University of Insubria

DIPARTIMENTO DI SCIENZA E ALTA TECNOLOGIA
PhD in Computer Science and Mathematics of Calculus

PhD First Year Report

PhD Student: *M. Tarsia*[*] Tutor: *D. Cassani* Advisor: *E. Mastrogiacomo*

Academic Year 2018–2019
20/09/2019

Training Activity

- RISM congress III: *Mathematical Modelling in Chemical Engineering and Beyond*. 13-14 December 2018, Villa Toeplitz, Varese (`http://www.rism.it/rism-congress-iii.html`).
- Workshop CVGMT: *ALESSIO FIGALLI, Fields Medallist 2018*. 14-17 January 2019, Scuola Normale Superiore and Aula Magna Pontecorvo, Pisa (`http://cvgmt.sns.it/event/503/`).
- Workshop CVGMT: *Variational Problems, PDEs and Applications*. 17 January 2019 only, Department of Mathematics, Pisa (`http://cvgmt.sns.it/event/508/`). In particular,
  - *Semigroups and Geometric Measure Theory*, Prof. Luigi Ambrosio (SNS Pisa);
  - *Free Boundaries in Obstacle Problems*, Prof. Alessio Figalli (ETH Zürich).
- PhD mini-course: *Statistical Learning Theory and Applications*, Dr. Silvia Villa and Dr. Lorenzo Rosasco (University of Genoa). 30-31 January and 1 February 2019 (12 hours), DiSAT, Como.
- RISM Workshop: *Advances and Challenges in Nonlinear Elliptic Systems*. 7-8 February 2019, Villa Toeplitz, Varese (`http://www.rism.it/advances-and-challenges.html`).
- RISM course III: *Generalized Solutions in Differential Equations: Theory and Applications*, Prof. Vieri Benci (University of Pisa). 11-15 February 2019, Villa Toeplitz, Varese (`http://www.rism.it/rism-course-by-vieri-benci.html`).
- APRE Members course: *MSCA - Le Marie Sklodowska-Curie Actions*, Dr. Angelo D'Agostino (APRE) and Dr. Marco Benini (University of Insubria). 19 February 2019 (4 hours), DiSAT, Como.
- PhD mini-course: *Foundation of Mathematical Logic*, Dr. Achille Frigeri (Politecnico di Milano). 25-27 February 2019 (14 hours), DiSAT, Como.
- PhD mini-course: *Risk Measures*, Dr. Elisa Mastrogiacomo (University of Insubria). 4 and 28 February 2019 (6 hours out of 9), DiECO, Varese.
- PhD seminary: *Shanks based transformations with applications to Data Science*, Dr. Stefano Cipolla (University of Padova). 19 March 2019, DiSAT, Como.
- Workshop: *Random Transformations and Invariance in Stochastic Dynamics* (*dedicated to Sergio Albeverio's 80º birthday*). 25-28 March 2019, Church of San Giorgio in Braida, Verona (`http://users.mat.unimi.it/users/ugolini/workshop2019/`).
- PhD mini-course: *Fractional Diffusion Equations*, Dr. Mariarosa Mazza (University of Insubria). 5, 8, 12 and 15 April 2019 (12 hours), DiSAT, Como.

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- PhD seminary: *General construction of spectra*, Dr. Axel Osmond (IRIF, Université Paris-Diderot). 14 May 2019, DiSAT, Como.

- PhD course: *An Introduction to Regularity Structures*, Prof. Francesco Caravenna (Bicocca University of Milan). 4, 11 and 17 April, 2, 9, 23 and 30 May, 6, 13 and 25 June 2019 (30 hours), Department of Mathematics and Applications, Milan (`http://staff.matapp.unimib.it/~fcaraven/did1819/phd/index.html`).

- PhD course: *(Markov Chain) Monte Carlo Simulation*, Prof. Antonietta Mira (University of Italian Switzerland), Dr. Stefano Peluso (Catholic University of the Sacred Heart of Milan), Dr. Louis Raynal (IMAG, University of Montpellier), Anthony Ebert (University of Italian Switzerland) and Cecilia Viscardi (DISIA, University of Florence). 4, 17, 24 and 26 June, 15 July 2019 (32 hours), DiSAT, Como and Institute of Computational Science, University of Italian Switzerland, Lugano.

- PhD mini-course: *Regularization by filtering and variational methods: theoretical and numerical aspects*, Dr. Alessandro Buccini (Kent State University, Ohio). 21 and 27 June 2019 (8 hours out of 12), DiSAT, Como.

- PhD seminary: *Computations of systemic risk measures*, Dr. Çağin Ararat (Department of Industrial Engineering, Bilkent University, Ankara). 28 June 2019, DiECO, Varese.

- PhD seminary: *A Novel Optimization Approach to Fictitious Domain Methods*, Prof. Patrick Guidotti (Department of Mathematics, University of California, Irvine). 3 July 2019, DiSAT, Como.

- Workshop: *Recent Trends in Stochastic Analysis and SPDEs*. 18-20 July 2019, Department of Mathematics, Pisa (`https://sites.google.com/view/spdespisa/home`).

- RISM Workshop: *XI Workshop in Nonlinear Differential Equations*. 29 July - 2 August 2019, C. Cattaneo College, Varese (`https://sites.google.com/view/brazitaly/home`).

- Passed exams (see above):

  √ *Statistical Learning Theory and Applications*, Dr. Silvia Villa and Dr. Lorenzo Rosasco;

  √ *Generalized Solutions in Differential Equations: Theory and Applications*, Prof. Vieri Benci.

  Reports written in LaTeX available on `my web page`.

- Scheduled exams (see above):

  ◦ *An Introduction to Regularity Structures*, Prof. Francesco Caravenna;

  ◦ *(Markov Chain) Monte Carlo Simulation*, Prof. Antonietta Mira, including research (see below).

Tutoring Activity

▶ Course of Study in Mathematics and Physics: *Analisi Matematica 2*. 2 April, 7, 14 and 21 May, 19 June 2019 (12 hours), DiSAT, Como. Notes written in LaTeX available on `my web page`.

Research Activity

Main topics: Mathematical finance. Risk measures. Optimal transport theory. Bayesian statistics.

Short description:

⋆ *Risk measures.* To study regular risk measures in both the scalar and possibly the conditional case especially regarding some of the following issues: law invariance; comonotonicity; less than convexity; links with the underlying scenario space; consistency with respect to appropriate orderings; connections with bond portfolios, game theory and climate changing. The most satisfying result would be to do all this not just for random variables or portfolio vectors which are bounded and also to get robust representation formulas, hoping finally for the chance of a reasonable limit in the conditional framework.

⋆ *Approximate Bayesian computation (ABC).* To study relationships between optimal transport theory and the innovative methodology of ABC possibly connected to appropriate metrics defined between probability distributions. The ABC methods are in fact computational methods based on Bayesian statistics and applicable to a given generative model to estimate its a posteriori distribution in case the likelihood function is intractable: the idea is to simulate from the model sets of synthetic data in correspondence with assigned parameters and therefore, rather than comparing prospects of these data with the corresponding observed values as typically occurs according to ABC, to employ precisely a distance between the empirical distribution of the synthetic data and that of the observed values.

Supported missions:

★ COST Short Term Scientific Mission on Statistics of Network Data Science (COSTNET STSM): *Approximate Bayesian Computation methods for Mechanistic Network Models* in collaboration with Prof. Antonietta Mira (University of Italian Switzerland), Dr. Louis Raynal (IMAG, University of Montpellier), Anthony Ebert (University of Italian Switzerland), Cecilia Viscardi (DISIA, University of Florence) and Francesco Denti (DISMEQ, Bicocca University of Milan). 11, 12 and 15 July 2019, Institute of Computational Science, University of Italian Switzerland, Lugano.

"Informal" talk: *An introduction to Optimal Transport Theory in Approximate Bayesian Computation.* 11 July 2019, University of Italian Switzerland, Lugano.