Daria Ghilli

Academic Curriculum

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Current Position

Since December 2024: Associate Professor at the Department of Economics and Management, University of Pavia (Italy).

Previous position

December 2021- Noverer 2024: Temporary assistant professor (tenure track, rtdb) at Department of Economics and Management, University of Pavia (Italy).

Postdoc

November 2020-October 2023: Research grant at Department of Economics and Finance, LUISS, University of Rome (Italy).
Project: PRIN 2017 "The Time-Space Evolution of Economic Activities: Mathematical Models and Empirical Applications".
Supervisor. Prof. Fausto Gozzi.

Postdoc

July 2019-October 2020: Research Grant at the Department of Mathematics Tullio Levi-Civita of the University of Padua (Italy).
Project: Starting grants 2015 Cariparo "Nonlinear partial differential equations: asymptotic problems and mean-field games".

PostDoc

March 2016-May 2019: Post-doc at the Institute of Mathematics and Scientific Computing, University of Graz, (Austria).
Project: ERC Advanced Grant Project OCLOC- from Open to Closed Loop Optimal Control.
Supervisor: Prof. Karl Kunisch.

PhD

January 2013-February 2016: Department of mathematics "Tullio Levi-Civita" University of Padua (Italy).
24/02/2016: Thesis defence, mention "excellent".
Supervisor: Prof. Martino Bardi.

Title of the thesis: *Some results in nonlinear PDEs: large deviations problems, nonlocal operators, and stability results for some isoperimetric problems.*
Manuscript can be found at the web page: paduaresearch.cab.unipd.it/9141/1/thesis.pdf.

Master degree

October 2010-July 2012: Department of Mathematics "Ulisse Dini", University of Florence (Italy).
13 July 2012: Thesis defence, with first-class honours, "Ulisse Dini" University of Florence (Italy).
Supervisor: Prof. Paolo Salani.
Thesis: *Stability results of isoperimetric inequalities for some Monge-Ampère functionals*.

Research activities

- In my bachelor and master thesis I worked in calculus of variations and geometric (especially convexity) properties for solutions of elliptic and parabolic equations. Within this area of research my specific interests have been **Isoperimetric and Brunn-Minkowski inequalities for variational functionals** and quantitative results (see papers [10] and [12]).

- In my PhD thesis I worked in nonlinear partial differential equations, in particular Hamilton-Jacobi equations and viscosity solutions. Within this field, my main interests are:
  - **Viscosity solutions for Hamilton-Jacobi equation: homogenization and singular perturbations problems**. In collaboration with M. Bardi and A. cesaroni (University of Padua), I dealt with applications to large deviations of multiscale stochastic volatility models (see papers [8] and [11]). Rate of convergence results for non periodic singular perturbations of HJ equations are under investigation in the preprint [2] in collaboration wiith C. Marchi (University of Padua).
  - **Integro-partial differential equations of Hamilton-Jacobi type related to Lévy processes**. Specifically, well-posedness of Neumann boundary value problems and large time behaviour of evolutive problems (see paper [9]). In collaboration with Adina Ciomaga, (LJLL, Paris) and Erwin Topp (University of Santiago, Chile), I worked on regularity results for nonlocal HJ equations with applications to homogenization (see paper [2]).
  - **Finite horizon optimal control problems with discontinuous dynamics and costs**, continuous and discontinuous terminal costs (see paper [6]).

- Within the ERC project, in collaboration with prof. K Kunisch and prof. V. Kovtunenko (University of Graz, Autria), I developed the following lines of research:
  - **non convex non smooth sparse optimization**, analytical and numerical aspects, with applications in optimal control of PDEs, reconstruction of images, and fractures mechanics (see papers [1],[5], [7] and Proceeding [1]).
  - **inverse problems in fractures mechanics** for the identification of crack by shape optimization techniques (see paper [4]).

- In the paper [3], in collaboration with Marco Cirant (University of Padua), I worked on evolutive (finite horizon) focusing **mean field games (MFG)**, which describe aggregation phenomena. These MFGs share a nonstandard structure, in particular a non monotone (decreasing) cost in the distribution. We proved non existence in the long time horizon when the aggregation is strong and existence for all times when the aggregation is weak.

- Further current interests (strating from November 2020):

- **MFG models for the time-space evolution of economic activities**. The peculiarity of the MFGs models we consider is a spatial interaction term in the human capital dynamics and in the utility. The main goal consists in studying the effect of the spatial interaction terms (called in economics spatial spillovers) on the abilities of each individual, due to the proximity, in terms of spatial distance, of other individuals. These models share a non standard and challenging structure with respect to the classical literature due to the economic modelling reasons: the Hamiltonian is not separable in the dependence on the gradient of the value function and the distribution and the cost is not monotone w.r.t. the distribution (see work in progress [3]). We prove existence of a solution of the evolutive finite horizon MFG, convergence to the infinite horizon MFG. Numerical experience in some cases is provided. In the preprint [4] we studied evolution of epidemics such as COVID19 in the above explained MFG economic model, where the rate of infection depends on the distribution of the population. Numerical experience is provided.
- **Infinite horizon economic models for pandemic economies**, such as the COVID19, i.e. with lockdown of a sector of the economy. The interest is to study how the lockdown of a sector of the economy may have altered the habits and therefore the demands of some goods even after the re-opening (see preprint [1]).

Research periods abroad

- **November 2014-June 2015**: Laboratoire de mathématiques et physique théorique, Université Francois-Rabelais de Tours, Tours (France).
  Supervisor: prof. Guy Barles.
  Topics of research:
  - Integro-partial differential equations related to Lévy processes. Neumann boundary value problems for nonlocal Hamilton-Jacobi equations of Lévy type: comparison principles, existence and uniqueness results and large time behavior for evolutive problems (see paper [9]).

- 5 **months PhD stage (November 2015-March 2016)**: ENSTA ParisTech, Palaiseau, Paris (France).
  Supervisor: prof. Hasnaa Zidani.
  Topics of research:
  - Finite horizon optimal control problems in multi-domains with continuous and discontinuous solutions. Characterization of the junction conditions on the interfaces as Hamilton-Jacobi-Bellman equations, comparison principle and stability results (see paper [6]).

- 2 **weeks visiting period (20/04/2018-04/05/2018)**: University of Santiago, Chile, collaboration with Erwin Topp on the paper [2].

Publications

1 *Optimal planning in Habit formation Models with Multiple Goods*, M. Bambi, D. Ghilli, F. Gozzi, M. Leocata, Decisions in Economics and Finance, 2024.
2 *Habits and demand changes after COVID-19*, M. Bambi, D. Ghilli, F. Gozzi, M. Leocata, Journal of Mathematical Economics, Volume 110, doi.org/10.1016/j.jmateco.2023.102933, 2024.
3 *A mean field game model for COVID-19 with human capital accumulation*, D. Ghilli, C. Ricci, G. Zanco, Economic Theory, DOI: 10.1007/s00199-023-01505-0, 2023.
4 *Rate of convergence for perturbation of Hamilton-Jacobi equations in unbounded spaces*, D. Ghilli,

C. Marchi, Journal of Mathematical Analysis and Applications, Vol 526, Issue 1, DOI:10.1016/j.jmaa.2023.127225, 2023.

5 *Nonconvex flexible sparsity regularization: theory and monotone numerical schemes*, D. Ghilli, D. Lorenz, E. Resmerita, Optimization, 71 (4), 1117-1149, DOI: 10.1080/02331934.2021.2011869, 2022.

6 *Periodic homogenization for weakly elliptic HJB, with critical fractional diffusion*, A. Ciomaga, D. Ghilli, E. Topp, Communications in Partial Differential Equations, DOI: 10.1080/03605302.2021.1941108,47 (1), 1-38, 2022.

7 *Existence and non existence for time-dependent mean field games with strong aggregation*, M. Cirant, D. Ghilli, Mathematische Annalen, DOI: 10.1007/s00208-021-02217-3, 2021.

8 *Inverse problem in breaking line identification by shape optimization*, D. Ghilli, V. Kovtunenko, K. Kunisch, Journal of Inverse and Ill-Posed Problems 28(1) 2019, DOI:10.1515/jiip-2019-0047.

9 *On a monotone scheme for nonconvex nonsmooth optimization with applications to fracture mechanics*, D. Ghilli, K. Kunisch, JOTA, Vol. 183, Issue 2, 609-641, 2019, DOI 10.1007/s10957-019-01545-4.

10 *Junction conditions for finite horizon optimal control problems on multi-domains with continuous and discontinuous solutions*, D. Ghilli, Z. Rao, H. Zidani, ESAIM:COCV, 2018, DOI 10.1051/cocv/2018072.

11 *On the monotone and primal dual active set schemes for ℓ^p-type problems, $p \in (0, 1]$*, D. Ghilli, K. Kunisch, Computational Optimization and Applications 72 (1), 45-85, 2018.

12 *Viscosity methods for large deviations estimates of multiscale stochastic processes*, D. Ghilli, ESAIM:COCV 24 (2), 605-637, 2018, DOI 10.1051/cocv/2017051.

13 *On Neumann problems for nonlocal Hamilton-Jacobi equations with dominating gradient terms*, D. Ghilli, Calculus of Variations and Partial Differential Equations 56:139, 2017, DOI 10.1007/s00526-017-1225-6.

14 *Quantitative Borell-Brascamp-Lieb inequalities for compactly supported power concave functions (and some applications)*, D. Ghilli, P. Salani, Journal of Convex Analysis 24 (3), 857-888, 2017.

15 *Large deviations for some fast stochastic volatility models by viscosity methods*, M. Bardi, A. Cesaroni, D. Ghilli, DCDS-A, 35 (9), 2015, DOI:10.3934/dcds.2015.35.3965.

16 *Stability of isoperimetric type inequalities for some Monge-Ampère functionals*, D. Ghilli, P. Salani, Annali di Matematica pura ed applicata, Vol. 193, Issue 3, 643-661, 2014, DOI 10.1007/s10231-012-0295-5.

Preprints and works in progress

1 *Linear quadratic Mean Field Games in Hilbert spaces,* S. Federico, D. Ghilli, F. Gozzi, submitted to SIAM Journal on Mathematical Analysis (accepted with minor revision)

2 *The Master equation and the convergence problem for linear quadratic Mean Field Games in Hilbert spaces*, D. Ghilli, M. Ricciardi, work in progress.

3 *A Mean Field Game model with spatial interactions in the human capital*, D. Ghilli, F. Gozzi, C. Ricci, G. Zanco, work in progress.

4 *Mean field control for a growth model with the Cobb-Douglas production function*, D. Ghilli, M. Leocata, D. Tonon, work in progress.

5 *Environmental quality perception: act local, think global?*, D. Ghilli, F. Gozzi, M. Leocata, E. Augeraud-Véron, work in progress.

6 *Understanding quality of the environment: mean field game and mean field control approaches*, D. Ghilli, F. Gozzi, M. Leocata, E. Augeraud-Véron, work in progress.

7 *A PES (Payment for Ecosystem Services) scheme for a regulation problem in the harvesting of biomass of forests*, E. Alguardi, D. Ghilli, F. Gozzi, M. Leocata, A. Xepapadeas, work in progress.

Proceedings

1 *A monotone scheme for sparsity optimization in ℓ^p with $p \in (0, 1]$*, D. Ghilli, K. Kunisch, IFAC 2017 Proceeding.

Refereeing activity for international journals

I have been carrying out refereeing activity for the following international journals:

- Communications on Pure and Applied Analysis
- European Journal of Operationsl Research
- Journal of Difference Equation and Applications
- Journal of Mathematical Economics
- Journal of Statistical Software
- Mathematical Methods in the Applied Sciences
- Nonlinear Differential Equations and Applications
- SIAM Journal on Control and Optimization
- SIAM Journal on Numerical Analysis

Organized conferences, mini symposia and special sessions in conferences

- "Mean field games and related topic 5 ", Levico Terme, September 2019.
- Nonsmooth PDE-constrained optimization: problems and methods, mini symposium in "EWM General Meeting", Karl-Franzens University of Graz, Graz (Austria), 3-7 September 2018.
- "Mean Field Games and Applications", special session in AMASES 2022, Palermo (Italy), 22-24 Septembre 2022.

Invited seminars in universities (45-60 minutes)

- *A Mean Field Game models in Economics with spatial interaction in the human capital*, Departement of Economics, University of Verona, June 2022.
- *A Mean Field Game model in Economics with spatial interaction in the human capital*, PMS^2 Pavia Milano seminar series on Probability and Mathematical Statistics, Department of Mathematics, University of Pavia, April 2022.
- *Time-dependent Mean Field Games with strong aggregation*, Differential Equations and Applications seminars, Department of Mathematics, University of Padua, January 2022.
- *Time-space evolution of economic activities: a Mean Field Game model*, Applied PDES seminars, Imperial College of Londong, October 2021.
- *Time-space evolution of economic activities: a Mean Field Game model*, DEF internal Seminars, LUISS University of Rome, October 2021.
- *Homogenization for nonlocal Hamilton-Jacobi-Bellman equations*, Department of Mathematics, University of Padua, April 2020.
- *On Neumann problems for nonlocal Hamilton-Jacobi equations related to jump processes, some recent results*, University of Paris-Dauphine (France), Autumn 2018.
- *On Neumann problems for nonlocal Hamilton-Jacobi equations related to jump processes, some recent results*, Department of Mathematics, University of Padua (Italy), January 2017.

- *On Neumann problems for nonlocal Hamilton-Jacobi equations related to jump processes, some recent results*, Johann Radon Institute RICAM (Linz), June 2016.
- *Large deviations for fast stochastic volatility models by viscosity methods*, Séminaire de Probabilité-Statistique-Contrôle, ENSTA ParisTech (France), January 2016.
- *Hamilton-Jacobi equations and optimal control: some recent results*, Institute of Mathematics and Scientific Computing (Graz, Austria), October 2015.
- *On Neumann problems for nonlocal Hamilton-Jacobi equations with dominating gradient terms*, Séminaire d'Analyse, Université de Rouen, Insa, (France), June 2015.
- *Large deviations for fast stochastic volatility models by viscosity methods*, Séminaire d'Analyse Numerique, Université de Rennes 1, Insa, (France), March 2015.
- *Large deviations for fast stochastic volatility models by viscosity methods*, Séminaire PDE, Laboratoire de mathématiques and physique theorique, Université Francois-Rabelais de Tours (France), October 2014.

Invited talks

- *A Mean Field Game model in Economics with spatial interactions in the human capital*, session "Mean Field Games and Applications", AMASES 2022, University of Palermo, (Italy), September 2022.
- *A Mean Field Game model in Economics with spatial interactions in the human capital*, special session "New trends in Mean Field Games", 19th ISDG Symposium at the Faculty of Mathematics Faculty of Sciences, University of Porto (Portugal), July 25-29, 2022.
- *A Mean Field Game model in Economics with spatial spillovers on the human capital*, ORCOS 2022, July 2022, Vienna (Austria).
- *Mean Field Games models with spatial interactions in the human capital: ideas for further research*, Workshop "The Time-Space Evolution of Economic Activities: Mathematical Models and Empirical Applications", Pisa (Italy), July 2022.
- *Existence and non existence for MFG with strong aggregation*, Large-Scale Scientific Computations, Sozopol (Bulgaria), June 2021.
- *Non existence for evolutive focusing mean field games*, 8th European Congress of Mathematics, Portoroz (Slovenia),June 2021.
- Future: *Inverse problem in crack identification by shape optimization*, 10th International Conference "Inverse problems: modeling and simulation", Malta, May 2022.
- *Inverse problem in crack identification by shape optimization*, "ICCOPT 2019", Berlin (Germany), August 2019.
- *Theory and numerical practice for optimization problems involving ℓ^p-functionals, with $p \in (0, 1]$*, "GAMM 2019", Vienna (Austria), February 2019, (20 minutes).
- *Theory and numerical practice for optimization problems involving ℓ^p-functionals, with $p \in (0, 1]$*, "ORCOS: VC2018", Vienna (Austria), July 2018 (25 minutes).
- *Theory and numerical practice for optimization problems involving ℓ^p-functionals, with $p \in (0, 1]$*, "PGMO days 2017", Paris (France), November 2017, (25 minutes).
- *On monotone and primal-dual active set schemes for ℓ^p-type problems, with $p \in (0, 1]$* "IFAC 2017", July 2017 (30 minutes).
- *Large deviations for fast stochastic volatility models by viscosity methods*, "Nonlinear PDEs: optimal control, asymptotic problems and mean field games", Padua (Italy), February 2016 (30 minutes).

Other communications at conferences

- *Theory and numerical practice for optimization problems involving ℓ^p-functionals, with $p \in (0,1]$*, "GAMM 2018", Munich (Germany), March 2018 (20 minutes).
- *On monotone and primal dual active set schemes for ℓ^p-type problems, with $p \in (0,1]$*, "Optimization of Infinite Dimensional Non-Smooth Distributed Parameter Systems", Darmstadt (Germany), October 2017 (40 minutes).
- *On monotone and primal-dual active set schemes for ℓ^p-type problems, with $p \in (0,1]$* International workshop "Optimal control of Dynamical Systems ", Mariatrost (Graz, Austria), May 2017.
- *On nonlocal Hamilton-Jacobi equations related to jump processes, some recent results*, Workshop on Numerical Methods for Hamilton-Jacobi equations in optimal control and related fields, Linz (Austria), November 2016.
- *A monotone scheme for sparsity optimization in ℓ^p with $p \in (0,1]$*, "Imaging with Modulated/Incomplete Data 2016", Graz (Austria), September 2016.
- *On Neumann problems for nonlocal Hamilton-Jacobi equations related to jump processes*, "Analysis and Applications of Stochastic systems", IMPA, Rio de Janeiro (Brasil), 28/03/16-1/04/16.
- *Large deviations for fast stochastic volatility models by viscosity methods*, Workshop "Optimal Control of Partial and Ordinary Differential Equations", École Polytechnique Palaiseau, Paris (France), November 2015.
- *On Neumann problems for nonlocal Hamilton-Jacobi equations with dominating gradient terms*, "Partial differential equations, optimal design and numerics ", Centro de Cienca de Benasque Pedro Pasqual, Benasque (Spain), August 2015.
- *Large deviations for fast stochastic volatility models by viscosity methods*, "New perspectives in optimal control and games ", Rome (Italy), November 2014.
- *Large deviations for fast stochastic volatility models by viscosity methods*, "Recent advances in mathematical finance ", Padua (Italy), September 2014.
- *Large deviations for fast stochastic volatility models by viscosity methods*, "Young researchers meeting in probability, ", WIAS-TU Berlin and Unipotsdam (Germany), October 2014.
- *Stability results for Urysohn inequalities involving elliptic operators*, "Joint research program on nonlinear PDE's of University of Florence and Tohoku University ", Florence (Italy), March 2014.
- *Stability of isoperimetric inequalites for some Monge-Ampère functionals*, Conference "Convex geometry ", Centro Internacional de Encuentros Matematicos, Castro Urdiales (Spain), September 2013.
- *Stability of isoperimetric inequalites for some Monge-Ampère functionals*, "Workshop for Young researchers in mathematics ", University Ovidius Costanta (Romania), May 2012.

Teaching

Academic year $2022/2023$:

- Course "General Mathematics" (14 hours), winter sememster 2022/2023, Bachelor in Economics, Department of Economics and Management, University of Pavia (Italy).
- PhD Course "Static and Dynamic Optimization" (10 hours), winter semester 2022/2023, PhD in Economics, Department of Economics, Management and Quantitative Methods, University of Milan (Italy).
- Course "Mathematics for Management", spring semester 2022/2023, Department of Economics and Management (University of Pavia). Total of hours: 44. Language: italian.

Academic year $2021/2022$:

- Course "Mathematics for Management", spring semester 2021/2022, Department of Economics

and Management (University of Pavia). Total of hours: 44. Language: italian.
- Support for the exercises classes for the course "Quantitative models for data science", winter semester 2021/2022, LUISS (University of Rome). Responsible for the course: Dr. Alessandro Calvia.
- Exercises for the course "Mathematical Methods for Economics and Finance", winter semester 2021/2022, LUISS (University of Rome). Responsible for the course: prof. Fausto Gozzi. Language: English.

Academic year $2020/2021$:
- Support for the exercises classes for the course "Mathematical Methods for Economics and Finance", winter semester 2020/2021, LUISS (University of Rome). Responsible for the course: prof. Fausto Gozzi. Language: English.

Academic year $2019/2020$:
- Exercises for the course "Instituzioni di Analisi" (Analysis), winter semester 2019/2020, University of Padua. Total of hours: 16. Language: Italian.

Academic year $2018/2019$:
- Exercises for the course "Partial Differential Equations", winter semester 2018/2019, University of Graz (Austria). Total of hours: 13. Language: English.

Academic year $2017/2018$:
- Exercises for the course "Computational Mathematic 2", winter semester 2017/2018, University of Graz (Austria). Total of hours: 14. Language: English.

Academic year $2016/2017$:
- Exercises for the course "Introduction to complex analysis", winter semester 2016/2017, University of Graz (Austria). Total of hours: 14. Language: English.

Projects and grants

- 2016-2019: Participant to the ERC Advanced Grant OCLOC (From Open to Cloosed Loop Optimal Control of PDEs) 2016-2021. Project supervisor: prof. Karl Kunisch (Graz and Linz, Austria).
- 2019-2020: Participant to the Starting Grants 2015 Cariparo "Nonlinear partial differential equations: asymptotic problems and mean-field games".
- 2020-2021: Participant to the PRIN 2017 "The Time-Space Evolution of Economic Activities: Mathematical Models and Empirical Applications". Project supervisor: prof. Fausto Gozzi (LUISS, Italy).
- 2022-2023: Coordinator of the GNAMPA project "Modelli MFGs in Economia per lo studio della dinamica del capitale umano con spillovers spaziali" (MFGs models in Economics for the study of the dynamics of the human capital with spatial spillovers). Participants: M. Leocata (LUISS), C. Ricci (Pisa), D. Tonon (Padova).

Memberships

- AMASES Associazione per la Matematica Applicata alle Scienze Economiche e Sociali (Association for Mathematics Applied to Social and Economic Sciences)
- EMS European Mathematical Society
- EWM European Women in Mathematics

Computer skills

- Good knowledge of Matlab.
- Elementary knowledge of C and Mathematica.

Languages

- Italian: mother tongue
- English: fluent: C1 (IELTS, grade:7.5)
- French: fluent: C1
- German: intermediate: B2
- Spanish: elementary

References

- Prof. Martino Bardi, Department of Mathematics "Tullio Levi-Civita", University of Padua (Padua, Italy).
  Email: bardi@math.unipd.it
- Prof. Guy Barles, Laboratoire de mathématiques et physique théorique, University of Tours (Tours, France).
  Email: barles@lmpt.univ-tours.fr
- Dr. Adina Ciomaga (Maître de conférences), Laboratoire LJLL, University Denis Diderot (Paris VII, France).
  Email: adina@math.univ-paris-diderot.fr
- Prof. Fausto Gozzi, Department of Economics and Finance, LUISS University of Rome (Rome, Italy).
  Email: fgozzi@luiss.it.
- Prof. Karl Kunisch, Institute of Mathematics and Scientific Computing, University of Graz (Graz, Austria).
  Email: karl.kunisch@uni-graz.at
- Prof. Paolo Salani, Department of mathematics "Ulisse Dini", University of Florence (Florence, Italy).
  Email: paolo.salani@unifi.it

Personal interests

- Sports:
  - Tennis. I am still learning and I am very passionated about it.
  - Trekking and running. I love Dolomites and I enjoyed the mountains in Austria.
  - Dancing. I took dancing lesson and danced for eight years (jazz and classical dance).
- Reading: books, newspapers, Peanuts.
- Studying new languages.

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Luogo e Data

Firma