Nibraas Khan

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Education

- **Vanderbilt University** — *Dec 2023 - December 2025 Expected*
  Ph.D. Computer Science — Nashville, TN
- **Vanderbilt University** — *May 2020 - Dec 2023*
  M.S. Computer Science — Nashville, TN
- **Middle Tennessee State University** — *Aug 2017 - May 2020*
  B.S. Computer Science — Murfreesboro, TN

Experience

- **Vanderbilt University - Robotics and Autonomous Systems Lab** — *May 2020 - Present*
  Research Assistant — Nashville, TN
  - Architecting a novel, tiered eXplainable AI framework to decode black-box model predictions on sequences of high-level motion primitives. The architecture was informed by a survey of 111 xAI studies and translates model decisions into insights for AI experts, domain specialists, and end-users.
  - Designing a semi-supervised pipeline to learn a vocabulary of semantic motion primitives from unlabeled time-series data. The system uses kernel based change point detection and HDBSCAN clustering with pairwise constraints to produce a set of interpretable concepts that serve as direct input for the hierarchical xAI framework.
  - Engineering an end-to-end, 9-axis IMU wearable system from custom PCB/firmware to a React data collection app. Deployed the system to capture kinematic data from 15 boxers and trained a Siamese network to learn the embedding space distance between novice and expert motion. This model powered a 3D avatar that provided real-time, corrective feedback to improve technique.
  - Developing REACT, a real-time behavioral precursor detection system for children with ASD, which involved developing wearable technology consisting of behavioral (IMU) and physiological (HR and EDA) components, collecting 35+ hours of multimodal data, and building a local-first React Native annotation app adopted by therapists across multiple labs. Our approached achieves an 84.6% F1-score in forecasting events using prototypical few-shot learning.
  - Engineering the core software for a Socially Assistive Robot - Virtual Reality therapeutic gaming system, developing the application in Unity, and architecting a robot-agnostic communication protocol to ensure system modularity. This platform was successfully deployed across 10 long-term care facilities, supporting data collection for over 150 older adults.
  - Developing a deep learning pipeline (Bi-GRU with multi-head attention) to classify functional sub-tasks for older adults with Mild Cognitive Impairment, achieving up to an 86% F1-score. Using SHAP analysis to identify distinct gyroscopic patterns as digital biomarkers of functional decline.
  - Mentoring 30+ students in advanced research topics, providing direct technical guidance on using machine learning to estimate biomechanical parameters, advanced prompt engineering techniques, and developing core software components for the SAR-VR therapeutic system.
- **JumpStart** — *Jan 2023 – Present*
  Co-Founder — Nashville, TN
  - Co-founded a community-focused organization that prepares students for tech careers through a dual-focus program: building pro-bono software for clients while providing technical workshops and direct connections to industry mentors and hiring partners.
  - Co-led the technical architecture and mentorship for a real-time UAV ground control station for NEXUS. Guided students in integrating a multi-component computer vision pipeline, featuring a YOLOv8 model fine-tuned on the VisDrone dataset for object detection and a DeepSORT algorithm for real-time tracking, all streamed with low-latency via WebRTC.
  - Guided the development of a clinical analysis tool for Vanderbilt's TRIAD. Mentored students in building and deploying an XGBoost model that predicted a therapist's ability to control behavioral escalations, trained it on data from the REACT clinical study, and designed it with an online learning component to continually improve its F1-score as therapists input new session data.

◦ Mentored teams on additional projects, including an interactive 3D web application for Vanderbilt's Wond'ry utilizing R3F, to provide students with a breadth of experience in modern front-end and data visualization frameworks.

• **MTSU's Phillip Lab** *August 2018 – May 2020*

Research Assistant Murfreesboro, TN

◦ Architected the SBFBWMtk, a novel hierarchical reinforcement learning framework that combines Sensory-Based and Feedback-Based task-switching mechanisms to solve complex, Non-Markovian problems. The model synthesizes the TD-learning-based Working Memory Toolkit with n-task learning and uses Holographic Reduced Representations for efficient state encoding.

◦ Engineered a dynamic transfer learning method that enables the model to retain and transfer its learned value function to a larger neural network as task complexity grows. This novel approach, not present in prior toolkits, was shown to reduce overall training time for agents in dynamic environments.

◦ Implemented a novel Abstract Task Representation switching mechanism that utilizes both positive and negative TD error signals, boosting model accuracy on complex combined tasks from a baseline of 38.33% to 96.88% after tuning. This research was published at the 2020 IEEE International Conference on Tools with Artificial Intelligence.

• **MTSU Mobile Team** *February 2019 – May 2020*

Android Developer Murfreesboro, TN

◦ Engineered key features for the official MTSU mobile app (serving 30,000+ students), including a schedule manager and push notification system through a modular MVVM design in Kotlin and Java. Collaborated with the iOS team to define shared RESTful API endpoints using Retrofit, ensuring a robust and consistent user experience across platforms.

◦ Managed the release lifecycle on the Google Play Store, which included generating signed app bundles, managing alpha and beta testing tracks, and monitoring post-launch performance and crash reports to ensure application stability.

PUBLICATIONS

C=CONFERENCE, J=JOURNAL, S=IN SUBMISSION, I=IN PRESS, A=ARTICLE, X=ARXIV, M=MANUSCRIPT

[C.S] **Khan, N.**, Wang, D., Ghosh, R., Tauseef, M., Mion, L., Ma, M., Sarkar, N. 2025. *Decoding Human Motion: A Scoping Review of Explainable AI Methods in Movement Analysis*

[M] **Khan, N.**, Cole, K., Sarkar, N. 2025. *Explainable Deep Learning for IADL Activity Prediction in Mild Cognitive Impairment using Wearable Sensors*

[M] **Khan, N.**, Shragge, I., Zilinskaite, G., Plunk, A., Staubitz, J., Rajaraman, A., Weitlauf, A., Sarkar, N. 2025. *Interpretable Deep Few-Shot Learning for Prediction of Precursors to Challenging Behaviors in Individuals with Intellectual and Developmental Disabilities*

[J] Tate, J., Mion, L., Migovich, M., Ghosh, R., **Khan, N.**, Kilpatrick, A., Scharre, D., Newhouse, P., Maxwell, C., Tan, A., Sarkar, N. 2025. *A multi-site randomized clinical trial of socially assistive robots on engaging older adults with cognitive impairment residing in long-term care settings: A protocol paper*

[C] **Khan, N.**, Haan R., Shragge, I., Zilinskaite, G., Plunk, A., Staubitz, J., Rajaraman, A., Weitlauf, A., Sarkar, N. 2025. *A Universal Web-Based Tool for Multimodal Data Synchronization and Labeling*

[J] Tate J., Maxwell, C., Migovich, M., **Khan, N.**, Ghosh, R., Colopietro, K., Kilpatrick, A., Sarkar, N. 2025. *Factors Affecting Implementation of Socially Assistive Robots in Long-Term Care Facilities*

[C.S] Weitlauf, A., **Khan, N.**, Plunk, A., Sargent, A., Staubitz, J., Dieffenderfer, J., Sarkar, N. 2024. *Autistic User Input on Wearable Technology: Preliminary Feedback to Inform System Design*

[J.I] **Khan, N.**, Plunk, A., Zhaobo, Z., Adiani, D., Staubitz, J., Weitlauf, A., Sarkar, N. 2024. *Pilot Study of a Real-time Early Agitation Capture Technology (REACT) for Children with Intellectual and Developmental Disabilities*

[J.S] Ghosh, R., **Khan, N.**, Migovich, M., Tate, J., Maxwell, C., Latshaw, E., Newhouse, P., Scharre, D., Tan, A., Colopietro, K., Mion, L., Sarkar, N. 2024. *User-Centered Design of Socially Assistive Robotic Combined with Non-Immersive Virtual Reality-based Dyadic Activities for Older Adults Residing in Long Term Care Facilities*

[C] Wang, H., **Khan, N.**, Chen, A., Sarkar, N., Wisniewski, P., Ma, M. 2024. *MicroXercise: A Micro-Level Comparative and Explainable System for Remote Physical Therapy*

[C] **Khan, N.**, Tauseef, M., Ghosh, R., Sarkar, N. 2024. *A Novel Loss Function Utilizing Wasserstein Distance to Reduce Subject-Dependent Noise for Generalizable Models in Affective Computing* HCI

[A] Maxwell, C., Ghosh, R., **Khan, N.**, Migovich, M., Tate, J., Latshaw, E., Lorraine, M., Sarkar, N. *User-Centered Design for Socially Assistive Robotic Activities with Older Adults in Long Term Care* Innovation in Aging

[J] Wagner, L., Corona, L., Hooper, M., **Khan, N.**, Dixon, A., Lavanderos, A., Sarkar, N., Zheng, Z., Sarkar, N., Warren, Z. *Development of a Patient-Facing Mobile Health App to Track Family Access and Engagement with Early Intervention Services in Underserved Communities* INSAR

[J] Adiani, D., Breen, M., Migovich, M., Wade, J., Hunt, S., Tauseef, M., **Khan, N.**, Colopietro, K., Lanthier, M., Swanson, A., Vogus, T., Sarkar, N. *Multimodal Job Interview Simulator for Training of Autistic Individuals* RESNA

[A] Lorraine, M., Latshaw, E., Lin, Y., Migovich, M., Ghosh, R., **Khan, N.,** Sarkar N., Tate, J. *Participatory Design: An Essential Process For Socially Assistive Robotic Activities In Long-term Care Settings* Innovation in Aging

[X] **Khan, N.,** Sarkar N. 2022. *Semi-Supervised Learning for Stress Detection Using Physiological Data for Partially Labeled Data*

[C] **Khan, N.**, Ghosh, R., Migovich, M., Johnson, A., Witherow, A., Taylor, C., Schroder, M., Vongpanya, T., Sarkar, M., Sarkar, N. 2022. *Data Collection and Annotation Tool for Asynchronous Multimodal Data.*

[C] Ghosh, R., **Khan, N.**, Migovich, M., Wilson, D., Latshaw, E., Tate, J., Mion, L., Sarkar N. 2022. *Iterative User Centered Design of Robot-Mediated Paired Activities for Older Adults with Mild Cognitive Impairment (MCI).* Human Aspects of IT for the Aged Population. Technology in Everyday Living

[C] Migovich, M., Ghosh, R., **Khan, N.**, Tate, J., Mion, L., Sarkar, N. 2021. *System Architecture and User Interface Design for a Human-Machine Interaction System for Dementia Intervention*

[C] **Khan, N.**, Phillips, J. L. 2020. *Combined Model for Sensory-Based and Feedback-Based Task Switching: Solving Hierarchical Reinforcement Learning Problems Statically and Dynamically with Transfer Learning.*

[X] **Khan, N.**, Haan, R., Boktor, G., McComas, M. and Daneshi,R. 2020. *Steganography GAN: Cracking Steganography With Cycle Generative Adversarial Networks.*

[X] **Khan, N.**, Phillips J. 2020. *Combined Model for Partially-Observable and Non-Observable Task Switching: Solving Hierarchical Reinforcement Learning Problems Statically and Dynamically with Transfer Learning.*

POSTERS

[1] **Khan, N**., Ghosh, R., Migovich, M., Johnson, A., Witherow, A., Taylor, C., Schroder, M., Vongpanya, T., Sarkar, M., Sarkar, N. 2022. *Developing an Asynchronous Multimodal Data Data Collection and Annotation Tool*. Remote

[2] Ghosh, R., **Khan, N**., Migovich, M., Wilson, D., Latshaw, E., Tate, J., Mion, L., Sarkar N. 2022. *Designing Iterative User Centered Design of Robot-Mediated Paired Activities for Older Adults with Mild Cognitive Impairment*. Remote

[3] Migovich, M., Ghosh, R., **Khan, N**., Tate, J., Mion, L., Sarkar, N. 2021. *Dementia Intervention System Architecture and User Interface Design*. Remote

[4] Haan, R., Boktor, G., **Khan, N.**, Barbosa, S. 2020. *CookieBox- Fake News Classifier*. Remote

[5] **Khan, N.** and Phillips J. 2020. *Combined Model for Partially-Observable and Non-Observable Task Switching: Solving Hierarchical Reinforcement Learning Problems Statically and Dynamically with Transfer Learning* . Murfreesboro, TN

[6] **Khan, N.** and Phillips J. 2019. *Working Memory for Fully Autonomous Systems (Combined Model for partially observable and non-observable task switching*. Murfreesboro, TN

PROJECTS

- **Algorithmic Trading** *Aug 2022 - Present*

  Live Trading
  - Architected an adaptive, dual-model system for portfolio rebalancing. The core strategy uses an LSTM to forecast market trends, while a meta-controller Reinforcement Learning agent detects the current market trends and dynamically adapts the LSTM's trading policy to maintain profitability across different economic conditions.
  - Developed a dividend capture strategy that uses SEC filings and news sentiment to predict a stock's post-dividend rebound potential. This predictive signal was used to optimize the timing of buying shares before the ex-dividend date to capture the payout.

SKILLS

- **Languages:** Python, Typescript, C#, Kotlin
- **ML Frameworks & Data Science:** PyTorch, TensorFlow, Scikit-learn, XGBoost, Pandas, NumPy, SHAP
- **Cloud & MLOps:** AWS (EC2, S3, SageMaker), Firebase, GCP, Docker, Git / GitHub Actions, DVC, Git LFS
- **Data Engineering & Orchestration:** Kafka, Airflow, Great Expectations, N8N
- **Databases:** MongoDB, SQLite
- **ML Specializations:** Explainable AI (xAI), Reinforcement Learning (Hierarchical RL, Policy Transfer), Deep Learning (LSTMs, GANs, Siamese Networks), Computer Vision (Object Detection & Tracking), Time-Series Analysis (Wearable Sensor Data), LLM Fine-Tuning
- **Developer Platforms & Tools:** Unity, React, React Native, FastAPI, Android Development, Pytest, RESTful API Design, Jira

ADDITIONAL INFORMATION

Languages: Fluent in English, Conversational in Hindi and Urdu
Interests: Cooking, Boxing, Exploring restaurants