

Amir Reza Peimani (He/His)

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EDUCATION

- University of Toronto** Toronto, ON, Canada
PhD Candidate in Biomedical Engineering; GPA: A (18 credits)
Graduate Certificate in Neuroscience (CPIN).
Thesis: Artificial Intelligence Driven Analysis of Brainstem Seizures in Rat Models of Epilepsy
Sep 2018 - May 2024
- York University** Toronto, ON, Canada
M.A.Sc. in Mechanical Engineering; GPA: A (15 credits)
Computational Engineering & Microfluidics
Thesis: Microfluidic Devices for Quantitative Investigation of Zebrafish Larvae's Electrotaxis and Their Applications to Dopamine System Studies
Sep 2015 - Dec 2017
- Isfahan University of Technology** Isfahan, Isf, Iran
B.A.Sc. in Mechanical Engineering; GPA: 16.8/20 (143 credits)
Specialized in Computational Mechanics, Mechatronics & Robotics.
Thesis: Wear Analysis and Simulation of Pin-on- Disk Contact Under Lubricating Condition by Finite Element Method (FEM) Using Computer Aided Design (CAD) Software
Sep 2011 - July 2015

RESEARCH INTERESTS

Deep Learning & Neural Networks, Network Connectivity, Machine Learning & Signal Processing, Epilepsy

SKILLS SUMMARY

- Programming:** Python, SQL, C/C++, R, Unix scripting
- Libraries & Packages:** NumPy, Pandas, Matplotlib, Seaborn, Scikit-Learn, SymPy, SciPy, NetworkX, TensorFlow, Keras, Pytorch, OpenCV, CUDA, MapReduce, Hive, Spark, PySpark, Hadoop
- Softwares:** MATLAB, Tableau, SolidWorks, VSCode, AutoCAD, CATIA, MS Office, L^AT_EX, GIT, ImageJ, Brian, ABAQUS

HONORS AND AWARDS

- Doctoral Completion Award (DCA)** Fall 2022
\$10,000 School of Grad. Studies, Uni. of Toronto
- Wildcat Graduate Scholarship** Fall 2020
\$10,000 Inst. of Biomedical Eng., Uni. of Toronto
- Mitacs Accelerate Fellowship** Winter 2020-Summer 2021
\$75,000 MITACS & Novela Neurotech & Uni. of Toronto
- Loo Geok Eng Found Grad Scholarship** Fall 2019
\$15,000 Inst. of Biomedical Eng., Uni. of Toronto
- International Doctoral Student Award (IDSA)** Summer 2018
\$5,000 Faculty of Math, Uni. of Waterloo
- Graduate Research Studentship** Summer 2018
\$5,000 Faculty of Math, Uni. of Waterloo
- Dean's Top 10% List, class of 2015, Mech. Eng., Isfahan Uni. of Tech.** Summer 2015
- Top 2% in National Grad. Entrance Exam for M.A.Sc in Biomedical Eng.,** Summer 2015
- Annual Student Appreciation Festival Award** Winter 2012
\$1,500 for **Ranking 1st** among all IUT 2011 undergrad. freshmen Isfahan Uni. of Technology
- Member of University's Exceptionally Talented Students' Club** Fall 2011-Fall 2015
- Top 0.1% (of 114,158 applicants) in Iran's National Undergrad. Entrance Exam** Summer 2011

JOURNALS

1. **A.R. Peimani**, (2023) Bayesian Networks Illuminate the Interactions of SUDEP Risk Factors: A Mathematical Perspective, *APL Machine Learning* [Under Prep]
2. **A.R. Peimani**, W. Sangphosuk, P. Carlen, (2023) Neural Network Connectivity and Seizure Propagation Patterns Alteration From Cortical To Subcortical Brain Regions In Amygdala Kindled Rats, *Journal of Neuroscience* [Under Prep]
3. **A.R. Peimani**, A. Khalili, N. Safarian, K. Youssef, G. Zoidl, and P. Rezai, (2019) Phenotypic Chemical & Mutant Screening of Zebrafish Larvae using On-Demand Response to Electric Stimulus, *Integrative Biology*, 11, 373-383
4. **A.R. Peimani**, G. Zoidl, and P. Rezai, (2018) Zebrafish Larvae's Electrotaxis and its Correlation with the Dopaminergic System Investigated in a Microfluidic Device, *Biomicrofluidics*, 12, 014113.
5. Nady, A., **A.R. Peimani**, G. Zoidl, and P. Rezai, (2017) A Microfluidic Device for Partial Immobilization, Chemical Exposure, And Behavioural Screening of Zebrafish Larvae, *Lab Chip*, 17, 4048-4058.
6. **A.R. Peimani**, G. Zoidl, and P. Rezai, (2017) A Microfluidic Device for Quantitative Investigation of Zebrafish Larvae's Rheotaxis, *Biomedical Microdevices*, 19:99.
7. Youssef, K., **A.R. Peimani**, P. Bayat, S. Dibaji, and P. Rezai, Miniaturized Sensors and Actuators for Biological Studies on Small Model Organisms of Disease, in Environmental, Chemical and Medical Sensors, S. Bhatia, Editor, 2017, *Springer*

CONFERENCES

1. **A.R. Peimani**, W. Sangphosuk, P. Carlen, From Nodes to Networks: Representation Learning for Seizure Propagation, Clustering and Biomarker Identification, *International Conference on Learning Representations (ICLR)*, 2024; Vienna, Austria [Under Prep]
2. **A.R. Peimani**, W. Sangphosuk, P. Carlen, Neural Network Dynamics in Amygdala Kindled Seizures, **Society for Neuroscience (SfN)**, 2023; Washington, D.C., USA.
3. **A.R. Peimani**, W. Sangphosuk, P. Carlen, Time Course and Semiology of Brainstem Seizure Invasion in Amygdala Rapid Kindling Model, in 77th AES Annual Meeting, 2023; Orlando, FL, USA.
4. **A.R. Peimani**, W. Sangphosuk, P. Carlen, Combining K-Nearest Neighbours and Few-Shot Learning Enhances Seizure Identification in a Kindled Rat Model, **T_CAIRES AI in Medicine**, 2023; Toronto, Canada.
5. W. Sangphosuk, **A.R. Peimani**, N. Silverman, V. Vejeyathaas, F. Le Devedec, K. Urban, P. Carlen, Cannabidiol Effects on Brainstem Seizures in Amygdala Rapid Kindling Rat Model, **Krembil Research Day**, 2023; Toronto, ON, Canada.
6. **A.R. Peimani**, A. Sabetghadam, H. El-Beheiry, P. Carlen, Isoflurane General Anesthesia Differentially Suppresses Brainstem Compared to Cerebral Seizure Like Events and Concomitant Respiratory Disruption, in 75th AES Annual Meeting, 2021; Chicago, IL, USA.

WORKSHOPS

1. **A.R. Peimani**, W. Sangphosuk, P. Carlen, Epileptic Episodes Analysis through Joint Representation Learning: A Multi-modal Approach Unifying LFP and Behavioral Indicators, *NeurIPS Workshop on Causal Representation Learning*, 2023; New Orleans, United States [Under Prep]
2. **A.R. Peimani**, W. Sangphosuk, P. Carlen, Multi-modal Integration of Video and LFP Using AI for Analysis of PGES in Amygdala-Initiated Seizures, *Machine Learning for Health (ML4H)*, 2023; New Orleans, United States [Under Prep]

CERTIFICATES

- **Supervised Machine Learning: Regression & Classification [Certificate]** Coursera-deeplearning.ai-Stanford
Building machine learning models in Python with NumPy and scikit-learn 2022
- **Mendeley Advisor [Certificate]** Mendeley Community Team
Experts who share their knowledge & skills with colleagues via workshops etc 2022
- **Business Fundamentals Program [Certificate]** Grad. Management Consulting Associ., Uni. of Toronto
Intro. to business concepts based on "Ten-Day MBA" by Silbiger 2021
- **Computational Neuroscience [Certificate]** Neuromatch Academy
3-Week intensive program focusing on Dynamical Systems, ML, RL, DL, Neuroscience 2020

WORK & ACADEMIC EXPERIENCES

Graduate Research Assistant

Sep 2018 - Sep 2023

University Health Network, University of Toronto

Toronto, ON, Canada

- **Seizure Identification in Kindled Rat Model::** Investigated the use of advanced machine learning techniques, such as few-shot learning and K-Nearest Neighbors, to distinguish seizure from non-seizure episodes in local field potential (LFP) recordings from kindled rat models. The approach has proven to overcome data scarcity limitations, offering an effective solution for enhancing seizure detection and understanding epilepsy.
- **Investigation of SUDEP Risk Factors::** Conducted a research study using Bayesian networks to illuminate the interactions of Sudden Unexpected Death in Epilepsy (SUDEP) risk factors. The study offers a novel mathematical perspective, potentially contributing to preventative measures and treatment plans for SUDEP.
- **Analysis of Neural Network Connectivity and Seizure Propagation::** Explored alterations in neural network connectivity and seizure propagation patterns from cortical to subcortical brain regions in amygdala kindled rats. This study provides valuable insights into the intricacies of seizure dynamics in different brain areas.
- **Representation Learning for Seizure Propagation::** Explored the representation learning for seizure propagation, clustering, and biomarker identification. The study was aimed to understand and visualize complex seizure dynamics and facilitate the identification of potential seizure biomarkers.
- **Brainstem Seizure Invasion Dynamics::** Investigated the time course and semiology of brainstem seizure invasion in an amygdala rapid kindling model. The study utilized in vivo local field potential (LFP) recordings and signal processing techniques to capture and analyze high-resolution electrophysiological data during seizure progression. The insights gathered could inform novel therapeutic strategies targeting specific neural networks.
- **Epileptic Episodes Analysis::** Developed an innovative approach for epileptic episodes analysis through joint representation learning. The approach unifies local field potential (LFP) and behavioral indicators, providing a multi-modal understanding of seizures and potentially improving epilepsy management strategies.
- **In Vivo Electrophysiology::** Hands-on experience with in vivo electrophysiology and awake behaving recordings has been a crucial aspect of my research. Using an amygdala rapid kindling rat model, I have been able to record and analyze high-resolution electrophysiological data from various regions of the brain during seizure progression. This has allowed me to draw valuable insights into the complex dynamics of neural network synchronization during seizures and their link with respiratory dysfunction.
- **Scientific Publishing::** My work in the field has culminated in the authorship of the comprehensive research abstract titled "Time Course and Semiology of Brainstem Seizure Invasion in Amygdala Rapid Kindling Model". The study's results have significantly advanced our understanding of the mechanisms of seizure propagation, the functional connectivity and synchronization patterns associated with kindling seizure progression, and the potential development of therapeutic strategies targeting specific neural networks.
- **Physiological Data Analysis::** In my work, I have employed advanced statistical and signal processing techniques for the analysis of collected physiological data, demonstrating proficiency with modern statistical inference and machine learning. By analyzing neural activity recorded from the cortex and brainstem deep nuclei, along with respiratory and cardiovascular signals, I have been able to better understand the complex relationships between seizures and cardiorespiratory function.
- **Experimental Design & Execution::** I have designed and executed rigorous experiments for physiological data collection, showcasing a strong understanding of scientific method and engineering principles. This has involved using in vivo electrophysiology to record neural activity, along with a pulse oximeter to capture respiratory and cardiovascular signals. The successful implementation of these methodologies has been crucial in supporting the findings of my research.
- **Cross-Disciplinary Collaboration::** As a passionate AI researcher & neuroengineer, I have worked closely with interdisciplinary teams, including neurologists, computer scientists, neuroscientists, and engineers. This collaboration has facilitated a multidisciplinary approach to understanding the pathophysiology of seizures leading to death, while also enabling me to build a strong repertoire of cross-disciplinary communication and collaboration skills.
- **Proficiency in Python::** In my research, Python has been an essential tool for developing and optimizing GNN algorithms, computational models, and analyzing data. I have used it to write custom scripts for the creation and testing of computational models, the visualization of network dynamics, and the analysis of physiological data. This has been instrumental in delivering impactful, high-quality research outputs.
- **Research Communication::** My commitment to the broader scientific community has been demonstrated through the dissemination of my research findings via academic publications, conference presentations, and public outreach initiatives. By doing so, I have not only broadened the reach of my work but also honed my ability to effectively communicate complex scientific information to a diverse audience. This commitment to knowledge sharing has significantly contributed to my success as an AI researcher & neuroengineer.

Mitacs Accelerate Intern

Jan 2020-Jan 2022

MITACS, Novela Neurotech, University of Toronto

Toronto, ON, Canada

- **Acute and Chronic Animal Models:** Developing novel acute hippocampal 4-AP model and chronic amygdaloidal electrical kindling of Sudden Unexpected Death in Epilepsy (SUDEP) in rats while concurrently recording in vivo deep brain electrical signals and vital signs such as heart rate, breath rate, and oxygen saturation (SpO2). Employing advanced computational techniques such as statistical analysis to identify seizure induction and propagation patterns from cortical regions such as the hippocampus and amygdala to subcortical regions including the brainstem and cerebellum.

- **Wireless Multichannel BCI:** Optimizing, validating, and testing a state-of-the-art wireless Brain-Computer Interface (BCI) developed by Novela Neurotech, which is capable of collecting large amounts of high-velocity, high-volume, and high-verity (Big Data) brain signal data for analysis. Leveraging the power of machine learning techniques to develop models to accurately interpret the acquired data and translate it into meaningful interpretation.
- **Brain Network Analysis:** Leveraging Graph Signal Processing techniques to analyze brain signals and vital signs to investigate the propagation of cortical-brainstem and identify important nodes and edges in the brain network.
- **Seizure Analysis:** Employing advanced computational techniques such as Partial Directed Coherence and Directed Transfer Function measures to examine the generation and propagation mechanisms of seizures. Analyzing features such as frequencies, cross-frequency coupling, seizure onset, and connectivity between different brain regions to provide a better understanding of the mechanisms behind seizures.

• Research Student

Aug 2017 - March 2018

Krembil Computational Neuroscience, University Health Network

Toronto, ON, Canada

- **Computational Neural Circuit Modeling:** Led the initial development and implementation of a computational single-cell Izhikevich spiking neuron model and built a network model using Python to simulate and analyze the complex dynamics of the mice somatosensory cortex. This involved modifying and refining the model under both control and 4-aminopyridine (4AP) conditions using advanced theoretical and computational techniques, and integrating the model with experimental data to validate its predictions. The resulting publication in a leading neuroscience journal demonstrated the potential for intrinsic inhibitory plasticity in the cortex, similar to what has been observed in the hippocampus. Acquired advanced skills in data analysis and visualization, statistical modeling, and machine learning algorithms, and developed a deep understanding of the computational principles underlying the dynamics of neural circuits. [Paper]

• Graduate Research Assistant

May 2018-Sep 2018

Applied Math. Dept., University of Waterloo

Waterloo, ON, Canada

- **Micro-swimmer Motion Model:** Modeling, simulating, and optimizing the locomotion of artificial micro-swimmers in viscoelastic fluids using Multi-Particle Collision Dynamics and Stochastic Rotation Dynamics methods, leading to potential applications in biomedicine monitoring, and microrobotics.

• Graduate Research Assistant

Sep 2015-Dec 2017

ACuTE Lab, Mech. Eng. Dept., York University

Toronto, ON, Canada

- **Neurobehavioral Research:** Conducted research in the field of bioengineering, specifically in the area of zebrafish larvae behavior and its correlation with dopaminergic system using microfluidic devices
- **Microfluidic Device Design:** Designed and fabricated microfluidic devices for immobilization, chemical exposure, and behavioral screening of zebrafish larvae for high-throughput drug screening
- **Phenotypic Screening Discovery:** Conducted phenotypic chemical and mutant screening of zebrafish larvae using on-demand response to electric stimulus, which led to the discovery of novel neuroactive compounds
- **Image Analysis Quantification:** Developed and implemented custom image processing and analysis algorithms to quantify the behavior of zebrafish larvae in microfluidic devices. Conducted statistical analysis of experimental data using MATLAB, resulting in shedding light on potential mutants with altered responses to electric stimulus.
- **Dopaminergic System:** Conducted experiments and statistical analysis of experimental data using MATLAB, resulting in the identification of significant correlations between electrotaxis behavior and dopaminergic signaling.
- **Rheotaxis Behavior Investigation:** Utilized microfluidic devices to investigate rheotaxis behavior of zebrafish larvae quantitatively and its potential as a tool for toxicity screening
- **Multidisciplinary Collaboration Skills:** Collaboration with researchers from diverse backgrounds including biology, engineering, and physics for multidisciplinary research
- **Wearable Cooling BCI:** Conceived and showcased a miniature brain-computer interface (BCI) device that enables localized cooling on the dorsal region of rats, prompting the production of brown adipose tissue and the subsequent conversion of calories into heat. This novel approach holds considerable promise for tackling obesity and its management.

• Visiting Undergrad. Student

Sep 2013-Sep 2014

Mech. Eng. Dept., Sharif University of Technology

Tehran, Teh, Iran

- **Vehicle suspension system:** Developed a control system to optimize the suspension of a multi-degree-of-freedom vehicle, with the aim of mitigating oscillations and enhancing obstacle traversal. The system was designed using advanced control theory techniques and simulated using MATLAB and relevant software packages, such as SIMULINK. The simulations allowed for effective tuning and validation of the system's performance, including the optimization of key parameters such as suspension stiffness and damping coefficients.

• Summer Research Student

April 2013-Sep 2013

Strength of Materials Lab, Mech. Eng. Dept., Isfahan University of Technology

Isfahan, Isf, Iran

- **Traction Coefficient Analysis:** Examined the traction coefficient by conducting experiments with a steel-on-steel machine, followed by data analysis using MS Office and simulations using the CAD software ABAQUS with numerical methods like Finite Element Methods with the goal of gaining a better understanding of the behavior of the traction coefficient.

TEACHING EXPERIENCE

- **University of Toronto** Toronto, ON, Canada
Sep 2018 - Sep 2023
 - Teaching Assistant:* course code: course name [term-year], W: Winter, F: Fall, S: Summer
 - **[CSC2516: Deep Learning & Neural Networks]** by **Jimmy Ba**: [W22 & W23]
 - **BME1510: Data Science for Bioengineers**: [W23]
 - **ECE448: Biocomputation**: [W21 & W22 & W23]
 - **BME1478: Coding for Bioengineers**: [F20 & F21 & F22]
 - **CSCA08: Intro to Computer Science I**: [F22]
 - **CSC236: Theory of Computation**: [F22]
 - **CSC111: Foundations of Computer Science II**: [W22]
 - **CSC108: Introduction to Python**: [W19 & F19 & W20 & F20 & W21 & F21]
 - **MIE334: Numerical Methods**: [W21]
 - **MIE1628: Big Data Science**: [F19 & S20]
 - **MAT185: Linear Algebra II**: [W19]
 - **Microteaching II: Effective Lesson Planning and Delivery**: [F18]
- **Northeastern University** Toronto, ON, Canada
Sep 2022 - Sep 2023
 - Teaching Assistant:* course code: course name [term-year], W: Winter, F: Fall, S: Summer
 - **ALY6020: Predictive Analytics**: [S23]
 - **ALY6130: Risk Management Analytics**: [S23 & W23]
 - **ALY6110: Data Management & Big Data**: [F22 & S23]
 - **ITC6000: Database Management Systems**: [F22]
- **University of Waterloo** Waterloo, ON, Canada
May 2018 - Sep 2018
 - Teaching Assistant:* course code: course name [term-year], S: Summer
 - **MATH118: Calculus II**: [S18]
- **York University** Toronto, ON, Canada
Sep 2015 - May 2018
 - Teaching Assistant:* course code: course name [term-year], W: Winter, F: Fall
 - **MECH3401: Mini Design Project II**: [W18]
 - **MECH3409: Machine Element Design**: [W18 & W16]
 - **MECH4502: Vibrations and Actuators**: [F17]
 - **MECH2112: Mech. Eng. Professionalism and Society**: [F17]
 - **ENG1101: Renaissance Engineer I**: [F17]
 - **MECH2302: Dynamics**: [W17 & W16]
 - **MECH2301: Mechanics of Material**: [F16]
 - **MECH2401: Eng. Graphics & CAD Modeling (Solidworks)**: [F16 & F15]
 - **ENG1102: Renaissance Engineer II**: [W16]
- **Isfahan University of Technology** Isfahan, Isf, Iran
Jan 2015 - May 2015
 - Teaching Assistant:* course code: course name [term-year], W: Winter
 - **MECH15437: Automatic Control**: [W15]
 - **MECH15225: Strength of Materials II**: [W15]

VOLUNTEERING & LEADERSHIP

- **Co-Founder & President** Mental Wellness Assoc. for International Students (MeWeIS)
2019-2020
 - Aiding & engaging with students' mental health*
- **President** BME Students' Association (BESA), Uni. of Toronto
2019-2020
 - Representing & serving over 400 Biomed. Eng. graduate students*
- **Vice-President Communication** International Students' Caucus (ISC), Uni. of Toronto
2018-2020
 - Helping & representing over 5500 international graduate students*
- **Graduate Student Member** SGS Mental Health Working Group, Uni. of Toronto
2019-2020
 - In response to students' mental health needs for advice to Dean's Office*
- **iConnect Graduate Mentor** Center For Internatioonal Experience, Uni. of Toronto
2019
 - Supporting 5 freshmen about cultural transition & new life in Canada*
- **ToBE 2019 Abstract Review Committee** Inst. of Biomed. Eng., Uni. of Toronto
2019
 - Reviewing 5 abstracts for the 2019 ToBE Annual Research Conference*
- **GECoS Mental Wellness Committee Member:** GECoS, Faculty of Sci Eng., Uni. of Toronto
2019
 - Co-Planning the Mental Wellness Carousel event in June 2019*

- **Editor & Writer** The Starfish Canada, Canada
Writing & editing Environmental articles for the Canadian youths audiences 2019
- **CPIN Undergraduate Program Mentor** Collab. Program in Neuroscience (CPIN), Uni. of Toronto
Assisting 2 students per year with their future graduate studies 2018-2019
- **ACuTE Lab Mentor** Deps. of Biology, Elec., & Mech. Eng., York University
Training 3 undergrad. & 2 grad students for researching 2016-2018
- **IUT Sofe Mountain Hiking Group Leader** Isfahan University of Technology (IUT)
Organizing biweekly events for social hiking at Sofe Mountain of Isfahan 2013-2015

EXTRACURRICULAR ACTIVITIES & HOBBIES

- BESA Indoor Soccer Player & Captain at Uni.of Toronto, Fall 2018-Fall 2022
Silver Medal, Summer 2019 UofT Eng. Tournament
- **1st Geup Rank** in Taekwondo, Certified in 2005 in Isfahan, Iran
- Soccer, Books, Music Theory, French & Spanish Languages, Evolutionary Biology
- **French Language NCLC 5** (equivalent to Intermediate / TEF-B1)