

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

Sep 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-Ismael, Ph.D., Mohammed Zaki, Ph.D., Vibha Anand, Ph.D. (External, IBM Research)

Rensselaer Polytechnic Institute

Sep 2019 – May 2021

M.S. in Computer Science | GPA: 3.68/4.00

Troy, New York

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

RESEARCH EXPERIENCE AND PROJECTS

IBM - RPI Research Projects

Feb 2022 – Present

Graduate Research Assistant, Team Lead — (Funding: IBM HEALS Project)

Troy, NY

- **Building “TrialBrain” - LLM Augmented clinical trial automation framework**
 - * Identified 3 types of Hallucination and implemented novel hallucination-adjusted metrics for LLM evaluations in clinical trial baseline feature generation task
 - * Developed end-to-end trial feature generation pipeline achieving 18% point improvement over baseline with RAG-based few-shot examples and 0.85 Cohen’s Kappa with human experts
 - * Released Llama-3.2-3B models fine-tuned (PEFT) on 65k+ clinical trials specializing on feature generation task
 - * Created “CT-Bench” (1700 trials, 1.6k+ medical conditions) for benchmarking LLMs in feature generation task
- **Architected “FRESCA” - a fairness-aware ML-Based patient recommendation framework**
 - * Engineered novel ML-based patient recommendation improving treatment effect estimation accuracy by 4% while reducing demographic disparity by 96%
 - * Implemented two-staged trial design framework potentially reducing control patient recruitment cost upto 49%

CDPHP - RPI Industrial 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 algorithm 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 using novel clustering algorithm to identify 3 distinct patient groups from imbalanced dataset (350K control vs 1.6K treatment cases), improving treatment personalization
 - * Implemented nearest-neighbor and exact matching techniques for unbiased treatment effect estimation
- **High-risk patient identification using Machine Learning**
 - * Engineered ML pipeline processing 22.5M+ temporal records achieving 95% physician agreement and 30% early detection rate
 - * Created hybrid preprocessing pipeline with PCA and downsampling for extreme class imbalance (0.5% positive class), achieving 200x efficiency gain through temporal windowing and sparse data handling

Under Review, Preprints & Abstracts

- [1] **Neehal, N.**, et al. (2024). Are Large Language Models Effective in Clinical Trial Design? A Study on Baseline Feature Generation. (Under Review in ARR)
- [2] **Neehal, N.**, et al. (2024). CTBench: A Comprehensive Benchmark for Evaluating Language Model Capabilities in Clinical Trial Design. arXiv:2406.17888. [[Arxiv](#)] [[Github](#)]
- [3] **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] Curran, C., **Neehal, N.**, et al. (2024). Examining Trustworthiness of LLM-as-a-Judge Systems in a Clinical Trial Design Benchmark. (Trustworthy ML4H @ IEEE Bigdata, To Appear)
- [2] **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](#)]
- [3] **Neehal, N.**, Anand, V., & Bennett, K. P. (2023). Framework for Research in Equitable Synthetic Control Arms. AMIA Annual Symposium Proceedings. [[Paper](#)] [[Github](#)]
- [4] Mavroudeas, G., **Neehal, N.**, et al. (2022). Subpopulation Analysis in Causal Inference: A Healthcare Case Study. IEEE BIBM. [[Paper](#)]
- [5] **Neehal, N.**, Mavroudeas, G., et al. (2022). Hybrid matching methods for treatment program evaluation: A case study. SPRINGER HIMS. [[Paper](#)] [[Github \(Non-Proprietary\)](#)]
- [6] Mavroudeas, G., **Neehal, N.**, et al. (2021). Predictive modeling for complex care management. IEEE BIBM. [[Paper](#)] [[Github \(Non-Proprietary\)](#)]
- [7] **Neehal, N.**, Karim, D. Z., et al. (2019). Runtime optimization of identification event in ECG based biometric authentication. IEEE ECCE. [[Paper](#)] [[Github](#)]
- [8] **Neehal, N.**, & Mottalib, M. A. (2019). Prediction of preferred personality for friend recommendation in social networks using artificial neural network. IEEE ECCE. [[Paper](#)]
- [9] Karim, E., & **Neehal, N.** (2019). An empirical study of cervical cancer diagnosis using ensemble methods. IEEE ICASERT. [[Paper](#)]
- [10] **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

Graduate Teaching Assistant

Sep 2019 – May 2020, Sep 2023 – Present
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

Lecturer

Jan 2017 – Aug 2019

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.

OPEN-SOURCE PROJECTS (SELECTED)

- [1] **BanglaLLM** [HF]: Developing fine-tuned open-source LLMs for reasoning and factual analysis in Bengali
- [2] **MAMA-GPT** [Github]: GPT-4 powered Bengali Voicebot, real-time STT/TTS and bidirectional translation
- [3] **Cerebro** [Github][Demo]: Fast, lightweight search engine for exploring papers from major AI/ML venues + ArXiv
- [4] **Trade-Mind** [Github] [Demo]: End-to-end MLOps pipeline for BTC/USD prediction using real-time OHLC features
- [5] **ChanBOT** [Github]: Fine-tuned Llama3.1-8B using PEFT and 4-bit quantization to mimic a fictional TV character

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

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)

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
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- **Vibha Anand, PhD**
Senior Research Scientist & Manager, Health Analytics,
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Cambridge, MA, USA
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