Madhurima Nath

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Senior Data Consultant with a PhD in Computational Physics, based in New York, USA. Research in network science and complex systems; industry work in Generative AI, NLP, and Data Engineering.

Education

Ph.D., Physics (Computational), Virginia Tech, Virginia, USA Dec 2018

- *Research Focus*: Complex systems analysis, Statistical physics, Network science, Community detection
- *Dissertation*: Application of Network Reliability to Analyse Diffusive Processes on Graph Dynamical Systems
- *US Patent* (US20210286859A1): System, method and computer readable medium for sensitivity of dynamical systems to interaction network topology

M.S., Physics, Virginia Tech, Virginia, USA May 2017

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

- *Thesis*: Study of Cold Atomic Condensates by Atom-Photon Interactions
- *Award*: Best Master of Science Thesis 2011-2012

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

- *Minors*: Mathematics and Chemistry

Professional Experience

Data & AI, Slalom, Inc., New York, USA Jan 2020 – Present

Senior Data Consultant (2024 – Present) || Data Consultant (2021 – 2024) || Associate (2020 – 2021)

- Translated business objectives into technical architectures, delivering AI applications and engineering pipelines across multiple cloud and data platforms.
- Directed end-to-end project lifecycles, bridging the gap between stakeholder requirements and technical roadmaps to drive cross-functional delivery.

Selected Consulting Projects

Generative AI Applications || **AI Engineer** || **Financial, Healthcare & Telecommunications** || Apr 2025 – Present

- Refactored codebases (BigQuery, Salesforce, Redshift) into YAML Databricks Asset Bundles (DABs) using Claude Code to enable a config-driven migration strategy (legacy to bronze/silver), replacing manual effort.
- Designed and delivered a Databricks Apps platform (FastAPI/React) and 4 AI/BI dashboards, integrating Genie Agent for real-time data entry and natural-language querying to provide a reconciled view of nationwide infrastructure, equipment and asset recovery tracking, project lifecycles, replacing fragmented processes.
- Developed a multi-agent RAG chatbot on Databricks Mosaic AI using LangChain, with rule-based routing, to improve information retrieval efficiency across structured (relational databases, CSV), semi-structured (JSON, MD, HTML), and unstructured (images, PDF) sources by 10-20% during a proof-of-concept.
- Enforced data governance and regulatory compliance across multiple projects, implementing and documenting access controls, tagging, audit logging in Unity Catalog and MLflow to ensure data security and production-readiness.

Network Predictive Maintenance Solution || **Analytics Engineer** || **Telecommunications** || Feb – Mar 2025 (1 month)

- Engineered a predictive maintenance pipeline to score daily device health using 3 radio frequency (RF) metrics and geographic clustering to proactively isolate faulty network infrastructure.
- Automated 90-day network telemetry processing in Google Cloud BigQuery for the New York metropolitan area, collaborating with network engineering teams to validate model-driven maintenance insights.
- Projected USD 8M in annual savings through a nationwide reduction of ∼30K customer calls and ∼6K service visits.

Technical Skills

- **Programming:** Python, SQL, PySpark, R, Bash/Shell || **Web Development:** HTML/CSS, JavaScript (basic)
- **Data & AI Platforms:** Databricks (Genie & Apps, Mosaic AI, MLflow, Unity Catalog), Snowflake (Snowpark, Streamlit)
- **Generative AI & Engineering:** Coding Agent (Pi, Claude Code), LangChain, Multi-agent Frameworks, RAG (retrieval-augmented generation), CI/CD (GitHub, BitBucket, GitLab)
- **Project Management:** Agile (JIRA), Technical Roadmaps, Stakeholder Communication

ACADEMIC RESEARCH

Virginia Tech, USA || ***Supervisor*: Prof. Stephen Eubank** May 2014 – Dec 2019

Post-doctoral Research Assistant (Feb 2019 – Dec 2019) || Graduate Research Assistant (May 2014 – Dec 2018)

- Developed hybrid computational framework using Bernstein basis functions as the polynomial basis set and combining Monte Carlo simulations with weak- and strong-coupling statistical physics perturbative expansions to estimate Moore-Shannon network reliability on graphs, an NP-hard challenge. *GitHub*. [arXiv: 2022, Complex Networks, 2018]
- Applied Moore-Shannon network reliability (originally developed for electronic circuits) to the National Longitudinal Study of Adolescent to Adult Health (Add Health) dataset to demonstrate that models matching local network statistics can overestimate infection numbers by $\sim$50%, applying Birnbaum importance measures to identify critical connections for targeted mitigation. [Journal of Theoretical Biology, 2018]
- Implemented Moore-Shannon network reliability approaches for community detection in large-scale weighted directed networks, characterising clusters with respect to underlying dynamical processes to overcome the limitations of traditional modularity-based approaches. [Complex Networks, 2022]
- Identified vulnerabilities within global food trade networks using commodity-specific data from the UN Comtrade database, analysing where pest and pathogen contamination could cascade through global supply chains. Achieved $\sim$96% precision in forecasting impact of mitigation strategies under various contagion scenarios. [Complex Networks, 2018]
- Reduced time complexity from $O(n^2)$ to $O(n)$ for estimating energy states in the Ising model, by proving an equivalence between network reliability and the Ising partition function. This enabled statistical-physics computation methods to be applied directly to network science. [Physical Review E., 2016]

ENVIRONMENTAL ENGAGEMENTS

Climate Analytics Architecture || **Databricks** [*GitHub*]

- Engineered an Infrastructure as Code (IaC) framework to ingest and standardise multi-source climate datasets into medallion layers using metadata driven Lakeflow Spark Declarative Pipeline (SDP) with automated testing and monitoring dashboard.
- Developed a Dynamic Line Rating (DLR) grid stress-test model across 3 countries using the IEEE 738 ampacity standards. Integrated 2010-2026 real weather data with simulated wind, solar, and congestion prices to demonstrate the cost-avoidance via an interactive AI/BI dashboard built on metric views.

Certifications & Courses

- *Energy and Climate Scenario Analysis*, Cornell University, New York, USA Aug – Dec 2026
- *Leave No Trace 101 Certificate of Completion*: Minimum-Impact Practices Jun 2026
- *Climate Intelligence: Using Climate Data to Improve Business Decision-Making*, University of Reading (Online) Jul 2026

Volunteer Experience

- *Tour Guide (Docent) at the Live Butterfly Exhibit*, Greenburgh Nature Center, New York, USA Jul – Aug 2026
  Led interactive tours for diverse visitor groups focussed on native butterflies and bees, covering life cycles, species identification, and local habitat conservation.
- Trained Super Steward NYC Parks (Municipal Conservation Program), New York City, USA Jul 2026 – Present
  Maintained urban green spaces through invasive plant removal, native planting, and street tree care.

SCIENTIFIC CONTRIBUTIONS

- ***Full-time Instructor***, Department of Physics, Virginia Tech, USA (Aug – Dec 2018): Led the delivery of three undergraduate physics modules - Optics, Thermal Physics, Waves & Sound, to $\sim$90 students across all modules, including curriculum design, course administration and and assessment criteria.
- ***Publications & Conference***: Authored 9 peer-reviewed papers and presented at 12 distinguished events, including *invited talk* at NASA Prebiotic Chemistry and Early Earth Environments, Nano- to Cosmic- Studies of Complex Systems, 2022.
- ***Outreach Activities***: Multiple speaking engagements at Women Who Code & Women in Machine Learning and Data Science (WiMDS), Conference Organiser at WiNS Satellite at Networks.
- **Peer Review**: Invited Reviewer for NeurIPS (2022, 2024), ICML (2023), Physical Review E (2022 – Present).