

# Madhurima Nath

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Multi-cloud certified machine learning scientist and data engineer, proficient in algorithm development and computational modeling.

## EDUCATION

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**Ph.D., Physics**, Virginia Tech, Blacksburg, VA Dec 2018

Dissertation: *Application of Network Reliability to Analyze Diffusive Processes on Graph Dynamical Systems*

This work explores the effects of the structural properties of an interacting system on the outcomes of a diffusive process on realistic socio-technical systems using an efficient and generalized probabilistic measure based on Monte-Carlo simulations and graph theory techniques.

US Patent: *System, method and computer readable medium for sensitivity of dynamical systems to interaction network topology*

**M.S., Physics**, Virginia Tech, Blacksburg, VA May 2017

**M.Sc., Physics**, Indian Institute of Technology Delhi, New Delhi, India May 2012

Thesis: *Study of Cold Atomic Condensates by Atomic Photon Interactions*

Award: *Best Master of Science Thesis 2011-2012*

**B.Sc. (Hons.)**, Physics, University of Calcutta, Kolkata, India May 2010

Minors: *Mathematics and Chemistry*

## SKILLS

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**Programming:** Python, SQL, PySpark, R || **CI/CD**<sup>1</sup>: Git/GitHub/Azure DevOps/BitBucket

**Tools:** Databricks, Azure Machine Learning (ML), Tableau, AWS<sup>2</sup> QuickSight, Power BI, Mathematica, MATLAB, Shell scripting

**Certifications:** Databricks Lakehouse Data Engineer Associate, GCP<sup>3</sup> Associate Cloud Engineer, AWS<sup>2</sup> Cloud Practitioner, Domino Data Lab Certified Data Science Practitioner, Tableau Desktop Specialist, Matillion Associate Certification

**Other Skills:** Data Modeling, Gap Analysis, Technical, Conceptual and Data Architecture Diagrams, Data Flows, Agile Delivery

**Awards:** Slalom Mogul Award recognizing outstanding client service and delivery excellence, Q1 2023, Q2 2022, Q4 2020.

## INDUSTRY EXPERIENCE

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**Data Science Consultant, Data & Analytics, Slalom Consulting, LLC, White Plains, NY Jan 2020 – Present**

- Led the development and deployment of sentiment analysis and topic modeling NLP<sup>4</sup> pipelines in Azure Databricks leveraging the free-form text gathered through current safety procedures to uncover safety-related themes and insights and identify possible improvement opportunities for a large Midwest utility provider.
- Co-led an initiative to develop fuzzy matching rules and data engineering pipelines to integrate syndicated datasets from multiple vendors - including Nielson and Skupos - into a centralized platform on Azure and to replace existing manual processes for a consumer packaged goods client.
- Co-led the development and deployment of a multi-class text classification model using NLP<sup>4</sup> techniques in Azure to classify product data into taxonomy groups for a comprehensive view of global procurement spend and accelerated the product launch roadmap by over a year for a consumer packaged goods client.
- Developed multiple solution accelerators on Azure Databricks - data ingestion pipelines using the medallion framework, data quality frameworks using great expectations, NLP<sup>4</sup> solution to implement semantic search - to enhance product delivery for clients.
- Coached and mentored summer interns, served as go-to resource to junior staff on statistical methods, machine learning solutions and computational modeling.
- Built a proof-of-concept ML solution to evaluate propensity scores and feature importance for accounts based on historical data in Salesforce, enabling sales and accounts teams to identify and prioritize potential buyers with 93% accuracy, replacing manual efforts.
- Created a segmentation model using historical customer viewership of sports events to implement better reporting, personalized marketing strategies and data governance for a media and television client.
- Designed and implemented global templates and data engineering pipelines for various datasets in supply chain for better annual forecasting as part of Integrated Business Planning for a consumer packaged goods client.
- Built AWS<sup>2</sup> QuickSight dashboards to provide quick insights into patient data related to treatments and clinical trials for a multinational biotechnology client.
- Performed gap analysis, gathered business requirements and analyzed customer engagement from historical data in Snowflake to define key performance metrics of a new product launch for a media and television client.
- Built scalable interactive visualization dashboards in Tableau for sales and commissions related analytics, enhancing existing solutions for a telecom client.

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<sup>1</sup>CI/CD: Continuous Integration & Continuous Development, <sup>2</sup>AWS: Amazon Web Services, <sup>3</sup>GCP: Google Cloud Platform, <sup>4</sup>NLP: Natural Language Processing

## RESEARCH EXPERIENCE

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### Post-graduate Research Assistant, Virginia Tech, VA

Mar 2019 – Dec 2019

- Developed a novel algorithm to identify the important elements of a graph dynamical system and their effects on the outcome of a Markov process, outperforming existing solutions.

### Graduate Research Assistant, Virginia Tech, VA

May 2014 – Dec 2018

- *Modeling Infectious Diseases*  
Developed an algorithm using a combination of graph theory tools and Monte-Carlo simulations to efficiently estimate the epidemic potential as a function of both infection rate and the interactions.
  - Demonstrated that both structural and global dynamics are statistically significant to approximate real-world scenarios for epidemic outbreaks instead of existing structurally similar graph models, which overestimate the number of infections by  $\sim 50\%$ .
  - Identified vulnerabilities in international food trade networks and estimated effects of mitigating contagion conditions with 96% accuracy to guide informed decision-making.
- *Sentiment Analysis*  
Implemented sentiment analysis on Twitter dataset of  $\sim 2.5\text{M}+$  users collected over a 6-months period to determine top influencers for both pro- and anti-electronic cigarettes, enabling targeted marketing.
- Developed an algorithm using concepts of Moore–Shannon network reliability to estimate the energy states of an interacting magnetic system, reducing the time complexity from  $O(n^2)$  to  $O(n)$ .

### Instructor of Record, Department of Physics, Virginia Tech, VA

Aug 2018 – Dec 2018

- Designed and facilitated weekly lectures, one-on-one sessions and recitation sessions for a 3-credit introductory physics course curriculum for  $\sim 120$  undergraduate engineering students.
- Supervised physics laboratory sessions along with office hours for both engineering and non-engineering students.

### Graduate Teaching Assistant, Department of Physics, Virginia Tech, VA

Aug 2013 – May 2015

- Taught and facilitated laboratory sessions and recitation classes for introductory physics courses for both engineering and non-engineering undergraduate students.

### Summer Research Fellow, Harish-Chandra Research Institute, India

Jun – Jul 2012

- Designed computational methods to analyze concepts of quantum information and computation.

### Research Assistant, Indian Institute of Technology Delhi, India

Jul 2011 – May 2012

- Developed a novel method to calculate diffraction properties and provide insights about the behavior of interacting quantum systems.

## PUBLICATIONS

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- S. Eubank, **M. Nath**, R. Mishra, and A. Adiga, Communities in directed weighted food networks using Moore-Shannon network reliability. (submitted to Applied Network Science).
- R. Mishra, S. Eubank, **M. Nath**, M. Amundsen and A. Adiga, Community detection using Moore-Shannon network reliability: Application to food networks, Complex Networks and Their Applications XI: Volume 2 Proceedings of The 11th International Conference on Complex Networks and Their Applications COMPLEX NETWORKS 2022, Springer International Publishing, 271-282, 2023.
- S. Eubank, **M. Nath**, Y. Ren and A. Adiga, Perturbative methods for mostly monotonic probabilistic satisfiability problems (arXiv preprint arXiv:2206.0355).
- **M. Nath** et. al., Using network reliability to understand international food trade dynamics, Complex Networks and Their Applications VII: Volume 1 Proceedings The 7th International Conference on Complex Networks and Their Applications COMPLEX NETWORKS 2018, Springer International Publishing, 524- 535, 2019.
- **M. Nath**, Y. Ren and S. Eubank, An approach to structural analysis using Moore-Shannon network reliability, Complex Networks and Their Applications VII: Volume 1 Proceedings The 7th International Conference on Complex Networks and Their Applications COMPLEX NETWORKS 2018, Springer International Publishing, 537-549, 2019.
- **M. Nath**, Y. Ren, Y. Khorramzadeh, and S. Eubank, Determining whether a class of random graphs is consistent with an observed contact network, J. Theor. Biol. 440C, 121-132, 2018.
- **M. Nath** and S. Eubank, Model selection for sequential designs in discrete finite systems using Bernstein kernels (arXiv preprint arXiv:1807.06661).
- Y. Ren, S. Eubank, and **M. Nath**, From network reliability to the Ising model: A parallel scheme for estimating the joint density of states, Phys. Rev. E 94.4: 042125, 2016.
- **M. Nath**, S. Eubank, M. Youssef, Y. Khorramzadeh, and S. Mowlaei, A two-parameter method to characterize the network reliability for diffusive processes, Complex Networks VI: Proceedings of the 6th Workshop on Complex Networks CompleNet 2015, Springer International Publishing 139-148, 2015.
- A. Agarwala, **M. Nath**, J. Lugani, K Thyagarajan, and S. Ghosh, Fock-space exploration by angle resolved transmission through a quantum diffraction grating of cold atoms in an optical lattice, Phys. Rev. A 85.6: 063606, 2012 (*equal contribution as first author*).

## CONFERENCE PRESENTATIONS

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- **Invited Talk:** Network reliability: a generic tool to explore diffusive processes on interacting systems, NASA PCE3 (Prebiotic Chemistry and Early Earth Environments) Virtual Workshop 2022 Nano- to Cosmic- Studies of Complex Systems, University of Wisconsin Madison, Madison, WI, Oct. 20, 2022.
- **Talk:** Perturbative methods for estimating relative contributions to network reliability, SIAM (Society for Industrial and Applied Mathematics) Workshop on Network Science, Virtual Workshop, Sep 13-15, 2022.
- **Talk:** Statistical mechanical applications of graph dynamical systems, Condensed Matter Seminar, Department of Physics, Virginia Tech, Blacksburg, VA, Oct. 30, 2017.
- **Talk:** Determining whether a particular contact network is consistent with a network model, 1st North American Social Networks Conference of the International Network for Social Network Analysis, Washington DC, Jul. 26-30, 2017.
- **Talk:** Network reliability: A novel measure to study the effects of network topology on the diffusive dynamics, Symposium for the Society of Young Network Scientists, NetSci 2017, Indianapolis, IN, Jun. 19-23, 2017.
- **Poster:** Network reliability: A measure to study diffusive dynamics on networks, Center for Soft Matter and Biological Physics Symposium 2017, Virginia Tech, Blacksburg, VA, May 17-18, 2017.
- **Talk:** Effects of network structure on propagation of infectious diseases, 33rd Annual Graduate Student Assembly Symposium and Exposition, Virginia Tech, Blacksburg, VA, Mar. 29, 2017.
- **Talk:** Renormalization group approaches for dynamics on irregular networks, APS (American Physical Society) March Meeting 2017, New Orleans, LA, Mar. 13-17, 2017.
- **Poster:** Diffusive dynamics on a network, SESAPS (Southeastern Section of the American Physical Society) Conference 2016, Charlottesville, VA, Nov. 9-12, 2016.
- **Poster:** Effects of network structure on epidemic modeling, Biocomplexity Institute Symposium 2016, Virginia Tech, Blacksburg, VA, Nov. 1, 2016.
- **Talk:** A two-parameter method to characterize the network reliability for diffusive processes, CompleNet 2015, New York City, NY, Mar. 25-27, 2015.
- **Poster:** Four-parameter characterization of network reliability and analysis of critical point phenomenology, APS (American Physical Society) March Meeting 2015, San Antonio, TX, Mar. 2-6, 2015.

## OUTREACH

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- Reviewer
  - Conference - Synergy of Scientific and Machine Learning Modeling, ICML2023\*. 2023
  - Journal - Physical Review E. 2022 - Present
  - Conference - Machine Learning and the Physical Sciences, NeurIPS2022†. 2022
- Industry Ambassador, Women in Network Science Society. Sep 2022 – Present
- Data science instructor at Slalom Q2 2022 NY-Metro Learning Session. Jun 2022
- Instructor at Women Who Code San Francisco Backend Study Group. Jul 2021
- Speaker at Women Who Code Data Science: NLP Fuzzy Matching Algorithms. Apr 2021
- Invited Speaker and Panelist at Women Who Code Statistics in Data Science Workshop Series Feb – Mar 2021
- Organizer of Women in Network Science Networks 2021 Conference Jun – Jul 2021
- Served as Graduate Student Representative, Department of Physics, Virginia Tech Aug 2017 – Jul 2018
  - Counseled incoming graduate students on course material, research design, and extra-curricular opportunities.
  - Assisted faculty with selection process of incoming graduate students as part of student-faculty council meetings.
- Committee Member, Women in Physics, Virginia Tech Aug 2014 – Dec 2018
  - Invited student speaker of APS Conference for Undergraduate Women in Physics, 2017. Jan 2017
  - Visited local K-12 schools to teach basic physics principles and share engaging science demos.

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\*ICML2023: 2023 International Conference on Machine Learning, †NeurIPS2022: Conference on Neural Information Processing Systems 2022