Luca Alberto Davide Ferrari

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Ecole Polytechnique
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Born: August 26^{th}, 1990
Italian Citizenship

Research interests

- Optimal and branched transportation problems
- Steiner and other minimal tree problem, Minimal surfaces or Plateau problems
- Applications of the Optimal transport theory, Moving earth distance or Wasserstein metric to machine learning

Employment

2015-: **P.H.D. in Mathematics** at *Ecole Polytechnique, CMAP* (Palaiseau, France).
Discussion: 5 October 2018
In June 2015 I was awarded a scholarship from the *Ecole Doctorale INTERFACES* to study the problem of approximating supply-demand distributions networks under the supervision of professor Antonin Chambolle. Usually the problem is casted in the context of graph theory, where networks are modeled as weighted trees and the optimal network is the one which minimizes a certain cost function. In this framework many instances of the problem require an exponential time with respect to the number of locations to be connected. It must be said that the Optimal Control community has developed some fast algorithms that work very well when networks develop only in two dimensions. Nevertheless these methods do not scale well when a third dimension is added, e.g. when dealing with the circulatory system in our body. In my thesis I developed new methods to approach these instances of the problem. Rather than using Optimal Control theory I chose the framework of Calculus of Variations and Geometric Measure Theory in which both the networks and the cost functions are described by means of more complex mathematical objects, a choice which rewards with more flexibility to generalization. More specifically, I have inquired the validity of the approach and conducted numerical simulations on some test problems. This results are contained in two published articles and one currently under review.

Education

2015: 6 month **research stage** at *Ecole Polytechnique (Palaiseau, France)*, under the supervision of prof. Antonin Chambolle (*Ecole Polytechnique*), and prof. Bernard Ruf, (*University of Milan*) I developed a variational approximation to the Steiner minimal tree problem.

2013-2015: **Master degree in pure Mathematics**, *University of Milan*, Italy, final grade 110/110 cum laude, July 2015.

2009-2013: **Bachelor degree in pure Mathematics**, *University of Milan*, Italy, final grade 107/110. Bachelor Thesis: Maximum principle and comparison theorems for first order differential equation.

2004-2009: **Scientific high school Diploma** at *'Istituto Sacro Cuore'* Scientific High School. I attended my fourth year of High School (2007-2008) at *St. Albans's High School*, London, UK.

Pubblications

Under review: With A. Chambolle and B. Merlet. *Strong approximation in h-mass of rectifiable currents under homological constraint.* ArXiv link: 1806.05046v1.

Under review: With B. Wirth and C. Rossmanith. *Phase field approximations of branched transportation problems.* ArXiv link: 1805.11399v1.

Published: With A. Chambolle and B. Merlet. *Variational approximation of size-mass energies for $k-$dimensional currents.*. Published in: **ESAIM: COCV**. DOI: https://doi.org/10.1051/cocv/2018027ArXiv link: 1710.08808v1.

Published: With A. Chambolle and B. Merlet. *A phase-field approximation for the Steiner problem in dimension two.* Published in: **Advances in Calculus of Variations**. DOI: 10.1515/acv-2016-0034 ArXiv link: 1710.08808.

Talks

26 Jun. 2018: Université Paris Diderot, Paris, FR. **Variational approximations of size-mass energies for $k-$dimensional currents**.

9 Oct. 2017: Université Pierre et Marie Curie, Paris, FR. **Phase-field approximations for branched transport and urban planning**.

26 Apr. 2017: University of Zurich, CH, **Phase-field approximation for the Steiner Problem**.

Workshops and schools

4-6 Dec. 2017: Laboratoire Jacques-Louis Lions, Paris, 'French-German-Italian LIA on Applied Analysis'.

24-26 Apr. 2017: Universität Irchel, Zurich, CH. 'Workshop on Transport problems'.

28 Feb.-3 Mar. 2017: Dept. of Mathematics and Computer Science, University of Münster, GE. Workshop: Shape, Images and Optimization.

6-10 Feb. 2017: Levico Terme, Trento, IT. XXVII Convegno Nazionale di Calcolo delle Variazioni.

25-28 Oct. 2016: SISSA, Trieste, IT. Workshop in Geometric Measure Theory, Shape Optimisation and Free Boundaries

5 Apr. 2016: Université Paris sud, Paris, FR. Working day on Branched Transport.

27 Jun.-15 Jul. 2016: Université Lyon 1, Lyon , FR. Calculus of Variations, Optimal Transportation and Geometric Measure Theory: from Theory to Applications.

15 Oct. 2015: Université Lille 1, Lille , FR.One-day conference on Calculus of Variations.

20-24 Jul 2015: Universitat Pompeu Fabra, Barcelona, ES. Nonlinear PDE's and applications to image analysis. A scientific tribute to Vicent Caselles.

Visiting periods

May 2017: Two weeks visiting period at **Munster Universitat, GE**, invited by professor Benedikt Wirth, to discuss an Ambrosio-Tortorelli type functional to approximate the Urban-Planning problem, and to write the first draft of a research paper with the exact result.

Mar. 2016: Short visiting period at **Cambridge University, UK**, invited by professor Antonin Chambolle. Discussed a phase-field approximation to the Steiner minimal problem tree in $\mathbf{R}^n$.

Teaching and other work experience

2016-: **Tutoring and marking:** *'Université Pierre et Marie Curie'*,

- $\mathbb{R}^n$-valued functions differential and integral calculus,
- Matrices and calculus,
- Series, successions and linear algebra.

Sept. 2017: **Stage SEME:** 'Semaines d'Etude Maths-Entreprises' *Université Paris Descartes*, One week collaborative stage between P.H.D. students on a project proposed by the enterprise 'Oscaro.com'

Nov. 2012: **Teaching stage:** *'Istituto Sacro Cuore' Scientific High School, Milan, Italy.* One month teaching stage in a secondary school.

2010-2014: **Private lessons in mathematics:** and physics for high school and university students.

2009-2014: **Reading tutoring for secondary school students:** *'Portofranco' centre, Milan, Italy* Reading tutoring for secondary school students, especially from foreign countries.

Scholarships and awards

2009: 'Incentives for students enrolled in degree courses in Chemistry, Physics, Mathematics', award assigned by the University of Milan for the best students of the first two years of the scientific degree courses.

Computer Skills

Os: Windows, Linux and OS X **Languages:** C, MatLab, Java, Python, Freefem and LaTeX.

Academic service

2011-2013: **Student representative** for the *Department of Mathematics* and the *Science Faculty* at *University of Milan.*

Languages

Italian: native English: fluent French: spoken