

Alekos Cecchin | Curriculum Vitae

Born 5 December 1991 in Cittadella (PD), Italy • Italian nationality

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UNIVERSITÀ DEGLI STUDI DI MILANO

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Current position

Post-Doc

Centre de Mathématiques Appliquées, 91128 Palaiseau (FR)
Supervisor Prof. Nizar Touzi

École Polytechnique

August 2020 - July 2022

Previous position

Post-Doc

Laboratoire J.A Dieudonné, 06108 Nice (FR)
Supervisor Prof. François Delarue

Université Côte d'Azur

February 2019 - July 2020

Education

Ph.D. in Mathematical Sciences

Curriculum Computational Mathematics
Supervisor Prof. Markus Fischer

University of Padova

October 2015 - September 2018

Thesis: Finite state N -player and mean field games
Defended on 14 January 2019, *cum laude*

I spent one month in 2016 at the *University of Warwick*. During this period I worked under the supervision of Professor Vassili N. Kolokoltsov and we wrote the paper [1] about my master thesis.

Master in Mathematics (Laurea Magistrale)

Curriculum Probability and Financial Mathematics
Final Mark: 110/110 cum laude - Exams average 29.8/30

University of Padova

October 2013 - July 2015

Thesis: Mean field limit optimization for fragmentation-coagulation models
Supervisor in Padova: Prof. Paolo Dai Pra

Erasmus program

I prepared my dissertation and 4 exams
Under the supervision of Prof. Vassili N. Kolokoltsov

University of Warwick
September 2014 - June 2015

Degree in Mathematics (Laurea Triennale)

Curriculum Application

University of Padova
October 2010 - July 2013

Final Mark: 110/110 cum laude - Exams average: 29/30

Thesis: Il teorema di Berry-Esseen

Supervisor: Paolo Dai Pra

Scientific Maturity: July 2010 at Liceo T.L. Caro in Cittadella (PD)

Research summary

My research so far has focused largely on the recent theory of mean field games and mean field control problems, first in the finite state space setting and more recently for diffusion-based models. During my Ph.D. in Padova, I first established well-posedness in a wide class, using probabilistic methods in [2], then I studied the convergence of the N -player game to the mean field game limit. In [3], in the monotone case, we constructed the classical solution to the master equation, which is a first order quasilinear PDE stated in the simplex of probability measures, and employed this solution to show convergence of the N -player value functions, as well as propagation of chaos and refined asymptotics for the N -player optimal trajectories. Then in [4] we studied a two state example with anti-monotone costs, which has multiple mean field game solutions and no classical solutions to the master equation. We proved that the N -player value functions converge to the weak entropy solution to the master equation, which in this case can be rewritten as a scalar conservation law, in one dimension. This is the first and still unique result of this type for the convergence problem in mean field games.

Then, during the Post-Doc in Nice, I focused on the problem of restoration of uniqueness for finite state mean field games. In [5], we showed that a form of common noise, called Wright-Fisher, gives uniqueness of mean field game solutions. We achieved this by analyzing the master equation, which becomes a second order PDE that degenerates at the boundary of the symplex: the main ingredient to show that it admits a classical solution is an a priori Hölder estimate obtained by a coupling argument. Then in [7] we studied the potential case and proved that these classical solutions converge, as the intensity of the common noise (which is understood as a viscosity parameter) vanishes, to the gradient of the value function of the corresponding mean field control problem, thus selecting a particular weak solution (in the sense of distributions) to the inviscid master equation. We also established intrinsic uniqueness of this solution within a suitable class of weak solutions satisfying a weak one-sided Lipschitz inequality.

During the Post-Doc in École polytechnique, I first studied the convergence problem for finite state mean field control problems. As opposed to mean field games, in the prelimit players are cooperative and have a common cost to minimize, while the limit can be written as a single deterministic control problem for the Fokker-Planck equation. In [6], I showed that the value function of the mean field control problem is the unique viscosity solution of a HJB equation in the simplex, and used this characterization to prove convergence of the N -player value functions, with a convergence rate. Now, I am working to extend this result to continuous state and diffusion based models, for which the HJB equation is stated in the infinite dimensional Wasserstein space of probability measures. Further, I am considering continuous state potential mean field games, the aim being to prove uniqueness of weak solutions within a suitable class, using tools from Gaussian analysis in Hilbert spaces. Moreover, I am studying the problem of convergence of finite state mean field games, as the number of states grows, to diffusion-based mean field games, which is reminiscent of finite difference numerical schemes for nonlinear PDEs.

In a joint project with the research unit at EDF (Électricité de France), I am working on applications of mean field games to the electricity market, and in particular to renewable energies. Specifically, we introduce a mean field model for the development of renewable capacities, in infinite horizon, and

in particular the aim is to establish the optimal subsidies to be provided by the central planner to the multitude of producers of the renewable energy, in order to reach a desired capacity in long time. This is a mean field model, as the producers behave as many small symmetric and indistinguishable players, and to attach the problem we develop some new numerical scheme for a PDE similar to the master equation of finite state mean field games.

Publications and preprints

Publications

1. A. Cecchin and V. N. Kolokoltsov. Evolutionary game of coalition building under external pressure. In: J. Apaloo and B. Viscolani (eds), *Advances in Dynamic and Mean Field Games*, pp. 71-106. Annals of the International Society of Dynamic Games, vol. 15, Birkhauser, Cham, doi.org/10.1007/978-3-319-70619-1-4, 2017.
2. A. Cecchin and M. Fischer. Probabilistic approach to finite state mean field games. *Applied Mathematics and optimization*, 81, 253-300, doi.org/10.1007/s00245-018-9488-7, 2020.
3. A. Cecchin and G. Pelino. Convergence, fluctuations and large deviations for finite state mean field games via the master equation. *Stochastic Processes and their Applications*, 129(11), 4510-4555, doi.org/10.1016/j.spa.2018.12.002, 2019.
4. A. Cecchin, P. Dai Pra, M. Fischer, and G. Pelino. On the convergence problem in mean field games: a two state model without uniqueness. *SIAM Journal on control and optimization*, 57(4), 2443-2466, doi.org/10.1137/18M1222454, 2019.
5. E. Bayraktar, A. Cecchin, A. Cohen, and F. Delarue. Finite state mean field games with Wright-Fisher common noise. *Journal de Mathématiques Pures et Appliquées*, 147, 98-162, doi.org/10.1016/j.matpur.2021.01.003, 2021.
6. A. Cecchin. Finite state N -agent and mean field control problems. *ESAIM: Control, Optimization and Calculus of Variations*, 27, n. 31, doi.org/10.1051/cocv/2021032, 2021.
7. A. Cecchin and F. Delarue. Selection by vanishing common noise for potential finite state mean field games. Accepted for publication on *Communications in Partial Differential Equations*. Pre-published online: doi.org/10.1080/03605302.2021.1955256, 2021.

Preprints

1. E. Bayraktar, A. Cecchin, A. Cohen, and F. Delarue. Finite state mean field games with Wright-Fisher common noise as limits of N -player weighted games. Preprint arXiv:2012.04845. Submitted to *Mathematics of Operations Research*, 2020.

Thesis

1. A. Cecchin. Finite state N -player and mean field games. Ph.D. Thesis, Department of Mathematics, University of Padova, Catalogue: paduaresearch.cab.unipd.it/11590. Defended on 14 January 2019, *cum laude*.

Teaching (in Italiano)

Ho svolto la Didattica di Supporto presso l'Università di Padova per i seguenti corsi

Statistica: Laurea in Biologia (25 ore)	Marzo - Giugno 2016
Probabilità e Statistica: Laurea in Matematica (25 ore)	Marzo - Giugno 2017
Analisi Matematica I: Laurea in Ingegneria Meccanica (24 ore)	Ottobre 2017 - Gennaio 2018
Calcolo Numerico: Laurea in Ingegneria Meccanica (24 ore)	Marzo - Giugno 2018
Analisi Matematica I: Laurea in Ingegneria Meccanica (24 ore)	Ottobre 2018 - Gennaio 2019

Durante le lezioni mi occupavo di svolgere esercizi riguardo gli argomenti spiegati dal docente titolare del corso.

Per il corso di Calcolo Numerico, ho fatto assistenza in laboratorio informatico per l'uso del linguaggio Matlab.

Conferences

Talks.....

I have been *invited* to give a talk at the following

Padova: Project meeting Large Scale Random Structures	3 - 4 July 2018
KAUST, Saudi Arabia: Project meeting on Mean Field Games	19 - 20 November 2018
Paris: Journées projet ANR Mean Field Games	7 - 8 December 2018
Paris: Séminaire Bachelier	28 February 2020
Les Andelys: Two days online workshop on Mean Field Games	18 - 19 June 2020
Berlin: Berlin Kolloqium	24 November 2021
Chicago: Workshop: Mathematical advances in mean field games	13 - 17 December 2021
Berlin: SIAM Analysis and PDE conference - Minisymposium on MFG	14 - 18 March 2022
Montréal: Workshop: Mean field games	10 - 17 April 2022

I gave a *contributed* talk at the international conferences

Turin: First Italian meeting on probability and statistics	19 - 22 June 2017
Freiburg: 13th German probability and statistics days	February 27 - March 2 2018
Grenoble: 18th Symposium on Dynamic Games and Applications	2 - 12 July 2018
Pavia: Optimal control and mean field games	19 - 21 September 2018
Vietri sul mare: 2nd Italian meeting on probability and statistics	17 - 20 June 2019
Levico terme: Mean field games and related topics - 5	9 - 13 September 2019

I also held seminars for the local community

Padova: Graduate seminar	22 November 2017
Padova: Seminar of differential equations and applications	9 April 2018
Nice: Seminar of probability and statistics	14 May 2019
Padova: Seminar of differential equations and applications	29 October 2019

Posters.....

I presented a poster at

Marseille, Cirm: Summer school Numerical methods for stochastic models	17 - 21 July 2017
Verona: Opening conference of Verona-Paris Stochastic modeling semester	18 -21 December 2017

Other conferences.....

I participated in other workshops, among which

Padova: Nonlinear PDEs: Optimal Control, Asymptotic Problems and MFG	25 - 26 February 2016
Leeds: Stochastic analysis of dynamical systems, c control and games	24 - 26 October 2016
Rome: PDE Models for Multi-agent phenomena	28 November - 2 December 2016

Rome: Mean field games and related topics, 4 14 - 16 June 2017
London, Turing Institute: Mean field games, energy and environment 14 - 16 February 2018

Also, I took part in the following schools for Ph.D. students. I received a grant to participate in
Barcelona: 3rd BCN summer school on stochastic analysis 27 June - 1 July 2016

L'aquila, GSSI: Stochastic PDEs, Mean Field Games and Biology 28 August - 5 September 2017
 and I attended also

Padova: Frontiers in stochastic modeling for finance 8 - 12 February 2016

Marseille, CIRM: Stochastic Dynamics out of Equilibrium 3 - 7 April 2017

Marseille, CIRM: Numerical methods for stochastic models 17 - 21 July 2017

Cetraro, CIME: Mean field games 10 - 14 July 2019

Service

I have been reviewing papers submitted to *SIAM Journal on Control and Optimization*, *Applied Mathematics and Optimization*, *ESAIM: Control, Optimization and Calculus of Variations*, *Annals of Applied Probability*, *Stochastic Processes and their Applications*, *Finance and Stochastics*, *Electronic Journal of Probability*, *Mathematics of Operations Research*, *Dynamic Games and Applications*, *Probability in the Engineering and Informational Sciences*, *Journal of Dynamics and Games*, *IEEE Transactions on Automatic Control*.

Skills

Computer

Advanced knowledge: software Matlab and Mathematica, program Latex, and Microsoft Office

Languages

Italian: mother language

English: very good

French: basic

Palaiseau, 19 October 2021