

Elioth Sanabria

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Research Interests

Supply chain networks and systemic risk; applied probability and stochastic networks; AI-driven Operations Research; data-driven decision systems deployed at scale in industry and the public sector.

Teaching Interests

AI-driven Operations Research: enhancement of classical Operations Research methodologies with AI-based frameworks, with applications to Supply Chain Management, Business Analytics, and Stochastic Systems Optimization and Design. Focused on creating practical learning experiences for students leveraging Generative AI technologies, with empirical measurement of learning outcomes.

Education

Columbia University, New York, NY

Ph.D., Operations Research

September 2017 – October 2022

Thesis: “On the Misclassification Cost Problem and Dynamic Resource Allocation Models for EMS”

M.Phil., Operations Research

September 2017 – February 2020

M.Sc., Operations Research

September 2014 – December 2015

Universidad de los Andes, Bogota, Colombia

B.A., Economics

August 2009 – December 2012

Professional Experience

Lehigh University - College of Business - DATA Department, Bethlehem, PA

Teaching Assistant Professor and Assistant Director for Industry Engagement

July 2026 – Present

- Teaching undergraduate and graduate courses in Supply Chain Management and Business Analytics, with a strong emphasis on practical learning experiences built in collaboration with industry partners and leveraging Generative AI technologies.
- Building industry-academia partnerships through the Center for Supply Chain Research at Lehigh (CSCRL), including corporate-sponsored student projects and executive engagement events.
- Developing a research agenda on data-driven supply chain risk: network stress testing, systemic contagion, and disruption analytics, at the intersection of education, industry, and public-sector partnerships.

Staffing Analytics LLC, New York, NY

Chief Executive Officer - Chief Scientist

June 2023 – Present

- Developing custom data-driven optimization applications for large-scale government and private projects, including dynamic pricing, resource scheduling, and vehicle routing, combining big data and AI with state-of-the-art mathematical and statistical optimization models.
- Built **Predictheus**, a data analytics platform for retail businesses providing demand forecasting, optimal pricing, inventory management, and staff scheduling using data-driven models.
- Developed a data-fusion platform that synthesizes multi-modal data (video, audio, and text) into data-driven knowledge graphs for large-scale data processing (e.g., analytics over thousands of traffic cameras), combining signal reconstruction principles from Compressive Sensing with ML techniques (CNNs, Small Language Models).

The City of New York, New York, NY

Assistant Commissioner of Operations Research and Chief Efficiency Officer - DOC

September 2022 – June 2023

- Led a team of scientists and data analysts delivering time-sensitive quantitative solutions for a 5,000+ member uniformed workforce: optimal staff scheduling via Stochastic Discrete Optimization to reduce overtime; jail population forecasting using econometric and queueing-theoretic models, informing the city’s long-term jail capacity planning; and Computer Vision (CNN-based) systems for attendance tracking on live video.

- Built and deployed web-based decision-support applications used daily by non-technical stakeholders, including population forecasting, optimal hiring and promotion schedules, and intake process optimization based on Queueing Theory and Second-Order Cone Programming.

The City of New York, New York, NY

Deputy Director of Operations Research - FDNY

June 2022 – September 2022

- Led a team of scientists providing mathematical modeling and optimization tools to improve ambulance dispatching, call center staffing, and risk-based fire inspection scheduling against key response-time metrics.
- Built and deployed web-based what-if analysis applications used by non-technical stakeholders for call center staffing, ambulance scheduling, and risk-reduction fire inspections.

Columbia University, New York, NY

Staff Research Assistant

July 2016 – September 2017

- Altair Engineering Inc., PG-008663, “Studies on Innovation Intelligence Quotient (IIQ) – A Data Analytic Approach” (PI: David D. Yao). Developed a data-driven latent-variable factor model estimating an innovation index for each company in the S&P 500; identified KPIs using LASSO and L-2 constrained regression on large databases (USPTO, COMPUSTAT, KLD); applied NLP techniques (Latent Dirichlet Allocation, PageRank) to build an innovation keyword dictionary.

Quantil — Applied Mathematics, Bogota, Colombia

Quantitative Analyst

August 2012 – August 2014

- Delivered quantitative projects for financial institutions including a stock brokerage and a major Colombian pension fund: portfolio optimization integrating investment-board views via integer programming, clustering, and Bayesian statistics; multi-factor HJM calibration for bond-basket derivatives; and risk optimization for a swaps portfolio against liquidity-weighted forward-curve exposures.

Research Experience

Staffing Analytics, New York, NY

Principal Investigator

June 2023 – Present

Grant writer and Principal Investigator for the following projects:

- Price and staff scheduling optimization algorithms powered by advances in non-linear stochastic optimization, targeting high-throughput labor-intensive businesses facing time-varying, price-elastic demand, using Machine Learning, Queueing Theory, and Stochastic Optimization.
- AI-driven cost-sensitive product obsolescence prediction and replacement scheduling: a data-driven misclassification-cost model estimating obsolescence risk over time against re-procurement and outage costs, hedged optimally via stochastic optimization and machine learning.
- Event-based lightweight Compressive Sensing algorithms for tracking in space: a sensing paradigm for Event-Based Cameras combining Compressive Sensing with machine-learned “physics-informed bases” for signal reconstruction in satellite applications.
- Reinforcement Learning-based optimal dynamic control of hot-walled CVD-SiC epitaxy: control algorithms for a single-wafer epi reactor maximizing throughput and minimizing surface defects by exploiting Design of Experiment data.

Columbia University, New York, NY

Graduate Research Assistant

July 2016 – July 2022

Research under the supervision of Prof. David D. Yao, Henry Lam, and Jay Sethuraman:

- Google, FDNY and Tides Foundation, “EMS Resource Deployment Modeling” (PI: Henry Lam). Forecasting models for incident prediction in space and time adaptive to unexpected surges; simulation-based redesign of ambulance deployment to improve NYC EMS response times; optimal ambulance scheduling via integer programming, convex optimization, and RL; optimal EMS call center staffing via second-order cone programming.
- AHRQ-R01-HS024915-01, “Nursing Intensity of Patient Care Needs and Rates of Healthcare-Associated Infections (NIC-HAI)” (PI: Elaine Larson). Recurrent-neural-network forecasting of Healthcare-Associated Infections and risk-factor identification; ML-based targeted preventive intervention minimizing misclassification costs and infection rates.
- NSF-CMMI-1462495, “A Dynamic Model for Systemic Risk in Networks Subject to Contagion” (PI: David D.

Yao). Time-dynamic default banking network model with illiquid assets; topology of worst-case banking networks under marginal-liability information in the Eisenberg-Noe model; optimal bail-out formulation under a bail-out budget.

City University of Hong Kong, Hong Kong, China
Visiting Fellow, Institute for Advanced Study

Summer, 2017 – 2018

Columbia University, New York, NY
Graduate Research Assistant

July 2015 – May 2016

Applied and computational research with Prof. Jose Blanchet:

- NSF-CMMI-1436700, “Collaborative Research: Modeling and Analyzing Extreme Risks in Insurance and Finance” (PI: Jose Blanchet). Robust performance analysis for actuarial applications: valuation of insurance claims under robust worst-case joint distributions preserving marginals, and under uncertainty in the marginals alone.
- “Steady-state simulation of reflected Brownian motion and related stochastic networks.” Parallel-computing simulation of the stationary distribution of multidimensional Reflected Brownian Motions.
- “Modeling and Analysis of Rogue Targets Avoiding Detection.” Importance sampling estimation of the energy of self-attractive multidimensional random walks in C++.

Quantil — Applied Mathematics, Bogota, Colombia
Quantitative Analyst

August 2012 – August 2014

Research under the supervision of Prof. Diego Jara on portfolio optimization with investment-board views, multi-factor HJM bond-basket valuation, and swaps portfolio risk optimization.

Central Bank of the Republic of Colombia, Bogota, Colombia
Research Assistant

2012

Research under the supervision of Prof. Jose Eduardo Gomez: ARFIMA estimation of fractional co-integration among emerging market indexes; non-parametric and semi-parametric CAPM estimation for the Colombian Stock Exchange.

Honors and Awards

Finalist, **Doing Good with Good OR Paper Competition**, INFORMS 2021.

Finalist, **U.S. Army xTechLive Competition** “Software-based AI-powered fusion engine”, DEF CON 33, 2025.

Academic Papers and Books

1. Sanabria E. *Supply Chain Networks*. Under review, 2026. arXiv:2607.17491. Companion interactive simulator featured on [UN Comtrade Labs: globaloilnetwork.staffinganalytics.io](https://globaloilnetwork.staffinganalytics.io) (40,000+ visitors, 20,000+ simulations).
2. Sanabria E. *Supply Chain Analytics: A Data-driven Approach*. Book manuscript, 2026.
3. Cohen B, Sanabria E, Liu J, Zachariah P, Shang J, Song J, Calfee D, et al. *Predicting Healthcare-associated Infections, Length of Stay, and Mortality with the Nursing Intensity of Care Index*. Infection Control & Hospital Epidemiology. 2022; 43(3):298-305.
4. Zachariah P, Sanabria E, Liu J, Cohen B, Yao D.D, Larson E. *Novel Strategies for Predicting Healthcare-Associated Infections at Admission: Implications for Nursing Care*. Nursing Research. 2020; 69(5):399-403.
5. Gomez J, and Sanabria E. *Non-parametric and semi-parametric asset pricing: An application to the Colombian stock exchange*. Economic Systems. 2014; 38(2):261-268.
6. Sanabria E, Lam H, Lelo de Larrea E, Sethuraman J. et al. *Short-Term Adaptive Emergency Call Volume Prediction*. Winter Simulation Conference (WSC), 2021.
7. Lelo de Larrea E, Lam H, Sanabria E, Sethuraman J. et al. *Simulating New York City Hospital Load Balancing During COVID-19*. Winter Simulation Conference (WSC), 2021.
8. Lam H, Lelo de Larrea E, Sanabria E, Sethuraman J. et al. *Hospital Load Balancing: A Data-Driven Approach to Optimize Ambulance Transports during the COVID-19 Pandemic in New York City*. Working paper, 2022. **Finalist, Doing Good with Good OR Paper Competition, INFORMS 2021.**
9. Sanabria E, Yao D.D, and Lam H. *Decision Tree Algorithms for MDP*. Working paper, 2021.
10. Sanabria E, and Yao D.D. *Minimizing Misclassification Cost in Machine Learning, with Applications to HAI*

Prediction. Working paper, 2019.

11. Sanabria E, and Yao D.D. *Generalization Bounds for Classification on Finite Support*. In preparation.

Invited Talks

CSCRL Supply Chain Fall Forum (keynote), Lehigh University, November 2026 (scheduled).

Quantil Research Seminar (Virtual), April 2025.

Urban Mobility AI Workshop, Columbia University, November 2024.

NYC Department of Transportation - DCAS, November 2024.

Amazon Tech Talk (Virtual), February 2024.

INFORMS Annual Meeting, Anaheim, California, October 2021.

Quantil Research Seminar, Bogota, Colombia, August 2019.

Nursing School Doctoral Seminar Series, Columbia University Medical Center, April 2019.

INFORMS Annual Meeting, Phoenix, Arizona, November 2018.

Ph.D. Student Seminar, Columbia University, July 2018.

Poster Presentations

Financial and Business Analytics - DSI capstone poster presentation, Columbia University, November 2018.

NYC Operations Day, Columbia University, March 2019.

Data Science Day, Columbia University, April 2019.

Teaching Experience

Lehigh University - DATA Department, Bethlehem, PA

Teaching Assistant Professor

Fall 2026

BUAN 244 - Business Analytics II

BIS 411 - Storytelling in Business Analytics

Columbia University - IEOR Department, New York, NY

Adjunct Assistant Professor

Spring 2026

IEOR 4108 Supply Chain Analytics.

Columbia University, New York, NY

Teaching Assistant

Fall 2017

IEOR 4106 Stochastic Models (CVN).

IEOR 4524 Analytics in Practice.