Sara Scaramuccia

Birth

Genova, Italy 08/02/1988

Date

Torino, 08/11/2021

Address

Via Tommaso da Celano 44

10125 Torino

Italy

Contacts

sara.scaramuccia@gmail.com

http://sarascaramuccia.wixsite.com/scara

(+39) 3477989536

Research fellow at **Università degli Studi di Roma Tor Vergata, Rome (Italy)** [0] in computational and theoretical aspects in Topological Data Analysis over unstructured data of large size

---

Post-doc Experience

Employed by Università degli Studi di Roma Tor Vergata, Rome (Italy) [0]

Feb., 2022 - now
Research Fellow at Università degli Studi di Roma Tor Vergata with fulltime commitment. I am member of the **Complex Analysis Group** [1] within the **Dipartimento di Matematica - Dipartimento di Eccellenza 2018-2022** [2]. My activity is developed *in collaboration with*:

- Prof. Paolo Salvatore
- the interdisciplinary company **Atos Italia SpA** [3] leader in cloud and digital workplace

Employed by Politecnico di Torino (Italy) [4]

Sep., 2020 - Jan. 2022
Postdoc researcher at Politecnico di Torino with fulltime commitment (more details in Section 'Academic Experience'). My project was devoted to the development of new techniques in computational topology, especially persistent homology, as well as to the integration of topological data analysis techniques into learning frameworks. My activity was developed *in collaboration with*:

- the group "Topological, algebraic and geometric data analysis" led by Prof. Francesco Vaccarino and belonging to the **DISMA - Dipartimento di Eccelenza 2018-2022** [5]
- the interdisciplinary center **SmartData@PoliTO** [6] focusing on Big Data technologies, Data Science and Machine Learning approaches

Employed by Université de la Côte d'Azur [7]

Feb., 2019 - Feb., 2020
Postdoc researcher at Université de la Côte d'Azur with fulltime commitment. My project consists in developing new clustering algorithms, designing multiple iterations guided by user feedbacks, to optimize clustering quality in the specific domain of flight recommendations. *Project leaders:*

- Doctor Florent Masseglia - at **Data Mining Zenith group - INRIA** [8] - Montpellier
- Doctor Nicolas Maillot - at **Amadeus** [9] - Sophia Antipolis

Industry Experience

Employed by Alten Group [10]

Sep., 2018 - Feb., 2019	**Data Scientist (consultant)** for Alten Group. with fulltime commitment. I was hired to join a consulting project with Amadeus under the supervision of Nicolas Maillot. Unfortunately, the project never started. At that time, I enhanced my skills in C++ and Java by taking extra courses waiting for a new project.

Employed by COLOUREE S.R.L. [11]

July, 2017 - July, 2018	**Data Scientist** for COLOUREE S.R.L. with part-time commitment. The start-up company provides visualization of data in the context of architectural environment. My role was that of combining finer techniques (such as Principal Component Analysis, Hierarchical Clustering, and Discrete Morse Theory) to enhance the analysis

Education

Feb. 2021	**Qualification aux fonctions de Maître de Conférences**; Section 27 "Informatique" of the Conseil national des universités - CNU (France)

N. of qualification: 21227356828

Nov. 2014 - May 2018	**PhD, Computer Science**; Università degli studi di Genova (Genova) (more details in Section 'Academic Experience')

Thesis title: Computational and Theoretical Issues of Multiparameter Persistent Homology in Data Analysis

IRIS ITEM: (4) http://hdl.handle.net/11567/929143

Supervisors:
- Professor Leila De Floriani - University of Maryland (MD, USA)
- Professor Claudia Landi - Università di Modena e Reggio nell'Emilia (Modena e Reggio Emilia)

Keywords: Information Visualization, Topology, Algorithm design, Algorithm evaluation, Persistent Homology, Discrete Morse Theory

---

2011-2013	**MSc, Mathematics**; Università degli studi di Genova (Genova)

Grade: 110/110 cum laude

Supervisors:
- Professor Bjørn Dundas - Universitetet i Bergen (Bergen, Norway)
- Professor Stefano Vigni - Università degli studi di Genova (Genova)

2007-2011   **BSc, Mathematics**; Università degli studi di Genova (Genova)

Grade: 96/110

Supervisor:
- Professor Ettore Carletti - Università degli studi di Genova (Genova)

Keywords: Differential Geometry

Study Experience Abroad

Jan.-May, 2017   **Visiting Student at University of Maryland (MD) USA**; I worked as part of the research group of Professor Amitabh Varshney and the research group of Professor Hanan Samet on data structures in the fields of topology-based analysis and visualization of large-size multivalued data sets. During that period, I obtained the core experimental results of my PhD thesis

---

2012-2013   **LLP Erasmus Programme**; Department of Mathematics of the Universitetet i Bergen, Bergen, Norway
My Master Thesis is the result of my Erasmus experience

Academic Experience

My current project. My role is that of exploiting algebraic topology tools to propose new computational techniques and to combine those with learning theory. As an example, in **(2)**, we have exploited the algebraic notion of set of generators for a graded module over the polynomial ring to introduce and compute a new kind of homological generator set called *interval basis* where relations occuring along a filtration are implicitly encoded. This way we contributed to shorten the distance in between topological descriptors and geometric localization. Furthermore in **(3)**, we have continued the work on the interplaying between Forman's discrete Morse Theory and multiparameter persistent homoogy by introducing inequalitites relating bigraded Betti numbers and critical points of a bi-parametrized function. This way we contributed to the interpretation of computable topological descriptors in the case of multiparameter filtrations. Part of my work is devoted to the spread persistent homology techniques within other communities, such as that of physicists working with higher-order networks **(1)**, and researchers in Visual-analytics **(9)**

My PhD project My **(5) thesis** is the result of my work on computational methods and data structures for Topological Data Analysis and Visual-analytics. In particular, I have worked on the multiparameter counterpart of *Persistent Homology*. My project included:

- **(7)** acquiring a solid state-of-the-art knowledge in peristent homology theory and algorthmics
- **(4)** designing new efficient algorithms for the retrieval of multiparameter persistent homology invariants

- **(3)** proposing a new discrete Morse-based notion of "optimal reduction" for multiscalar domains
- **(6) (7)** based on the latter, investigating multivariate segmentation of domains via discrete Morse theory.

Reviewing Activity

Apr. 2022 reviewer for the *Journal of Applied and Computational Topology (APCT)* - Springer

Apr. 2022 reviewer for the *30. Jubilee Int. Conf. on Computer Graphics, Visualization and Computer Vision 2022*

Sep. 2021 reviewer for the *Computational Geometry: Theory and Applications Journal* - Elsevier.

Sep. 2021 reviewer for the *Pure and Applied Mathematics Journal* - PAMJ, Science Publishing Group.

Dec. 2020 reviewer for the workshop *TDA and beyond* - at NEURIPS 2020.

Selected Works

(1) Apr. 2022: F. Vaccarino, U. Fugacci, and S. Scaramuccia. **"Persistent Homology: a topological tool for higher-interaction systems"**. In **"Higher-Order Systems"** chapter 4, F. Battiston, G. Petri Ed., in "Understanding Complex Systems" Series, Nature - Springer Verlag.

(2) Jun. 2021: A. De Gregorio, M. Guerra, S. Scaramuccia, F. Vaccarino. *Parallel decomposition of persistence modules through interval bases*, Preprint in ArXiv **arXiv:2106.11884v1**.

(3) Apr. 2021: C. Landi, S. Scaramuccia. *Relative-perfectness of discrete gradient vector fields and multi-parameter persistent homology*, in Journal of Combinatorial Optimization.

(4) Feb. 2020: S. Scaramuccia, F. Iuricich, L. De Floriani, C. Landi. *Computing multiparameter persistent homology through a discrete Morse-based approach*, in Comutational Geometry

(5) May 2018: S. Scaramuccia. *Computational and Theoretical Issues of Multiparameter Persistent Homology in Data Analysis*. PhD Thesis.

(6) Dec. 2016: F. Iuricich, S. Scaramuccia, C. Landi, L. De Floriani. *A Discrete Morse-based Approach to Multivariate Data Analysis*. 9th ACM SIGGRAPH in Asia. Macao, China.

(7) Oct. 2016: U. Fugacci, S. Scaramuccia, F. Iuricich, L. De Floriani. *Persistent Homology: a Step-by-step Introduction for Newcomers*. STAG, Italian Eurographics Chapter. Genova, Italy.

(8) Sep. 2016: F. Iuricich, S. Scaramuccia, C. Landi, L. De Floriani. *Computing Shape Descriptord Based on Vector-valued Functions*. In Proceedings of the 25th International Meshing Roundtable and User Forum. Washington (DC), USA.

Accepted works

(9) Accepted chapter. U. Fugacci, F. Iuricich, S. Scaramuccia, L. De Floriani. "Multiparameter persistent homology for shape analysis". In Shape Analysis: Euclidean, Discrete and Algebraic

Geometric Methods (Dagstuhl Seminar 18422) Michael Breuß, Alfred M. Bruckstein, Christer Oscar Kiselman, Petros Maragos. In Dagstuhl Reports. Schloss Dagstuhl-Leibniz-Zentrum für Informatik.

Speaker at:

- May, 2021. "Persistent Homology for Market Basket Analysis", speaker at ENBIS2021 - European Network for Business and Industrial Statistics - Spring Meeting - teleconference.
- Dec., 2020. "Topological methods for social data analysis: an overview", speaker at DSSR2020 - Data Science & Social Research - teleconference.
- Apr., 2018. "Computational and Theoretical Issues in Multiparameter Persistent Homology for Data Analsysis", invited speaker at Geometry Seminars - Tecnhische Universistät Graz, Graz, Austria
- Apr., 2017. "A Discrete Morse-based Approach to Multivariate Data Analysis", speaker at SCGP - Spring School on Discrete and Computational Geometry, Stony Brook (NY), USA
- Dec., 2016. "A Discrete Morse-based Approach to Multivariate Data Analysis", speaker at Siggraph Asia - Symposium on Visualization, Macao, China
- Aug., 2016. "Towards the Analysis of Multivariate Data via Discrete Morse Theory", poster presentation at Applications and Statistics of Multidimensional Persistence Workshop, École Polythecnique fédérale de Lausanne (EPFL), Switzerland
- Jul., 2016. "Towards the Analysis of Multivariate Data via Discrete Morse Theory", poster presentation at ATMCS7 - Applied Topology: Methods, Computations and Science, Politecnico di Torino, Italy
- May, 2016. "Multidimensional Persistent Homology: the Algebraic Setting", invited speaker at Algebra & Geometry Seminars, Università degli studi di Genova (DIMA), Italy

---

Chairpersonships:

- Jun. 2022. Programme Chair, WoCG 2022: 10th Annual Minisymposium on Computational Topology. WoCG is an yearly workshop within the international symposium Computational Geometry Week - SOCG.

Teaching Activity

Courses:

- AY 2021-2022. Lecturer of a 16 hours course at the second level University Master in Mathematical and Physical methods for Space Sciences at Università degli Studi di Torino

Supervisions:

- AY 2021-2022. Co-supervisor supervision as external member of MSc Thesis in Stochastics and Data Science at Università degli Studi di Torino

Other activities:

- AY 2021-2022. On-going supervision of MSc Thesis in Mathematical Engineering at Politecnico di Torino
- AY 2021-2022. Mentor in Data Science at the interdisciplicary Master course "Challenge@PoliTo_by Firms", at Politecnico di Torino
- AY 2019-2020. Invited speaker at the Statistics stage for high school students, at Università degli studi di Genova
- AY 2016-2017. Teaching assistant of the Elementi di Matematica e Logica Undergraduate course in Computer Science, at Università degli studi di Genova
- AY 2015-2016. Teaching assistant of the Geometria Undergraduate course in Computer Science, at Università degli studi di Genova
- AY 2015-2016. Co-author of the Geometric Modeling Graduate course notes, Computer Science, at Università degli studi di Genova
- AY 2015-2016. Examinator Assistant to the Algoritmi e Strutture Dati Undergraduate course, Computer Science, at Università degli studi di Genova
- AY 2014-2015. Co-author of the Mathematical Logics Graduate course notes, Computer Science, at Università degli studi di Genova
- AY 2014-2015. Guest Lecturer in the Geometric Modeling Graduate course, Computer Science, at Università degli studi di Genova
- AY 2014-2015-2016. Co-author and Guest Lecturer at the Mathematics stage for high school students, at Università degli studi di Genova

---

Attended International Academic Events

- 2021. CompPers - Computational Persistence Workshop - teleconference.
- 2017. SCGP - Spring School on Discrete Computational Geometry - Stony Brook (NY), USA
- 2016. ACM SIGGRAPH Asia - Conference and Exhition on Computer Graphics and Inteeractive Techniques in Asia, Symposium on Visualization - Macao, China
- 2016. STAG - Conference on Smart Tools and Apps in Computer Graphics, Italian Eurographics Chapter - Genova, Italy
- 2016. Workshop on Applications and Statistics of Multidimensional Persistent Homology - Lausanne, Switzerland
- 2016. ATMCS7 - Conference in Applied Topology: Methods, Computations and Science - Turin, Italy
- 2015. CAT - School on Computational Algebraic Topology - Oxford, UK
- 2015. HTCA - School on Homology: Theoretical and Computational Aspects - Genova, Italy
- 2015. BISS - Bertinoro International Spring School - Bertinoro, Italy

---

Other projects

from 2020   member of the European project ELBA devoted to the "Establishment of Training and Research Centers and Courses Development on Intelligent Big Data Analysis in Central Asia". My role is that of providing and discussing contents for the teaching to be provided at Asian partners. Furthermore, I am lecturer of a 5-day course for Asian partners in TDA to be held when possible in presence.

Awards

2014   three-years Phd Scholarship from the Università degli studi di Genova, from 01/11/2014 to 01/11/2017

Memberships

from 2018   Professional member of the Association for Computing Machinery (ACM)

from 2017   Student member of the Association for Computing Machinery (ACM)

from 2015   Associate member of the London Mathematical Society

Technical Skills

Operating Systems   Good knowledge of **Windows**, **OSX** and **Linux**

Software   Good knowledge of **Paraview** for scientific visualization

---

Programming   Optimal knowledge of **Latex Editor** necessary for producing scientific documents

Good knowledge of **Python**, especially Scikit-learn, Scikit-TDA for developing and visualizing new methods

Good knowledge of **Git** for version handling

Good knowledge of **Matlab** for the plotting of scientific results

Basic knowledge of **C**, **C++**, **Java**, **Paraview**, **SAS** necessary for performing experiments and customizing the open source libraries **TTK**, **Topcat**, **PHAT**, **JPlex**, **RIVET**

Design of simple **html** pages such as [12]

Personal Skills

Human Languages

Certifications:

- Italian (native speaker)
- English (B2) FCE - 2007
- French (A2) DELF - 2002
- Norwegian (A1) Course at Universitetet i Bergen - 2012

	Listening	Reading	Speaking	Writing
English	C1 Proficient	C2 Proficient	C1 Proficient	C1 Proficient
French	C1 Proficient	C1 Proficient	B2 Independent	B1 Independent
Norwegian	A1 Basic	A1 Basic	A1 Basic	A1 Basic

Cooperative Skills Optimal communication skills enhanced during my PhD programme due to the interaction with supervisors, collegues and graduate students as part of the **Computer Graphics, Vision, and Multimodal Systems Group** [13] - at DIBRIS, Università degli studi di Genova.

Outstanding attitude to collaborating with people with different backgrounds in the accomplishment of a common task.

Deep enthusiasm towards new challenging tasks and sharing/learning new skills which strongly motivated my choice of a PhD programme in Computer Science.

Management Skills Optimal scheduling skills enhanced as part of the above mentioned research group and derived from the necessary coordination in perfoming experiments and in managing the teaching activity.

Particular skills in the remote cooperation (via Skype) among far apart-living collaborators: part of the research group works in Maryland (USA) and one of my supervisors works in Modena (Italy).

Licences

2010	driving licence A (motorbikes)
2007	FIN Lifeguard licence
2006	driving licence B (cars)

Personal Interests

2020-now	*Soccer* at non-competitive level
2018-2020	*Soccer* at competitive level (Division d'Honneur - Ligue de la Mediterranée), team member of F.C. Golfe Juan, and A.S. Cannes
2007-2012	*Soccer* at competitive level (Serie C), team member of Molassana Boero Calcio
1991-2007	*Swimming* at competitive level, team member of R.N. San Fruttuoso, and A.S. Genova Nuoto
	Guitar player as a personal hobby

External Links

[0]: http://web.uniroma2.it

[1]: https://www.mat.uniroma2.it/~complex/area.php

[2]: http://www.mat.uniroma2.it

[3]: https://atos.net/en/industries/healthcare-life-sciences/research

[4]: https://www.polito.it/

[5]: https://www.disma.polito.it

[6]: https://smartdata.polito.it

[7]: http://univ-cotedazur.fr/fr

[8]: https://www.inria.fr/equipes/zenith

[9]: https://amadeus.com/en

[10]: http://www.alten.fr

[11]: www.colouree.com

[12]: http://htmlpreview.github.io/?https://github.com/IuricichF/ICT/blob/master/index.html

[13]: http://www.dibris.unige.it/en/research/programs?view=prdetail&prog=3

Publications links

(1): https://link.springer.com/chapter/10.1007/978-3-030-91374-8_3

(2): https://arxiv.org/abs/2106.11884

(3): https://link.springer.com/article/10.1007/s10878-021-00729-x

(4): https://www.sciencedirect.com/science/article/abs/pii/S0925772120300171

(5): http://hdl.handle.net/11567/929143

(6): http://dl.acm.org/citation.cfm?id=3002166

(7): http://diglib.eg.org/handle/10.2312/stag20161358

(8): https://pdfs.semanticscholar.org/9875/e6c5b5e8c7af21db1649104de4a14ba0100c.pdf

---

sara.scaramuccia@gmail.com • +39 3477989536 • 33 years old
Via Saluzzo 70 int. 12 - 10125 - Torino, Italia