Nafis Neehal

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Research Profile

Research Interests: Healthcare AI, Clinical Trial Automation, Natural Language Processing, Machine Learning Systems, Causal Inference, Health Recommender Systems, AI-Powered Clinical Decision Support
Core Areas: Large Language Models in Healthcare, Clinical Trial Design Automation, Health Recommender Systems, Patient Matching, Risk Prediction, Treatment Effect Estimation, Bias-Aware AI Systems

Education

Rensselaer Polytechnic Institute Aug 2019 – May 2025 (Expected)
*Ph.D. in Computer Science | **GPA**: 3.74/4.00* *Troy, New York*

- **Thesis:** Large-Scale Machine Learning and Language Model Applications in Improving Healthcare Systems
- **Advisor:** Kristin P. Bennett, Ph.D.
- **Committee:** Kristin P. Bennett, Ph.D., Malik Magdon-Ismail, Ph.D., Mohammed Zaki, Ph.D., Vibha Anand, Ph.D. (External, IBM Research)

Rensselaer Polytechnic Institute Aug 2019 – May 2021
*M.S. in Computer Science | **GPA**: 3.68/4.00* *Troy, New York*

- **Thesis:** High-risk Patient Identification in large-scale Health Intervention Programs using Machine Learning
- **Advisor:** Kristin P. Bennett, Ph.D.

Research Experience and Projects

IBM Research - RPI Research Projects Feb 2022 – Present
Graduate Research Assistant, Team Lead — (Funding: IBM HEALS Project) *Troy, NY*

- Leading TrialBrain development - AI augmented clinical trial automation framework:
  - Released 4-bit quantized Llama-3.2-3B models fine-tuned (PEFT) on 65k+ clinical trials specializing on feature generation task
  - Created CT-Bench Benchmark (1700 trials, 1.6k+ conditions) for evaluating LLMs in feature generation task
  - Identified 3 types of Hallucination in our task and implemented novel hallucination-adjusted metrics for GPT-4/LLaMA-70B evaluations
  - Developed end-to-end trial feature generation pipeline achieving 48.5% accuracy improvement over baseline with RAG-based few-shot examples and 0.85 Cohen's Kappa with human experts
- Architected FRESCA - a fairness-aware ML-based patient matching framework:
  - Engineered novel ML-based patient recommendation improving treatment effect estimation accuracy by 75-80%
  - Implemented dual-adjustment pipeline for bias detection improving demographic alignment by 96-99% and achieving substantial cost efficiencies by demonstrating patient recruitment cost reduction by 25%
  - Published in top ML/Healthcare venues - [RecSys'24] [AMIA'23] [SCT'23 (Best Poster Award)]

CDPHP - RPI Research Projects May 2020 – Jan 2022
Graduate Research Assistant — (Funding: CDPHP Industrial Research Grant) *Troy, NY*

- Type-2 Diabetes Health Management Program Evaluation using Machine Learning:
  - Developed deep autoencoder for patient matching (35% faster, 40% memory reduction) and multi-stage survival analysis for health outcome tracking
  - Optimized 9M+ patient record processing pipeline using PySpark/AWS achieving 60% faster processing time
- Improving Targeted Intervention using Machine Learning:
  - Built hybrid ML framework combining novel PCM clustering algorithm to identify 3 treatment-response subgroups in 350K control vs 1.6K treatment cohort
  - Implemented nearest-neighbor and exact matching techniques for unbiased treatment effect estimation with high class imbalance
- High-risk patient identification using Machine Learning:
  - Engineered ML pipeline processing 22.5M+ records (87 temporal features) achieving 95% physician agreement and 30% early detection rate
  - Implemented PCA-based preprocessing pipeline achieving 200x efficiency gain for 0.5% positive class ratio

Publications (Citations: 267, h-index: 8, i10-index: 6)

Under Review, Preprints & Abstracts

[1] Curran, C., **Neehal, N.**, et al. (2024). Examining Trustworthiness of LLM-as-a-Judge Systems in a Clinical Trial Design Benchmark. (Under Review in Trustworthy ML4H @ IEEE Bigdata)

[2] **Neehal, N.**, et al. (2024). Are Large Language Models Effective in Clinical Trial Design? A Study on Baseline Feature Generation. (Under Review in ARR)

[3] **Neehal, N.**, et al. (2024). CTBench: A Comprehensive Benchmark for Evaluating Language Model Capabilities in Clinical Trial Design. arXiv:2406.17888. [Arxiv] [Github]

[4] **Neehal, N.**, Anand, V., & Bennett, K. P. (2023). EquiSCAT: Strategies for Equity Considerations in Synthetic Control Arm Design. Society for Clinical Trials. [Abstract]

Books

[1] **Neehal, N.** (2018). Machine Learning Algorithms (Bengali Language). [Link]

Conference Publications

[1] **Neehal, N.**, Anand, V., & Bennett, K. P. (2024). Design and Assessment of Representative Hybrid Clinical Trials using Health Recommender System. ACM RecSys (HealthRecSys). [Paper] [Github]

[2] **Neehal, N.**, Anand, V., & Bennett, K. P. (2023). Framework for Research in Equitable Synthetic Control Arms. AMIA Annual Symposium Proceedings. [Paper] [Github]

[3] Mavroudeas, G., **Neehal, N.**, et al. (2022). Subpopulation Analysis in Causal Inference: A Healthcare Case Study. IEEE BIBM. [Paper]

[4] **Neehal, N.**, Mavroudeas, G., et al. (2022). Hybrid matching methods for treatment program evaluation: A case study. SPRINGER HIMS. [Paper] [Github (Non-Proprietary)]

[5] Mavroudeas, G., **Neehal, N.**, et al. (2021). Predictive modeling for complex care management. IEEE BIBM. [Paper] [Github (Non-Proprietary)]

[6] **Neehal, N.**, Karim, D. Z., et al. (2019). Runtime optimization of identification event in ECG based biometric authentication. IEEE ECCE. [Paper] [Github]

[7] **Neehal, N.**, & Mottalib, M. A. (2019). Prediction of preferred personality for friend recommendation in social networks using artificial neural network. IEEE ECCE. [Paper]

[8] Karim, E., & **Neehal, N.** (2019). An empirical study of cervical cancer diagnosis using ensemble methods. IEEE ICASERT. [Paper]

[9] **Neehal, N.**, Karim, D. Z., & Islam, A. (2017). Cloud-poa: A cloud-based map only implementation of PO-MSA on amazon multi-node ec2 hadoop cluster. IEEE ICCIT. [Paper] [Github]

Supervised Undergraduate Research

[1] Shultana, S., Moharram, M. S., & **Neehal, N.** (2020). Olympic sports events classification using convolutional neural networks. IEEE IJCCI 2018. [Paper]

[2] Foysal, M. F. A., Islam, M. S., Karim, A., & **Neehal, N.** (2019). Shot-Net: A convolutional neural network for classifying different cricket shots. SPRINGER RTIP2R 2018. [Paper]

[3] Haque, S., Rabby, A. S. A., Laboni, M. A., **Neehal, N.**, & Hossain, S. A. (2019). ExNET: deep neural network for exercise pose detection. SPRINGER RTIP2R 2018. [Paper]

[4] Junayed, M. S., Jeny, A. A., **Neehal, N.**, et al. (2019). Incept-N: a CNN based classification approach for predicting nationality from facial features. SPRINGER RTIP2R 2018. [Paper]

[5] Junayed, M. S., Jeny, A. A., Atik, S. T., **Neehal, N.**, et al. (2019). AcneNet-a deep CNN based classification approach for acne classes. IEEE ICTS 2019. [Paper]

[6] Islam, M. S., Foysal, F. A., **Neehal, N.**, Karim, E., & Hossain, S. A. (2018). InceptB: a CNN based classification approach for recognizing traditional bengali games. Elsevier Procedia. [Paper]

[7] Harun-Ur-Rashid, M., Khatun, S., Trisha, M. Z., **Neehal, N.**, & Hasan, M. Z. (2018). Crick-net: a convolutional neural network based classification approach for detecting waist high no balls in cricket. arXiv Preprint. [Paper]

Conference Presentations (Selected)

[1] **Neehal, N.**, Anand, V., & Bennett, K. P. (2024). Design and Assessment of Representative Hybrid Clinical Trials using Health Recommender System. HealthRecSys at ACM RecSys [Slide].

[2] **Neehal, N.**, Anand, V., & Bennett, K. P. (2023). Framework for Research in Equitable Synthetic Control Arms. AMIA Annual Symposium Proceedings, 2023, 530. American Medical Informatics Association. [Slide].

[3] Mavroudeas, G., **Neehal, N.**, Kuruzovich, J., Bennett, K. P., & Magdon-Ismail, M. (2022). Subpopulation Analysis in Causal Inference: A Healthcare Case Study. 2022 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 1673–1676. IEEE. [Slide].

[4] **Neehal, N.**, Mavroudeas, G., Magdon-Ismail, M., Kuruzovich, J., & Bennett, K. P. (2022). Hybrid matching methods for treatment program evaluation: A case study. International Conference on Health Informatics and Medical Systems. [Slide].

Teaching Experience

Rensselaer Polytechnic Institute Sep 2019 – May 2020, Sep 2023 – Present
Graduate Teaching Assistant *Troy, NY*

- Facilitated core Computer Science courses, including Foundations of Computer Science, Algorithms, Data Structures, and Operating Systems, delivering comprehensive weekly problem-solving sessions, lab instruction, and one-on-one mentoring to enhance student comprehension.
- Simplified core/advanced concepts including object-oriented programming, probability theory, discrete mathematics, OS architecture, and algorithmic implementations (dynamic programming, graph traversal, search optimization etc.), fostering deep conceptual understanding among a diverse student body.

Daffodil International University Jan 2017 – Aug 2019
Lecturer *Dhaka, Bangladesh*

- Designed and taught comprehensive undergraduate courses in Artificial Intelligence, Compiler Design, Bioinformatics, and Computer Networks, creating custom course materials and integrating practical lab components to establish a strong foundation in both theoretical concepts and hands-on implementation.
- Established and directed the university's first AI Research Lab, supervising 10+ undergraduate research groups that resulted in multiple peer-reviewed publications, while providing extensive mentorship in research methodology, technical writing, and project development.
- Performed various administrative and academic leadership roles, including serving as course coordinator for Bioinformatics and AI Lab, moderating multiple programming contests, and actively contributing to curriculum development and academic policy formation.

Professional Services

[1] Peer Review Service for multiple venues: AMIA CIC, International Journal of Computer Applications (Taylor & Francis), PLOS ONE, Recent Trends in Image Processing and Pattern Recognition (RTIP2R)

[2] Core Committee Member, Project Compatibility Assessment Committee for National ICT Policy 2015, ICT Division, Government of Bangladesh (2018)

[3] Program Committee Member, SPRINGER RTIP2R Conference (2018), contributing to paper reviews and program organization

[4] Co-founded and managed DIU HCI Research Lab, establishing international research collaboration with Charles Darwin University, Australia (2018-2019)

[5] Academic Leadership: Counsellor of IEEE DIU Student Branch (2017), Advisor to Daffodil Programming Club (2018-2019)

[6] Member, Organizing Committee for multiple national events: ACM-ICPC Dhaka Regionals (2018), National Girls Programming Contest (2018)

Technical Skills

[1] Programming & Databases: Python, R, SQL, Cypher, C++, Google Firestore, Neo4j, MySQL

[2] Machine Learning & Deep Learning: PyTorch, DDP, TensorFlow, Scikit-Learn, AutoML, OpenCV, Spacy, Langchain, LlamaIndex, HuggingFace

[3] LLM Development: Advanced experience in fine-tuning (SFT/PEFT), quantization, prompt engineering, RAG/GraphRAG architectures, benchmarking and evaluation frameworks

[4] MLOps & Development Tools: MLflow, Docker, Axolotl, Unsloth, ChromaDB, Comet, Opik, PySpark, Hopsworks

[5] Cloud Computing & Deployment: AWS (SageMaker, Lambda, EC2, S3), Git Actions (CI/CD), HopsWorks, HuggingFace Spaces, Heroku

[6] Data Visualization & Interface Development: Tableau, Streamlit, Gradio, R-Shiny

Honors and Awards

[1] Best Poster Award - Society for Clinical Trials (2023) for research on equitable synthetic control arm development

[2] World Semi-Finalist (Top-12), Geneva Challenge, Graduate Institute Geneva and Kofi Annan Foundation (2017)

[3] District and Divisional Champion, Solve-A-Thon, by Access to Information (Bangladesh Government) (2016)

[4] National Champion, IT Based Business Idea Contest, Dhaka University IT Society (2015)

[5] OIC Merit Scholarship - Full academic scholarship worth 1 Million BDT covering complete tuition and monthly stipend (2012-2016)

References

- **Kristin P. Bennett, PhD**
  Professor, Department of Computer Sciences,
  Professor, Department of Mathematical Sciences,
  Associate Director of the Institute for Data Exploration and Applications (IDEA),
  Rensselaer Polytechnic Institute
  Troy, New York, USA
  Email: bennek@rpi.edu

- **Vibha Anand, PhD**
  Senior Research Scientist & Manager, Health Analytics,
  IBM Research,
  Cambridge, MA, USA
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- **Mohammed Zaki, PhD**
  Professor, Department of Computer Sciences,
  Co-director for the NSF IUCRC
  Fellow IEEE, ACM, AAAS
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