Muhammad Umair

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SUMMARY

Investigating turn-taking mechanics to enhance Conversational AI's capability for natural, unscripted interactions. Using human subjects experiments, Bayesian modeling to decode human behavior, and evaluating Large Language Models (LLMs) for both formal and functional competence. Focusing on the impact of paralinguistic features on LLM performance, curating behavioral datasets, and designing software to streamline conversation analysis workflows. Skilled in interdisciplinary research and project management.

EDUCATION

Tufts University, Medford, MA

PhD in Computer Science: Human-Robot Interaction   **Sept. 2021 - May 2026 (Expected)**

SAGE Concept Grants 2023 Winner (**$25,000**) | Graduate Student Research Award (**$1,000**)

Bachelors in Computer Science & Minor in Cognitive and Brain Science   **Sept. 2017 - May 2021**

GPA: 3.62/4.0 | De Florez Prize in Human Engineering | Magna Cum Laude

RELEVANT TECHNICAL SKILLS

PROGRAMMING LANGUAGES	Python • C • C++ • Java • JavaScript • SQL • MATLAB
ANALYTICAL TECHNIQUES	Statistical analysis • Bayesian probabilistic modeling and inference • Human-centered experimental design • Machine learning methods (transfer, supervised, semi-, and unsupervised) • Dialogue modeling for conversational AI • Language Models (LLMs etc.)
FRAMEWORKS AND TOOLS	PyTorch • Tensorflow • Keras • PyTorch-Lightning • Huggingface - Transformers & Datasets • Numpy • Pandas • Scipy • OpenCV • ROS-2 • Docker • AWS • Git

RELEVANT EXPERIENCE

Graduate Researcher (Conversational AI) | *Tufts Human Interaction Lab*   **Sept. 2021 - Present**

- Advancing the naturalness of turn-taking in Conversational AI by collecting and annotating over **2,000 minutes** of unscripted dialogue with detailed **paralinguistic** markers, including laughter and prosody.
- Collected and **publicly released** an empirical dataset to identify conversational entry points by **recruiting over 120 participants** and capturing real-world opportunities for speech in natural conversations.
- Evaluated LLM content quality and consistency in spoken language tasks by correlating model outputs with **human behavioral data**, revealing critical performance insights.
- Secured **$25,000** in competitive funding through the prestigious SAGE Concept Grant, surpassing multiple start-ups, to expand GailBot—a transcription ecosystem that precisely annotates paralinguistic features like prosody and intonation.

Artificial Intelligence Intern (Computer Vision and Robotics) | *Vicarious Surgical*   **May 2020 - Dec. 2020**

- Developed a GUI tool that corrected radial and tangential distortions in a surgical robots vision system, increasing visual accuracy, **reducing calibration time by approximately 30%,** and deploying it as a Dockerized ROS-2 application.

Research Assistant (Paralinguistic Features & Data Annotation) | *Tufts Human Interaction Lab*   **May 2018 - Jun. 2021**

- Applied various machine learning techniques to identify and annotate paralinguistic features in conversation, such as laughter and overlaps, **reducing transcription time by 80–95%**.
- Developed a bi-directional format converter to **standardize conversational data** between informal transcriptions and XML.

SELECTED PUBLICATIONS

Umair, M., Mertens, J.B., Warnke, L., & de Ruiter, J.P. (2024). Can language models trained on written monologue learn to predict spoken dialogue? *Cognitive Science*. Cognitive Science Society. (In Press.)

Umair, M., Sarathy, V., & de Ruiter, J. (2024). Large Language Models Know What To Say But Not When To Speak. *Findings of the Association for Computational Linguistics: EMNLP*. Association for Computational Linguistics. (In Press.)

Umair, M., Mertens, J., Albert, S., & de Ruiter, J.P. (2022). GailBot: An automated transcription system for Conversation Analysis. *Dialogue & Discourse,* 13(1), 63-95.

Threlkeld, C., **Umair, M.**, & De Ruiter, J.P (2022), "Using transition duration to improve turn-taking in conversational agents", in *Proceedings of SIGDIAL*, 2022.

SELECTED PROJECTS

Large Language Models (LLMs) know what to say but not when to speak   **May 2024 - Oct. 2024**
- Released a fully diarized, participant-labeled dataset identifying opportunities for speech, comprising **30 minutes** of conversation data annotated by **120 participants.**
- Formulated a novel labeling task for LLMs, demonstrated limitations across various metrics (**best F1 = 0.152, GPT-4**).

Can LLMs trained on written monologue predict spoken dialogue?   **Jul. 2022 - Oct. 2024**
- Augmented GPT-2 with speaker identity embeddings to **assess model sensitivity** to speaker identity when predicting across turn boundaries in spoken dialogue.
- Directly compared LLM-produced surprisal values with human plausibility ratings, using specially designed dialogue stimuli to evaluate **alignment with human expectations**.

Using Transition Duration to Improve Turn-Taking in Conversational Agents   **Mar. 2022 - Jul. 2022**
- Constructed and compared Bayesian models to represent and evaluate two competing theoretical approaches to turn-taking.
- Validated the categorization of opportunities for speech into distinct types, providing a **data-driven** foundation for analysis.

GailBot: An Automatic Transcription System for Conversation Analysis   **May 2018 - Present**
- Developed an automated transcription ecosystem with a web-based interface, a plugin framework, a development SDK.
- Reduced transcription time by **80–95%** for **100+ global research users**, boosting efficiency.
- Led a team of **20+ undergraduates** over four years, managing development to enhance functionality and user experience.

SELECTED PRESENTATIONS AND LEADERSHIP

Co-Chair (Case Study Track), Methods for Teaching Ethics in Data Science 2024   **Oct. 2024**
University of Michigan (ADSA Conference), Ann Arbor, MI

Lead Organizer, UCLA GailBot Hackathon Workshop   **Apr. 2024**
University of California, Los Angeles, CA

Lead Organizer "AI Governance for Whom" Symposium   **Mar. 2024**
Tufts University, Medford, MA

Presenter, "Towards Improving Turn-Taking in Dialogue Systems" - HRI Colloquium Series   **Sept. 2022**
Tufts University, Medford, MA

TEACHING EXPERIENCE

Computational Models in Cognitive Science | *Graduate Teaching Assistant*	**Fall 2023 & 2024**
Data Structures | *Graduate Teaching Assistant*	**Spring 2024**
Access for Computing (ACE) Program | *Graduate Fellow*	**Summer 2023 & 2024**
Introduction to Computer Science | *Graduate Teaching Assistant*	**Summer 2022 & Fall 2022 & Spring 2023**
Programming Languages | *Graduate Teaching Fellow*	**Fall 2021**
Introduction to Computational Design | *Teaching Assistant*	**Fall 2018**