Madhurima Nath

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Multi-cloud certified machine learning scientist with 10+ years of experience in algorithm development and computational modeling, recognized for immense business, leadership and project management skills.

Skills

Programming: Python, SQL, PySpark, R || **CI/CD**[1]: Git/GitHub/Azure DevOps/BitBucket
Certifications: Azure Data Scientist Associate, Databricks Machine Learning Associate, Databricks Data Engineer Associate, AWS[2] Cloud Practitioner, GCP[3] Associate Cloud Engineer, Salesforce AI Associate, Domino Data Lab Data Science Practitioner
Others: Data Modeling, Gap Analysis, Technical, Conceptual & Data Architecture Diagrams, Data Flows, Agile Delivery

Industry Experience

Senior Data Scientist, Data & Analytics, Slalom, Inc., New York, NY **Jan 2020 – Present**

- Developed an interactive Q&A chatbot powered by Anthropic Claude model on AWS[2] Bedrock, delivering hypotheses and insights from biopharmaceutical and medtech datasets to users within a healthcare technology startup. Improved application interface, boosting customer satisfaction by enhancing usability and accessibility across diverse user groups.
- Engineered and deployed an interactive knowledge-based application chatbot utilizing the RAG[4] approach to assist sales representatives at a leading equipment rental firm, reducing customer inquiry response times by $\sim 22\%$ and streamlining document search processes, enhancing overall efficiency. Leveraged OpenAI LLM[5] model and LangChain in development, marking the client's inaugural digital innovation initiative.
- Spearheaded the design and development of an NLP[6] based architecture on AWS[2] SageMaker to evaluate document relevance in e-discovery, overseeing the ingestion of millions of documents and implementing batch updates with human-reviewed data. This initiative yielded notable efficiency gains, saving numerous hours of manual review time and thousands of dollars in expenses for a legal services client.
- Collaboratively led the implementation of a Delta Lakehouse solution on Azure Databricks and developed NLP[6] pipelines with MLOps best practices for future scalability. This accelerated the data foundation roadmap by over a year, delivering improved visibility, uniformity, and consistency, and resulting in significant efficiency gains and millions of dollars in savings for one of the world's largest consumer packaged goods companies.
- Directed the implementation of NLP[6] pipelines in Azure Databricks for sentiment analysis and topic modeling to extract safety-related themes. Empowered the executive safety committee of a large Midwest utility client to refine policies, ensuring employee safety and reducing incident frequency and severity.
- Migrated 1TB of data spanning 20 years across 27 data objects from a legacy system to Salesforce for a nonprofit organization. Responsible for refactoring and developing SQL stored procedures, executing data pipelines in Azure Data Factory, performing error and root cause analysis, and implementing validation checks to ensure data integrity throughout the migration process.
- Designed and developed fuzzy matching rules and data engineering pipelines to consolidate syndicated retail data from various vendors (such as Nielsen, IRI, and Skupos) into a centralized platform using Azure Databricks. Replaced manual processes, resulting in a $\sim 38\%$ efficiency improvement in product comparison for a consumer packaged goods client.
- Played a pivotal role in formulating proposals for potential clients, leading to a $\sim \$1.2$M revenue boost in the New York market. Proven track record of driving revenue growth through proactive proposal development, resulting in a substantial increase in pipeline revenue from 2023 to 2025.

Education

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 (US20210286859A1): *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*

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[1] *CI/CD: Continuous Integration & Continuous Development*, [2] *AWS: Amazon Web Services*, [3] *GCP: Google Cloud Platform*, [4] *RAG: Retrieval-Augmented Generation*, [5] *LLM: Large Language Model*, [6] *NLP: Natural Language Processing*, [7] *AI/ML: Artificial Intelligence/ Machine Learning*

Research Experience

Post-doctoral Research Assistant, Virginia Tech, VA **Feb 2019 – Dec 2019**

- Formulated an innovative algorithm combining Monte Carlo simulations and perturbative methods to accurately solve NP-hard problems. Applied this method to analyze food network data from the UN Comtrade database, achieving a $\sim 10\%$ improvement over heuristic solutions in identifying crucial communities for preventing global pestilence distribution.

Instructor of Record, Department of Physics, Virginia Tech, VA **Aug 2018 – Dec 2018**

- Recognized as a top-performing physics instructor for creating a respectful learning environment and delivering engaging lectures, recitations, and one-on-one sessions.
- Facilitated supervised laboratory sessions, held office hours, and offered tailored support, resulting in a $\sim 15\%$ increase in student grades by improving comprehension of course materials.

Graduate Research Assistant, Virginia Tech, VA **May 2014 – Dec 2018**

- Developed an algorithm employing Monte Carlo simulations to effectively simulate real-world epidemic outbreak scenarios, providing policymakers with improved estimates compared to existing methods which overestimate infections by $\sim 50\%$.
- Identified vulnerabilities within global food trade networks and accurately forecasted the impact of mitigating contagion conditions with $\sim 96\%$ precision to understand and mitigate the spread of pests, guiding strategic decision-making processes.

Publications

- Eubank, S., **Nath, M.**, Mishra, R., and Adiga, A. (2023). Communities in directed weighted food networks using Moore-Shannon network reliability. (submitted Applied Network Science).
- Mishra, R., Eubank, S., **Nath, M.**, Amundsen, M., and Adiga, A. (2022, November). Community Detection Using Moore-Shannon Network Reliability: Application to Food Networks, In International Conference on Complex Networks and Their Applications (pp. 271-282). Cham: Springer International Publishing.
- Eubank, S., **Nath, M.**, Ren, Y., and Adiga, A. (2022). Perturbative methods for mostly monotonic probabilistic satisfiability problems. arXiv preprint arXiv:2206.03550.
- **Nath, M.,** et. al. (2019). Using network reliability to understand international food trade dynamics. In Complex Networks and Their Applications VII: Volume 1 Proceedings The 7th International Conference on Complex Networks and Their Applications COMPLEX NETWORKS 2018 7 (pp. 524-535). Springer International Publishing.
- **Nath, M.**, Ren Y., and Eubank, S. (2019). An approach to structural analysis using Moore-Shannon network reliability. In Complex Networks and Their Applications VII: Volume 1 Proceedings The 7th International Conference on Complex Networks and Their Applications COMPLEX NETWORKS 2018 7 (pp. 537-549). Springer International Publishing.
- **Nath, M.**, Ren, Y., Khorramzadeh, Y., and Eubank, S. (2018). Determining whether a class of random graphs is consistent with an observed contact network. Journal of theoretical biology. 440, 121-132.
- **Nath, M.,** and Eubank, S. (2018). Model selection for sequential designs in discrete finite systems using Bernstein kernels. arXiv preprint arXiv:1807.06661.
- Ren, Y., Eubank, S., and **Nath, M.**. (2016). From network reliability to the Ising model: A parallel scheme for estimating the joint density of states. Physical Review E, 94(4), 042125.
- **M. Nath**, et. al. (2015). A two-parameter method to characterize the network reliability for diffusive processes. In Complex Networks VI: Proceedings of the 6th Workshop on Complex Networks CompleNet 2015 (pp. 139-148). Springer International Publishing.
- Agarwala, A., **Nath, M.**, Lugani, J., Thyagarajan, K., and Ghosh, G. (2012). Fock-space exploration by angle resolved transmission through a quantum diffraction grating of cold atoms in an optical lattice. Physical Review A, 85(6), 063606. (*equal contribution as first author*).

Conference Presentations

- **Invited Speaker**: 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.
- 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.
- Statistical mechanical applications of graph dynamical systems, Condensed Matter Seminar, Department of Physics, Virginia Tech, Blacksburg, VA, Oct. 30, 2017.
- 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.
- 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.
- 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.
- Effects of network structure on propagation of infectious diseases, 33rd Annual Graduate Student Assembly Symposium and Exposition, Virginia Tech, Blacksburg, VA, Mar. 29, 2017.
- Renormalization group approaches for dynamics on irregular networks, APS (American Physical Society) March Meeting 2017, New Orleans, LA, Mar. 13-17, 2017.
- Diffusive dynamics on a network, SESAPS (Southeastern Section of the American Physical Society) Conference 2016, Charlottesville, VA, Nov. 9-12, 2016.
- Effects of network structure on epidemic modeling, Biocomplexity Institute Symposium 2016, Virginia Tech, Blacksburg, VA, Nov. 1, 2016.
- A two-parameter method to characterize the network reliability for diffusive processes, CompleNet 2015, New York City, NY, Mar. 25-27, 2015.
- 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

- Reviewer - Machine Learning and the Physical Sciences, NeurIPS2024 - Conference on Neural Information Processing Systems.
- Reviewer - Synergy of Scientific and Machine Learning Modeling, 2023 International Conference on Machine Learning.
- Reviewer - Machine Learning and the Physical Sciences, NeurIPS2022 - Conference on Neural Information Processing Systems.
- Reviewer - Journal - Physical Review E. 2022 – Present
- Industry Ambassador, Women in Network Science Society. Sep 2022 – Present
- Invited Speaker at Women in Machine Learning and Data Science, Bay area chapter. Aug 2023
- Speaker at Women Who Code Data Science and San Francisco Backend chapters. Apr – Jul 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
- Invited student speaker of APS Conference for Undergraduate Women in Physics, 2017. Jan 2017