

DOCTORAL RESEARCH

On Geometric & Topological Methods for Analysis of Biophysical Timeseries Data

Using reparametrization invariant iterated integrals, my work introduced clustering & cyclic ordering to aperiodic yet repeating multi-dimensional signals. These invariants enabled detection of slow cortical waves propagating in the brain using functional magnetic resonance imaging data. Further, utilizing geometric diffusion processes, my work also showed that synergy detection in human motor control, specifically using electromyography signals, is appropriately interpreted as a nonlinear clustering problem.

WORK EXPERIENCE

AUG 2023 - PRESENT

University of Illinois, Urbana-Champaign – USA

POSTDOCTORAL RESEARCH ASSOCIATE | COORDINATED SCIENCE LABORATORY

Involved in creating analysis methods for high dimensional timeseries data using applied mathematical techniques from topology & geometry. Expanding on prior work developed for *cyclic signals* to infer brain dynamics, stereotypy in animals & propagation patterns in networks. Also studying use of novel classification & ML tools to generate interpretable feature from high-dimensional data.

ADJUNCT LECTURER | DEPT. OF ELECTRICAL & COMPUTER ENGINEERING

Teaching: **(a)** a **core curriculum course** on introduction to programming using C & LC3 assembly language and **(b)** an introductory graduate course in control systems theory & design. Serving as the *course coordinator* for the undergraduate course with a team of three instructors, nine graduate TAs and over two dozen undergraduate course aides.

JAN 2023 - MAY 2023

ADJUNCT LECTURER | DEPT. OF BIOENGINEERING

Taught a core curriculum sophomore level course on signal processing and systems analysis for the Department of Bioengineering. Developed course material including lecture notes, online demonstrations, homework sets, and [course website](#) for effective delivery of content and for possible use by future instructors.

AUG 2022 - MAY 2023

Discovery Partners Institute – USA

POSTDOCTORAL RESEARCH ASSOCIATE

Research associate with the Neuroscience Program and with the **Hearing Health Institute's** science faculty. Investigated the possibility of harmonizing multi-site fMRI data using deep learning (DL) techniques like domain adaptation, transfer learning as well as generative & adversarial neural network algorithms.

MAY 2022 - AUG 2022

PROGRAM ASSISTANT

Organized & led process of standardization, harmonization & curation of terabytes of multi-site multi-paradigm MRI data. Started development & investigation of methods addressing cross-site, scanner & demographic differences. Created and supervised a 10-week internship program for undergraduates at Hearing Health Institute.

University of Illinois, Urbana-Champaign – USA

TEACHING AND RESEARCH ASSOCIATE

Taught or assisted with delivery of three undergraduate & three graduate level courses (see below). Worked on application of topological & geometric methods for analysis of high-dimensional timeseries data.

MAR 2015 – JUL 2015 (FT)

Texas A&M University – Qatar

TEMPORARY RESEARCH ASSISTANT

Worked on design, fabrication & assembly of gas based super plastic forming machine. Involved in control design & mechanical assembly of the equipment as well as generation of Project Safety Analysis reports & documentation.

JAN 2015 – MAR 2015 (FT)

Carnegie Mellon University – Qatar

TEMPORARY RESEARCH ASSOCIATE

Installed, set-up and commissioned processor simulation package from MIT (Graphite) on network file system based prototype cluster. Tested & benchmarked pilot cluster with four nodes, resulting in creation of commissioning manual for future clusters & identification of bugs.

JUL 2014 – AUG 2014 (FT)

Supreme Committee for Delivery & Legacy – Qatar

INTERN

Researched under program consultant (CH₂MHILL) to ascertain carbon offset initiatives towards carbon neutral FIFA 2022. Applied GHG accounting protocols & principles to preliminary analysis of suitable offset projects & made recommendations regarding possible industry partnerships.

EDUCATION

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- 2017 – 22 **Doctor of Philosophy**
Electrical & Computer Engineering
University of Illinois, Urbana-Champaign
- 2015 – 17 **Master of Science**
CUM. CGPA: 3.91
Mechanical Science & Engineering
University of Illinois, Urbana-Champaign
- 2010 – 14 **Bachelor of Science**
CUM. CGPA: 3.94
Mechanical Engineering
Texas A & M University, Qatar

AWARDS

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- 2014 **Science Faculty Student of the Year**
Texas A & M University, Qatar
- 2012 – 14 **Full Academic Scholarship**
Qatar Foundation
- 2011 – 13 **Dean's Honor Roll**
Texas A & M University, Qatar

COMPUTER SKILLS

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- BEGINNER Haskell, Rust, NI LabVIEW
- INTERMEDIATE C/C++, Mathematica, MATLAB
HTML/CSS, L^AT_EX, Linux
- ADVANCED Python, Julia

TEACHING

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- INSTRUCTION Engineering Materials - Laboratory
Signals & Systems in Bioengineering
- TEACHING Assistant Control System - Theory & Design
Nonlinear Systems
Nonlinear & Adaptive Control
Undergraduate Control Systems
Intro. to Electronics

PATENT**Automated, Objective Method of Assessing Tinnitus Condition**

Fatima T. Husain, Yuliy Baryshnikov, Benjamin J. Zimmerman, Ivan T. Abraham.

US Patent No: 10,959,670

PUBLICATIONS

Slow cortical waves via cyclicity analysis

Ivan Abraham, Somayeh Shahsavarani, Benjamin J. Zimmerman, Fatima T. Husain, Yuliy Baryshnikov.

(Preprint: Submitted to *Network Neuroscience*)

doi:<https://doi.org/10.1101/2021.05.16.444387>

Dissociating tinnitus patients from healthy controls using resting-state cyclicity analysis and clustering

Benjamin J. Zimmerman, Ivan Abraham, Sara A. Schmidt, Yuliy Baryshnikov, and Fatima T. Husain.

Network Neuroscience. 2019.

doi:https://doi.org/10.1162/netn_a_00053

Comparing cyclicity analysis with pre-established functional connectivity methods to identify individuals and subject groups using resting state fMRI

Somayeh Shahsavarani, Ivan T. Abraham, Benjamin Z. Zimmerman, Yuliy M. Baryshnikov, Fatima T. Husain.

Frontiers in Computational Neuroscience. 2020.

doi:<https://doi.org/10.3389/fncom.2019.00094>

PRESENTATIONS

Reduced functional connectivity in auditory & attention networks in the presence of hearing loss

Ivan Abraham, Amber Leaver, Brad Sutton, Yuliy Baryshnikov, Jonathan Peelle, F. Husain

2023 Virtual Conference on Computational Audiology

Virtual, June 29-30, 2023

Harmonizing independent MRI datasets for greater statistical power in hearing research

Ivan Abraham, Shagun Ajmera, Rafay Khan, Amber Leaver, Jonathan Peelle, Brad Sutton, Fatima Husain

46th Annual Midwinter Meeting of The Association for Research in Otolaryngology

Orlando, Florida, February 11-15, 2023

Cyclicity vs. similarity measures for fMRI resting state time series analysis

Ivan Abraham, Somayeh Shahsavarani, Benjamin Zimmerman, Yuliy Baryshnikov, Fatima Husain

Analytical Computational Models. The 49th Annual Meeting, Society for Neuroscience.

Chicago, Illinois, October 19-23, 2019

Automated identification of tinnitus patients using replicable resting state fMRI data

Fatima T. Husain, Benjamin Zimmerman, Ivan Abraham, Sara Schmidt, Somayeh Shahsavarani, Rafay Khan, Yuliy Baryshnikov

Sixth Biennial Conference on Resting-State and Brain Connectivity

Montreal, Quebec, Canada, September 26-28, 2018

Classification of tinnitus patients vs. control subjects based on cyclicity analysis

Ivan Abraham, Benjamin Zimmerman, Sara Schmidt, Yuliy Baryshnikov, Fatima Husain

Inaugural Workshop on Brain Dynamics and Neurocontrol Engineering

Washington University in St. Louis, MO. June 25-27, 2017