Rossana Capuani

Curriculum Vitae

Updated October 21th, 2021

Education

1 November 2014 – 24 April 2018 — **Ph.D. in Mathematics**, *Joint Ph.D. program between University of Roma Tor Vergata and Paris-Dauphine University*, *Supervisors: Prof. Piermarco Cannarsa and Prof. Pierre Cardaliaguet*.
Ph.D.'s Thesis: *Mean Field Games with state constraints*

1 October 2011 – 20 June 2014 — **Master's Degree in Pure and Applied Mathematics**, *Federico II University*, Naples, *Grade – 110/110 cum laude*.
Master's Degree Thesis: *De Giorgi regularity theorem and nonlinear potential theory*.

1 October 2007 – 26 May 2011 — **Bachelor's Degree in Mathematics**, *Federico II University*, Naples, *Grade – 110/110 cum laude*.
Bachelor's Degree Thesis: *Linear stability for the linear methods multistep*.

Ph. D. Thesis

Title — Mean Field Games with state constraints

Supervisors — Prof. Piermarco Cannarsa (University of Rome Tor Vergata) and Prof. Pierre Cardaliaguet(Paris-Dauphine University)

Description — The aim of this Thesis is to study deterministic mean field games for agents who operate in a bounded domain. In this case, the existence and uniqueness of Nash equilibria cannot be deduced as for unrestricted state space because, for a large set of initial conditions, the uniqueness of the solution to the associated minimization problem is no longer guaranteed. We attack the problem by interpreting equilibria as measures in a space of arcs. In such a relaxed environment the existence of constrained MFG equilibrium follows by set-valued fixed point arguments. Then, we give a uniqueness result for such equilibria under a classical monotonicity assumption. At this point, it is natural to define a mild solution of the constrained MFG problem as a pair $(u, m) \in C([0,T] \times \overline{\Omega}) \times C([0,T]; \mathcal{P}(\overline{\Omega}))$, where m is given by $m(t) = e_t \sharp \eta$ for some constrained MFG equilibrium η and

$$u(t,x) = \inf_{\substack{\gamma \in \Gamma \\ \gamma(t) = x}} \left\{ \int_t^T \Big[L(\gamma(s), \dot{\gamma}(s)) + F(\gamma(s), m(s)) \Big] \, ds + G(\gamma(T), m(T)) \right\}.$$

Under suitable assumptions on the data, we have analyzed the regularity and sensitivity of the mild solutions. Finally, using the regularity of mild solutions and the structure of our problem, we show that (u, m) satisfies the MFG system in suitable.

Employment

1 August 2021 –present — **Post-doc position**, *Department of Mathematics*, University of Trento, Italy.
Supervisor: Prof. Fabio Bagagiolo

1 August 2020 –31 July 2021 — **Post-doc position**, *Department of Computer Sciences*, University of Verona, Italy.
Supervisor: Prof. Antonio Marigonda

1 January 2019 – 31 December 2019 — **Post-doc position**, *Department of Mathematics*, North Carolina State University, USA.
Supervisor: Dr. Khai T. Nguyen

1 September 2018 – 31 December 2018 — **Research Assistant**, *Department of Computer Sciences, University of Verona, Italy*.
Enrolled in the research activity "Analytical aspects of mean field optimal control for multi-agent systems" (CEESARAS-UA.VR.050.DIPINF.DINF-REST, Prof Riccardo Muradore)

Research Interests

- Mean Field Games Theory
- Optimal Control Theory
- Nonsmooth Analysis
- Viscosity solutions of Hamilton–Jacobi equations
- Optimal Transportation Theory
- Models of mathematical finance
- Models of traffic flows
- Multiagent systems

Publications

Publications in Journals

2021 Cannarsa, P., Capuani, R. & Cardaliaguet, P. Mean field games with state constraints: from mild to pointwise solutions of the PDE system. Calc. Var. 60, 108, https://doi.org/10.1007/s00526-021-01936-4, 33 pages

2021 Capuani, R., Dutta, P., Nguyen, K. T., Metric entropy for functions of bounded total generalized variation, SIAM J. Math. Anal., 53(1), DOI: 10.1137/20M1310953, 22 pages.

2020 Capuani, R., Gilmore, S., Nguyen, K. T., A model of debt with bankruptcy risk and currency devaluation, Minimax Theory and its Applications , 5, no. 2, 23 pages.

2018 Cannarsa, P.,Capuani, R., and Cardaliaguet, P.,$C^{1,1}$–smoothness of constrained solutions in the calculus of variations with application to mean field games,Mathematics in Engineering,1(1), doi:10.3934/Mine.2018.1.174, 29 pages.

2018 Cannarsa, P., Capuani, R., Existence and uniqueness for Mean Field Games with state constraints,"PDE models for multi-agent phenomena", P. Cardaliaguet, A.Porretta, F. Salvarani editors, Springer INdAM Series, 22 pages

Conference Proceedings

2021 Capuani, R., Marigonda, A., Mogentale, M., Random lifting of set-valued maps, **accepted** to appear In Large-scale scientific computing, Springer.

Submitted Paper

2021 Capuani, R., Di Persio, L., Kondratiev, Y., Ricciardi, M., da Silva, J.L., Random time dynamical system, **submitted**.

Work in Progress

- with A. Marigonda, *A model for multi-agent system with visibility constraints*.
- with A. Marigonda and A. Briggi (MSc student), *Methods of mean field control in S.A.R. operations*
- with A. Marigonda, M. Ricciardi, *Random Lift Of Set-Valued Maps And Applications.*
- with F. Bagagiolo and L. Marzufero, *Analysis of some models for pursuit-evasion game between two populations.*

Teaching Experience

2021 **Teaching at University of Verona**

Spring 2021 **Instructor**, *Remedial Course in Mathematics*.

2020 **Cultore della materia**, *presso il Corso di studio di Scienze dell'architettura (Università Mediterranea di Reggio Calabria) in Istituzione di Matematica, settore scientifico-disciplinare MAT/05-Analisi Matematica*.

2019 **Teaching at NCSU**

Fall 2019 **Instructor**, *MA 141-Calculus I*.

Spring 2019 **Instructor**, *MA 108-Precalculus II*.

2015-2017 **Teaching at Univeristy of Rome Tor Vergata**

Fall 2017 **Teaching assistant**, *Analysis I*.

Fall 2015 **Teaching assistant**, *Calculus II*.

Spring 2015 **Teaching assistant**, *Ordinary Differential Equations*.

Spring 2015 **Teaching assistant**, *Fourier Analysis*.

Student Supervision

April 2021 – October 2021 **Co-supervisor of the MSc thesis of A. Briggi**, *co-supervised with Prof. A. Marigonda*, University of Verona. **Title Thesis**: Methods of mean field control in S.A.R. operations, Grade: 110/110 cum laude.

January 2019– **Co-supervisor of the PhD candidate Prerona Dutta**, co-supervised with Prof. Tien Khai Nguyen, North Carolina State University, Raleigh, North Carolina, USA.

January 2019– **Co-supervisor of the PhD candidate Steven Gilmore**, co-supervised with Prof. Tien Khai Nguyen, North Carolina State University, Raleigh, North Carolina, USA.

Organization of Conferences and Seminars

2020 **"Online seminars in Analysis, Control and Inverse Problems for PDEs"**, organizers: Piermarco Cannarsa, Rossana Capuani, Giuseppe Floridia.

January 2021-present **Young Researcher Seminars, Maths Applications & Models**, organizers: Giacomo Albi, Rossana Capuani, Antonio Marigonda, Michele Ricciardi, Nicola Sansonetto, Chiara Segala, https://mathseminarsverona.wordpress.com/.

Research Visits

December 2021 **Institute for Mathematical & Statistical Innovation**, *University of Chicago, Chicago,USA*, Invited as a Research Member and as a participant in Long Program Distributed Solutions to Complex Societal Problems..

Jan. -Mar. 2020 **Prof. K. T. Nguyen**, *Department of Mathematics*, North Carolina State University, Raleigh, NC, USA.

June 2019 **Prof. A. Marigonda**, *Department of Computer Science*, University of Verona, Verona, Italy.

November 2018 **Prof. K. T. Nguyen**, *Department of Mathematics*, North Carolina State University, Raleigh, NC, USA.

Peer-Review Experience

Referee for SIAM J. Math. Anal, and Journal of Dynamical and Control Systems.

Selected Presentations in Conferences, Workshops and Seminars

March 2022 **SIAM Conference on Analysis of Partial Differential Equations (PD22)**, 14-18 March 2022, Technical University Berlin (Berlin - Germany). Invited talk for the minisymposium "Mean field games and applications" organized by Jameson Graber and Alpar Meszaros. Invited talk's title: Mean Field Games with state constraints: from mild to pointwise solutions of the PDE system.

November 2021 **Seminar of Analysis**, with a **talk** entitled "*Random Lift Of Set-Valued Maps And Applications*", Department of Mathematics, University of Trento(invited)

June 2021 **13th International Conference on "Large-Scale Scientific Computations"**, with a **talk** entitled "*First order Mean Field Games with state constraints*",Institute of Information and Communication Technologies, Bulgarian Academy of Sciences, Sozopol, Bulgaria, (invited)

April 2021 **Seminar of online Young Researcher Seminars, Maths Applications & Models**, with a **talk** entitled "*First order Mean Field Games with state constraints*" Department of Computer Sciences, University of Verona, (invited)

September 2020 **XLV Summer School on Mathematical Physics**, with a **talk** entitled "*Metric entropy for functions of bounded total generalized variation*"Ravello, Italy

March 2020 **Seminar of Differential Equations and Nonlinear Analysis**, with a **talk** entitled "*Metric entropy for functions of bounded total generalized variation*",Department of Mathematics, NCSU (invited)

October 2019 **39th Southeastern-Atlantic Regional Conference on Differential Equations**, with a **talk** entitled "*Introduction to Mean Field Games with state constraints*", Daytona Beach (Florida), USA

August 2019 **The V AMMCS International Conference** with a **talk** entitled "*First order Mean Field Games systems with state constraints*", Waterloo (Ontario), Canada

June 2019 **Seminar of Analysis**, "*Mean Field Games with state constraints: from mild to pointwise solutions of the PDE system"*, Department of Computer Sciences, University of Verona (invited)

May 2019 **Indam intesive period-2019: Shape optimization, control and inverse problems for PDEs** with a **talk** entitled "*Mean Field Games with state constraints: from mild to pointwise solutions of the PDE system*" , Naples, Italy(invited)

February 2019 **Seminar of Differential Equations and Nonlinear Analysis**, with a **talk** entitled"*First order Mean Field Games with state constraints*"Department of Mathematics, NCSU (invited)

November 2018 **Seminar of Analysis**, with a **talk** entitled "*Mean Field Games with state constraints*", Department of Mathematics, University of Trento, (invited)

October 2018 **Seminar of Analysis**, with a **talk** entitled"*Fractional semiconcavity and some applications to state constrained problems*", Department of Mathematics, University of Padova, Italy (invited)

September 2018 **Optimal Control and Mean Field Games** with a **talk** entitled "*First order Mean Field Games with state constraints*", Pavia, Italy (invited)

August 2017 **Summer-school: VII Partial differential equations, optimal design and numerics** with a **talk** entitled "*Mean Field games with state constraints*", Benasque, Spain

Selected conferences and schools

December 2021 **Mathematical Advances in Mean Field Games**, Institute for Mathematical & Statistical Innovation, Chicago, Illinois, USA

December 2021 **Applications to Financial Engineering**, Institute for Mathematical & Statistical Innovation, Chicago, Illinois, USA

November 2021 **Applications of Mean Field Games: from Models to Practice**, online

November 2021 **Mean-Field Models for interacting agents**, online

October 2021 **Aggregate Dynamics in Models with Heterogeneous Agents**, online

October 2021 **Short Courses on the Mean Field Approach in Machine Learning and Statistics**, online

September 2021 **Analysis, Control, and Numerics for PDE Models of Interest to Physical and Life Sciences**, online

September 2021 **New Trends in Nonlinear Diffusion: a Bridge between PDEs, Analysis and Geometry**, online

July 2021 **INdAM workshop Analysis and Numerics of Design, Control and Inverse Problems**, online

June 2021 **Summer School: Model Order Reduction and Applications**, Cetraro, Italy

May 2021 **Workshop on Control Theory and Partial Differential Equations**, online

September 2020 **Variational methods in nonlinear phenomena**, online

September 2020 **XLV Summer School on Mathematical Physics**, Ravello, Italy

November 2020 **15th Young Researchers Workshop in Geometry, Mechanics, and Control** , online

June 2019 **Singular Nonlinear Problems in Calculus of Variations and PDEs**, Naples, Italy

June 2019 **Summer-school: Mean Field Games**, Cetraro, Italy.

November 2018 **Optimal Transportation and Applications**, Pisa, Italy

June 2018 **METE: Mathematics and Economics: Trends and Explorations**, Zurich, Switzerland.

December 2017 **First meeting of the French-German-Italian LIA on applied analysis**, Paris, France.

July 2017 **INdAM Workshop-New trends in control theory and PDEs**, Rome, Italy.

June 2017 **Variational analysis and equilibrium models in physical and socio-economic phenomena**, Naples, Italy.

June 2017 Mean field games and related topics-4, Rome, Italy.

March 2017 **Mathematical Approach to climate change Impacts-MAC ^2I**, Rome, Italy.

December 2016 **PDE Models for Multi-agent phenomena**, Rome, Italy.

February 2016 **Nonlinear PDEs: Optimal Control, Asymptotic Problems and Mean Field Games**, Padua, Italy.

June 2015 **The Hamiltonian-Jacobi equation : at the crossroads of PDE, Dynamical Sistems and Geometry**, Cortona, Italy.

June 2015 **MFG and Related Topics-3**, Paris, France.

April 2015 **Workshop on Control of PDEs**, L'Aquila, Italy.

July 2014 **Summer-school: ERC School on Free Discontinuity Problems**, Pisa, Italy.

Research Groups

2020–present time Member of research group Contemporary Applied Mathematics, University of Verona, Verona, Italy

2020–present time Member of research group AI&ML&MAT-Mathematics for Artificial Intelligence & Machine Learning of UMI (Italian Mathematical Union)

2020–present time Member of research group PRISMA-PRobability In Statistics, Mathematics and Applications of UMI (Italian Mathematical Union)

2019-2020 Member of Nonlinear Analysis thematic group, North Carolina State University, Raleigh, NC, USA

2018– present time Member of UMI - Unione matematica Italiana

2015–present time Member of GNAMPA (research group in mathematical analysis, probability theory and applications) of INdAM (Italian National Institute of High Mathematics)

Research Projects

2018 Analytical aspects of mean field optimal control for multi-agent systems project. Funded by University of Verona. Role in the project:

2015-2018 LEARN.NET project. Funded by ECOS-SUD, Chile-France collaboration. Role in the project: Participant.

2015 GNAMPA 2015 "Processi di diffusione degeneri o singolari legati al controllo di dinamiche stocastiche" (Degenerate or singular diffusion processes related to the control of stochastic dynamics). Funded by INdAM (Italian National Institute of High Mathematics). Role in the project: Participant.

Honors and Awards

2015 Call's Vinci 2015 for joint PhD program between Italian-France Universities, approx. 5,000 euros

Digital skills

LaTEX, Matlab, C, Linux, Julia, Fortran 95

Language skills

Italian *Native speaker*

English *Fluent in listening, reading, writing and speaking*

French *Basic*

Spanish *Basic*

Use of personal data

In compliance with the Italian legislative Decree no. 196 dated 30/06/2003, I hereby authorize you to use and process my personal details contained in this document.