2020 - now
  Using deep learning to find faint moving objects / Planet 9 in TESS data
  Co-advised with Dan Foreman-Mackey.
- **Angeli Sandoval** - Astronomy Undergrad at CUNY Hunter - AstroCom Program — June 2020 - August 2021
  Influence of age on relative frequency of super-earths and sub-neptunes
  Led to one publication at AJ. Co-advised with Trevor J. David.
- **Elaine C. Cui**, **Yuanxi Sun** - MSc. students at NYU Center for Data Science — Oct 2019 - June 2021
  Deep representation learning for cosmology: building 'interpretable' novel summary statistics.
  Co-advised with Francisco Villaescusa-Navarro, Yin Li and Shirley Ho.
- **Ademola Oladosu, Philip Ekfeldt, Tony Xu, Brian A. Kelly** - NYU CDS — 2019 - 2020
  Meta-learning One-Class Classification for stellar streams characterization.
  Led to one paper.
- **Siddhanth Vinay, Gehua Zhang** - MSc. students at Columbia Data Science Institute — 2019 - 2020
  Features learning for galaxy formation.
  Co-advised with Shy Genel.
- **Xinyue Zhang, Yanfang Wang, Wei Zhang, Yueqiu Sun** - MSc. students at NYU CDS — 2018 - 2019
  Jacky HT. Yip - MSc at Chinese University of Hong-Kong
  Predicting galaxy distribution from dark-matter simulation with deep convolutional networks.
  Led to one publication (ML4Physics Workshop NeurIPS). Co-advised with Siyu He and Shirley Ho.

Publications

First author and co-lead papers:

G. Contardo, D. W. Hogg, J. E. Peek, and J. A. Hunt, "The emptiness inside: Finding gaps, valleys, and lacunae with geometric data analysis.", *in prep*, 2021.

A. Sandoval, **G. Contardo**, and T. J. David, "The influence of age on the relative frequency of super-earths and sub-neptunes", *The Astrophysical Journal*, vol. 911, no. 2, p. 117, 2021.

A. Oladosu, T. Xu, P. Ekfeldt, B. A. Kelly, M. Cranmer, S. Ho, A. M. Price-Whelan, and **G. Contardo**, "Meta-learning for one-class classification with few examples using order-equivariant network: Application in the milky way", *arXiv preprint arXiv:2007.04459*, 2020.

K. W. Wong, **G. Contardo**, and S. Ho, "Gravitational-wave population inference with deep flow-based generative network", *Physical Review D*, vol. 101, no. 12, p. 123 005, 2020.

J. H. Yip, X. Zhang, Y. Wang, W. Zhang, Y. Sun, **G. Contardo**, F. Villaescusa-Navarro, S. He, S. Genel, and S. Ho, "From dark matter to galaxies with convolutional neural networks", in *Machine Learning and the Physical Sciences @ NeurIPS*, 2019.

G. Contardo, "Machine learning under budget constraints", Ph.D. dissertation, 2017.

G. Contardo, L. Denoyer, and T. Artières, "A meta-learning approach to one-step active learning", in *AutoML Workshop @ ECML-PKDD*, 2017.

G. Contardo, L. Denoyer, and T. Artières, "Sequential cost-sensitive feature acquisition", in *International Symposium on Intelligent Data Analysis*, Springer, 2016.

G. Contardo, L. Denoyer, and T. Artières, "Recurrent neural networks for adaptive feature acquisition", in *International Conference on Neural Information Processing (ICONIP)*, Springer, 2016.

G. Contardo, L. Denoyer, and T. Artieres, "Representation learning for cold-start recommendation", in *ICLR Workshop*, 2015.

G. Contardo, L. Denoyer, T. Artieres, and P. Gallinari, "Learning states representations in pomdp", in *ICLR workshop*, 2014.

Collaborated publications:

T. David, **G. Contardo**, A. Sandoval, R. Angus, Y. Lu, M. Bedell, J. Curtis, D. Foreman-Mackey, B. Fulton, S. Grunblatt, and E. Petigura, "Vizier online data catalog: Compared rotation periods for 1189 cks host stars (david+, 2021)", *VizieR Online Data Catalog*, J–AJ, 2021.

F. Villaescusa-Navarro, S. Genel, D. Angles-Alcazar, L. Thiele, R. Dave, D. Narayanan, A. Nicola, Y. Li, P. Villanueva-Domingo, B. Wandelt, *et al.*, "The camels multifield dataset: Learning the universe's fundamental parameters with artificial intelligence", *arXiv preprint arXiv:2109.10915*, 2021.

H. Shao, F. Villaescusa-Navarro, S. Genel, D. N. Spergel, D. Angles-Alcazar, L. Hernquist, R. Dave, D. Narayanan, **G. Contardo**, and M. Vogelsberger, "Finding universal relations in subhalo properties with artificial intelligence", *arXiv preprint arXiv:2109.04484*, 2021.

W. E. Kerzendorf, C. Vogl, J. Buchner, **G. Contardo**, M. Williamson, and P. van der Smagt, "Dalek: A deep learning emulator for tardis", *The Astrophysical Journal Letters*, vol. 910, no. 2, p. L23, 2021.

V. A. Villar, M. Cranmer, E. Berger, **G. Contardo**, S. Ho, G. Hosseinzadeh, and J. Y.-Y. Lin, "A deep learning approach for active anomaly detection of extragalactic transients", *arXiv preprint arXiv:2103.12102*, 2021.

T. J. David, **G. Contardo**, A. Sandoval, R. Angus, Y. L. Lu, M. Bedell, J. L. Curtis, *et al.*, "Evolution of the exoplanet size distribution: Forming large super-earths over billions of years", *The Astronomical Journal*, vol. 161, no. 6, p. 265, 2021.

V. A. Villar, M. Cranmer, **G. Contardo**, S. Ho, and J. Y.-Y. Lin, "Anomaly detection for multivariate time series of exotic supernovae", in *Machine Learning and the Physical Sciences Workshop at NeurIPS.*, arXiv preprint arXiv:2010.11194, 2020.

F. Villaescusa-Navarro, C. Hahn, E. Massara, A. Banerjee, A. M. Delgado, D. K. Ramanah, T. Charnock, E. Giusarma, Y. Li, E. Allys, *et al.*, "The quijote simulations", *The Astrophysical Journal Supplement Series*, vol. 250, no. 1, p. 2, 2020.

A. Ziat, **G. Contardo**, N. Baskiotis, and L. Denoyer, "Learning embeddings for completion and prediction of relationnal multivariate time-series.", in *ESANN*, 2016.

A. Ziat, **G. Contardo**, N. Baskiotis, and L. Denoyer, "Car-traffic forecasting: A representation learning approach", in *MUD@ ICML*, 2015.

Honors and Grants

- Flatiron Fellowship 2018-2022
- Best Student Paper Award + Travel Grant Award, ICONIP Conference 2016
- Doctoral Grant / Scholarship (3 years funding) French Ministry of Research 2013-2016
- Support Grant / Scholarship for International Studies from Region Ile de France and from Sorbonne UPMC 2011

Other

Service & Leadership

- Organizer of the Machine Learning group meeting at CCA 2018 - now
- Co-organizer of Flatiron Wide Conference on Algorithms and Mathematics 2019, 2020
- Co-organizer of the Machine Learning 'journal club' / seminar at CCA 2018 - 2020
- Member of the Flatiron Research Fellow Hiring Process Committee for CCA 2018 - 2020

- Reviewer for Machine Learning Journal, AAS Journals, Astronomy and Computing, Machine Learning and the Physical Science Workshop (NeurIPS)
- Reviewer for NSF and NASA panels grants

Recent selected talks and community events:

- SISSA, Trieste, Data Science Seminar, invited talk 2021
- AAS 238, Meeting-in-a-Meeting on Machine Learning, invited talk 2021
- Sarah Lawrence University, Science Seminar, invited talk 2020
- Michigan State University, Machine Learning Seminar, invited talk 2019
- NASA Goddard, Joint Exoplanet and Machine Learning Seminar, invited talk 2019
- Ringberg Machine Learning in Astronomy Workshop, contributed talk 2019
- Columbia Stat-Astro Meeting, invited talk/tutorial 2019
- Invited Teacher and participant of AstroHackWeek, Cambridge 2019
- MicroLensing Hackdays 2019

References

- Shirley Ho (CCA) (sho@flatironinstitute.org)
- David W. Hogg (CCA/NYU) (dhogg@flatironinstitute.org)
- Ludovic Denoyer (Facebook/UPMC) (denoyer@fb.com)