Rene Cabrera
Department of Mathematics
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Curriculum Vitae

Overview

I am a mathematician working on topics in optimal transportation, calculus of variations, and nonlinear partial differential equations. Recently, I've been interested in variational mean field games only associated to optimal transport, and kinetic equations. You can find my homepage here: renecabrera.weebly.com

Employment

1. **NSF (RTG) Postdoctoral Instructor of Mathematics,** September 2022 - May 2025
   at the University of Texas, Austin

Education

- **University of Massachusetts** Amhesrt, MA
  Ph.D., Mathematics *September 2015 - May 2022*
  Advisor: Nestor Guillen
  Thesis: *An optimal transportation theory for interacting paths*
- **University of Massachusetts** Amherst, MA
  M.A., Mathematics *May 2017*
- **California State University** Los Angeles, CA
  M.S., Mathematics *September 2013 - June 2015*
- **UCLA** Los Angeles, CA
  B.S., Mathematics *September 2010 - June 2013*

Teaching

1. Fall 2022: Math 408M, Multivariable Calculus, UT Austin
2. Fall 2021 - Spring 2022: Not teaching; under Fellowship grant *Spaulding-Smith Fellowship*.
3. Spring 2016 - Spring 2021: Teaching Assistant
   - UMass, Amherst
   - Department of Mathematics and Statistics
   - TA: Differential Equations math 645 (graduate course), Differential Calculus math 131, Infinite Series Calculus math 132, Calculus for Life Sciences math 127

- Instructor of record: Ordinary differential equations math 331 (remote instruction), Infinite Series Calculus math 132, Differential Calculus math 131
- Grader: MATH 645 ODE and Dynamical Systems, Graduate course consisting of 15 students.

4. 22 June 2018 - 3 August 2018 & 25 June 2019 - 2 August 2019: Teaching Assistant

   - SCS Noonan Scholars Program at Amherst College (now known as Thrive Scholars)
   - TA: Differential Calculus, Infinite Series Calculus, and Multvariable Calculus
   - Supplemented students of low-income and of color who struggle to transition from high school to college that are first generation students who have overcome significant challenges and excelled through their own grit and resiliency in calculus.

5. Winter 2014 - Summer 2015: Teaching Associate

   - California State University, Los Angeles
   - Instructor of record: Precalculus, College Algebra, Elementary Algebra

Papers & Preprints

1. An optimal transportation principle for interacting paths and congestion.(2021) arXiv:2109.01946, submitted.

Selected Awards & Honors

NSF, MPS-Ascend Research Fellowship (declined) 2022
UMass, Amherst Spaulding-Smith Fellowship ($25 000) . . . . . 2021 - 2022
UMass, Amherst Northeast Alliance for Graduate Education and the Professoriates Fellow . 2015

Workshops Attended

1. Winter 2020: Canadian Mathematical Society, Optimal Transport and Applications.

   - Organized by Jun Kitagawa (Michigan State) and Abbas Momeni (Carleton)

2. Summer 2019: Columbia University, Workshop on free boundary problems.

   - Organized by Daniela De Silva, Nestor Guillen, Ovidiu Savin, and Hui Yu.

3. Spring 2019: University of Connecticut, Storrs, Geometric and Analysis Workshop for Graduate students.

   - Organized by Matthew Badger

Conferences (invited speaker)

1. Optimal Transport and Applications, 2020 CMS Winter Meeting

    - Organizers: Jun Kitagawa (Michigan State) and Abbas Momeni (Carleton)
    - **Talk Title**: The Monge-Kantorovich Optimal Transportation Mass Problem On Rectifiable Continuous Paths
    - **Abstract**: This topic is part of my doctoral dissertation studies at UMass, Amherst. The Monge-Kantorovich problem (MKP) is the study of transferring mass from an initial location to a final location in the most efficient way possible. Essentially, in the classical MKP we are a priori transferring mass along straight lines. But suppose that we now want to transfer mass along paths. In this talk, we present the MKP along paths and show that minimizers exist using a coercivity property. We consider maps $\Gamma(x,t) := (\gamma(x))(t)$ defined on the space of paths such that $\Gamma(x,0) = x$ and $\Gamma(x,1) = T(x)$, where T pushes forward μ_0 to μ_1—probability measures on $\overline{B}_R(0)$. Then for given transference plan on the space of paths, $\pi_\Gamma = \Gamma_\sharp \mu_0$, MKP takes the form $\int c(\gamma)\, d\pi(\gamma) = \int c(\Gamma)\, d\mu_0$. When the cost is $c(\gamma) := \int_0^1 \frac{1}{2}|\dot{\gamma}|^2$, perturbations and optimality conditions of Γ show π_Γ concentrates on constant speed geodesics. Then we untrivialize the problem on paths by adding congestion with interaction term: $\mathcal{E}(\pi) := \int c(\gamma) d\pi(\gamma) + \int\int \int_0^1 u(|\gamma(t) - \sigma(t)|)\, dt d\pi(\gamma) d\pi(\sigma)$ between paths σ's, keeping γ fixed, with different endpoints. We require u to satisfy a Lipschitz condition. The methods that we used to prove existence of minimizers for MKP on paths apply equally well to this new formulation. Formally, the minimizers of $\mathcal{E}(\pi)$ are solutions of $-\partial_{tt}\Gamma(x,t) + \int u'(|\Gamma(x,t) - \Gamma(y,t)|) \frac{\Gamma(x,t) - \Gamma(y,t)}{|\Gamma(x,t) - \Gamma(y,t)|}\, d\mu_0(y) = 0$.
    - CMS Optimal Transport and Applications

2. Geometric and Harmonic Analysis, Uconn, Storrs, 2019

    - **Talk Title**: Optimal Transportation Along Paths
    - **Abstract**: In this talk we introduce the Monge-Kantorovich problem of optimally transporting one distribution of mass onto another, where optimality is measured against a cost function $c(x,y)$. We state important results which solve Monge-Katorovich given by Gangbo and McCann. Connections to inequalities and partial differential equations will be briefly discussed. Lastly, a formulation of optimal transportation along paths will be described as well.
    - Talk Website

Visiting Graduate Student

1. **Fall 2020**. University of Alberta, Topics in applied mathematics I—Optimal Transport + Economics (full remote instruction) instructed by Brendan Pass.

2. **Spring 2020**. University of Texas at Austin, visiting graduate student—hosted by Maria Pia Gualdani and organized by Nestor Guillen.

Seminar talks

1. Analysis Seminar, "An optimal transportation principle for interacting paths", UT Austin, September 14, 2022
2. Applied Mathematics and Computation Seminar, "Optimal transportation with interacting paths", UMass, Amherst February 15, 2022
3. GRAduate Student Seminar (GRASS), "Optimal transportation with interacting paths", UMass, Amherst February 9, 2022
4. Math Club Seminar, "Optimal path transportation with interaction", Cal State LA Univ. October 2021
5. Differential equations and applied math seminar, "Path-dependent Optimal Transport", Texas State University, April 2021 (Click here)
6. Optimal Transport and Applications, "The Monge-Kantorovich Mass Transportation Problem On Rectifiable Continuous Paths", 2020 CMS Winter Meeting, December 2020.
7. Geometric and Harmonic Analysis Conference, Uconn, Storrs "Optimal Transportation Along Paths" March 2019
8. Graduate Student Seminar (GRASS), Umass, Amherst " Optimal Transportation On Paths" February 8 2019
9. Math Club, Umass, Amherst "Countable and Uncountable sets" April 2017
10. Math Club, Umass, Amherst "Starting at the beginning: the natural numbers" September 2016
11. Math Seminar in California State University, Los Angeles "Triangulable and nontriangulable manifolds" February 2015
12. Topology Seminar in UCLA "The Wecken property for 2-valued linear maps of the 2-torus" August 2013