Optimal Transport and Applications

Luigi Ambrosio

2019 Balzan Prize for Theory of Partial Differential Equations

Balzan GPC Adviser: Étienne Ghys
Principal Investigator: Luigi Ambrosio
Senior Collaborators: Simone Di Marino, Giuseppe Savaré, Pierluigi Contucci
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Luigi Ambrosio is Director of the Scuola Normale Superiore in Pisa, Italy.

Ambrosio's Balzan research project is inspired by his recent work at the interface of several areas, including calculus of variations, geometric measure theory, optimal transport and its applications to partial differential equations and to metric geometry. He considers this ability to bring techniques from one field to another an important ingredient of his research, and will use the Balzan Prize to keep his research goals as broad and interdisciplinary as possible in a five-year project which combines traditional topics like optimal transport, partial differential equations and curvature bounds for metric measure spaces with new emerging topics like machine learning. Ambrosio's interests derive from the use of transport distances in the design of the so-called loss functions on the one hand, and from the many emerging connections between neural networks and partial differential equations (especially gradient flow type equations) on the other.

The prize will be used for two-year, non-teaching postdoctoral research grants based on the experience developed at the Centro di ricerca matematica Ennio De Giorgi of the Scuola Normale Superiore in Pisa. The positions will be advertised internationally, and the project will also involve international travel, conferences and publication of research results in leading mathematical journals.

Optimal Transport and Applications is comprised of four parts:

Optimal transport and partial differential equations: to be carried out jointly with Simone Di Marino, Associate Professor at the University of Genoa and Giuseppe Savaré, Full Professor at the University of Pavia, and their collaborators. The project will investigate potential directions for gradient flows in metric spaces and the space of probability measures.

Optimal transport and metric measure geometry: investigating potential directions for the fast and remarkable developments in the theory of metric measure spaces satisfying upper bounds on dimension and lower bounds on the Ricci tensor.

Optimal transport and machine learning: an exploration of the many emerging connections between the theory of optimal transport and models and algorithms currently used in the Machine Learning community, in particular, the use of Wasserstein metrics and the relation between discrete models and their continuous counterparts.

The statistical mechanics approach to machine learning: to be carried out jointly with Pierluigi Contucci, Full Professor at the University of Bologna and his collaborators. This part of the project aims at identifying and developing connections between the corpus of statistical mechanics and the rapidly emerging field of machine learning, especially the recent deep neural network methods.