# Elchanan Solomon

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I am a mathematician working in applied topology and geometry. I'm interested in stability and inverse properties of topological transforms, connections between applied topology and metric geometry, optimization and learning with topological invariants, and their applications to data science and machine learning.

## Current Position

**Duke University** — Durham, NC
*Phillip Griffiths Assistant Research Professor in Mathematics* — *2019-2022*

## Education

**Brown University** — Providence, RI
*PhD. in Mathematics* — *2013-2019*

**UCLA** — Los Angeles, CA
*B.S. and M.A. in Mathematics, Regents Scholar* — *2010-2013*

## Publications & Preprints

**Improving Metric Dimensionality Reduction with Distributed Topology** 2021
(joint with Alex Wagner and Paul Bendich), arXiv:2106.07613

**From Geometry to Topology: Inverse Theorems for Distributed Persistence** 2021
(joint with Alex Wagner and Paul Bendich), arXiv:2101.12288
Accepted at Symposium on Computational Geometry (SOCG) 2022

**A Fast and Robust Method for Global Topological Functional Optimization** 2021
(joint with Alex Wagner and Paul Bendich), AISTATS 2021: 109-117

**Geometric Fusion via Joint Delay Embeddings** 2020
(joint with Paul Bendich), FUSION 2020:1-8

- Won 2nd runner up in the general category of the Fusion 2020 Best Paper Award.

**Intrinsic Topological Transforms via the Distance Kernel Embedding** 2019
(joint with Clément Maria and Steve Oudot), SoCG 2020: 56:1-56:15

**Inverse Problems in Topological Persistence** 2018
(joint with Steve Oudot), Abel Symposia, Springer, 2020

**Barcode Embeddings for Metric Graphs** 2017
(joint with Steve Oudot), Algebraic & Geometric Topology

**Relaxing the Integral Test: A Challenge for the Advanced Calculus Student** 2017
(joint with Paul Carter), College Mathematics Journal.

## Publicly Available Code

**Code for implementing the DIPOLE dimensionality reduction algorithm** 2021
Based on the paper *Improving Metric Dimensionality Reduction with Distributed Topology.*

**Code for implementing topological optimization via STUMP algorithm** 2020
Based on the paper *A Fast and Robust Method for Global Topological Functional Optimization.*

**Code for implementing joint delay embeddings** 2020
Based on the paper *Geometric Fusion via Joint Delay Embeddings.*

**Demo code for smooth Euler Characteristic Transform** 2018
Written for *TRIPODS Summer Bootcamp on Topology and Machine Learning.*

## Selected Talks & Presentations

**Special Session on Computational Topology and Applications** — Upcoming
Spring Western AMS Sectional Meeting 2022, Virtual

**Special Session on Statistics and Machine Learning using Topology and Geometry** — 9/04/2022
Joint Math Meetings (JMM), Virtual

**Duke Postdoc Soapbox** — 02/12/2021
"Are Machines Visual Learners? The Mathematics of Perception"
Duke University, North Carolina

**Applied Algebraic Topology Research Network** — 25/08/2021
"Dimensionality Reduction via Distributed Persistence: DIPOLE"
Online

**YData Machine Learning Meetup** — 10/08/2021
"Dimensionality Reduction and Topological Data Analysis"
Tel Aviv University, Israel

**Topological Data Analysis Workshop** — 26/04/2021
"From Geometry to Topology: Inverse Theorems for Distributed Persistence"
Institute for Mathematical and Statistical Innovation (IMSI), Online

**AISTATS: Artificial Intelligence and Statistics** — 14/04/2021
"A Fast and Robust Method for Global Topological Functional Optimization"
Online

**Applied Topology in Albany Seminar** — 19/02/2021
"From Geometry to Topology: Inverse Theorems for Distributed Persistence"
Online

**University of Barcelona Topology Seminar** — 15/12/2020
"Fast and Robust Optimization of Topological Functionals"
Online

**Symposium on Computational Geometry (SOCG)** — 24/06/2020
"Intrinsic Topological Transforms via the Distance Kernel Embedding"
Online

**23rd International Conference on Information Fusion** — 05/05/2020
"Geometric Fusion via Joint Delay Embeddings"
Online

**University of Florida Topological Data Analysis conference** — 31/01/2020
"Topological Transforms via Kernel Embeddings"
University of Florida, Gainesville

**Theory and Foundations of TGDA** — 21/05/2018
"Inverse Results for an Intrinsic Persistence-Based Transform on Metric Graphs"
Mathematical Biosciences Institute, The Ohio State University

**TAGS - Linking Topology to Algebraic Geometry and Statistics** — 20/02/2018
"Embedding Metric Graphs in the Barcode Space"
Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

**Joint Math Meetings** — 17/01/2014
"Quantitative Portfolio Construction Using Various Optimization Methods"
Baltimore, MD

**Joint Math Meetings** — 06/01/2012
"Quantitative Modeling of Financial Contagion"
Boston, MA

## Conferences and Seminars Organized

**Applied Algebraic Topology Research Network (AATRN)** 2020-
(co-director with Henry Adams, Sara Kališnik, Teresa Heiss, Hana Dal Poz Kouřimská, and Bastian Rieck)

**$\Delta$ Applied Topology & Geometric Reading Group** 2021
(Founder and organizer)

**Brown Applied Topology and Geometry Seminar** 2018-2019
(co-organized with Melissa McGuirl)

**TRIPODS Summer Bootcamp: Topology and Machine Learning (ICERM)** 2018
(on the organizing committee)

## Teaching

**Duke**: Math 466 (Math of Machine Learning), Math 216 (Linear Algebra and Differential Equations).
**Duke Kunshan University**: Math 409 (Topology), Stats 302 (Principles of Machine Learning), Math 202 (Linear Algebra).
**ICERM**: TA for Summer@ICERM REU in Applied Topology.
**Brown**: Math 1620 (Mathematical Statistics and Data Science), Math 200 (Multivariable Calculus), DATA 1010 TA (Data Science Probability and Statistics), Math 520 (Linear Algebra), Summer@Brown Combinatorics TA, Math 202 (Linear Algebra), Math 90 TA (Calculus), Math 2410 TA (Algebraic Topology).
**UCLA**: Docent at UCLA Math Circle.

## Mentoring

**Duke**: Capstone Project Manager for Duke Masters in Data Science (MIDS). Mentoring an undergraduate, Angikar Ghosal, in a research project on applied topology and computational linguistics.
**Brown**: Mentor for two students in the Directed Reading Program (Algebraic Topology, Differential Topology). Sponsor for Undergraduate Independent Study in Model Theory.

## Skills

**Coding**: Python (including numpy, scipy, matplotlib, pandas, tensorflow, gudhi) and LaTeX. Past experience with C++, Java, and MATLAB.
**Languages**: English (native), Hebrew (fluent), Spanish (advanced intermediate), Catalan (advanced intermediate), French (intermediate), Yiddish (low intermediate), Mandarin (low intermediate), Russian (elementary).