GASSER ELBANNA

Doctoral student in the Speech and Hearing Bioscience and Technology program at Harvard University. I am interested in studying how humans perceive speech and voice. I build artificial neural networks to crack the code of speech and voice in minds and brains.

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EDUCATION

Harvard University
September 2023 – Present
Ph.D. in Speech and Hearing, Bioscience and Technology (SHBT)
Cambridge, USA

- **Advisor:** Prof. Josh H. McDermott *(Harvard/MIT, USA)*.

EPFL
September 2020 – April 2023
MSc. in Neuroscience and Neuro-engineering
Lausanne, Switzerland

Grade: 5.7/6.0 **(mention d'Excellence/with High Distinction)**

- **Thesis Title:** Evaluating Speaker Identity Coding in Self-supervised Models and Humans.
- **Thesis Advisors:** Dr. Satrajit S. Ghosh *(Harvard Medical School, USA)* and Dr. Antoine Bosselut *(EPFL, Switzerland)*.
- Nominated for Best Masters Project.

Cairo University
September 2015 – August 2020
BSc. (Honors) in Systems and Biomedical Engineering
Cairo, Egypt

Grade: Distinction with Honors

- **Thesis Title:** Building Analytical Surface EMG Model for ALS Early Detection.
- **Thesis Advisors:** Prof. Ayman M. Eldieb *(Cairo University, Egypt)* and Prof. Sherif Elbasiouny *(Wright State University, USA)*.

RESEARCH AND INDUSTRY EXPERIENCE

IDIAP Research Institute
April – August 2023
Speech ML Research Intern
Martigny, Switzerland

- Studying the relation between speech signal and heart activity.
- Identifying the salient acoustic features for predicting heart activity.
- Training CNN-based neural networks to predict heart activity (BPM & HRV) from raw speech.
- Benchmarking hand-crafted and self-supervised speech features on predicting heart activity features from speech.
- This internship yielded a paper in *Interspeech 2024*.

Harvard Medical School and McGovern Institute for Brain Research
March 2022 – February 2023
Graduate Research Student | Bertarelli Fellow
Cambridge, MA, USA

- Exploring the invariances and equivariances of self-supervised speech models on speaker recognition and discrimination tasks.
- Conducting behavioral experiments using **GORILLA** to evaluate the performance of humans and models on a speaker discrimination task.
- Identifying the brain regions best-predicted by self-supervised models using a naturalistic fMRI data.
- This work yielded multiple invited talks at *BCS/MIT*, *CSAIL/MIT* and *SHBT/Harvard* in addition to three poster presentations at *NeurIPS*, *Bridge2AI*, and *OHBM* as well as a journal paper in-prep.

Logitech Europe SA
August 2021 – February 2022
Voice AI Intern
EPFL Innovation Park, Switzerland

- Designing a DINO-like training objective to learn data-driven and handcrafted acoustic features simultaneously (Hybrid BYOL-S).
- Benchmarking speech-based ANNs (e.g. BYOL-A, TRILL, YAMNET, VGGish,...etc) on voice stress detection tasks (Cognitive & Physical Load).
- Exploring the effect of using a hyperbolic embedding space on performance in speech emotion recognition tasks.
- This work yielded two papers in *Interspeech* and *PMLR* as well as a model ranked in the top 3 at *NeurIPS HEAR competition*.

Machine Learning and Optimization Laboratory
March – October 2021

ML & Data Visualization Research Assistant
EPFL, Switzerland

- Detecting and visualising patterns in medical data to guide targeted interventions and medical training (Epidemiology).
- Implementing supervised and unsupervised anomaly detection ML Models for the Dynamic Project and using **Tableau** as a web-based dashboard development tool for visualization integrated with **Python** scripts to run ML models.
- This work yielded a journal paper in *Emerging microbes & infections*.

Advintic
May – August 2020

Computer Vision AI Intern
Cairo, Egypt

- Training a U-Net based architecture to detect and segment main heart coronaries from chest X-rays using **Keras with TensorFlow**.
- Segmenting the heart ROI using IoU loss function.

Opto-Nano-Electronics Lab
August – October 2019

Research Intern
Cairo University, Egypt

- Building a text to speech (TTS) keyboard for minimally-verbal autisitc children by using a **Raspberry Pi** that runs an open source TTS client (**Festival**) in real-time.

Life from Water Organization
October – December 2018

R&D Intern
Cairo, Egypt

- Planning and Implementing different innovative solutions for water delivery problems in 2 cities in Egypt and 1 city in Kenya.
- Assessing the feasibility of operations and technical solutions proposed for water development.

Life Medical Center for Prosthetics and Orthosis
Aug – Sep 2018

Biomedical Engineer Trainee
Cairo, Egypt

- Designing and building lower limb prosthetics for above- and below-knee amputation.

ACHIEVEMENTS & AWARDS

Awarded Best Poster in the NIH Bridge2AI Voice Symposium 2024
May 2024

- Best Student Poster in the category of *"Current Technological or Methodological Barriers to Clinical Use"*.

Top 3% Paper Recognition at ICASSP 2023
June 2023

- Paper with title *"Efficient Speech Quality Assessment using Self-supervised Framewise Embeddings"*.

Nominated for Best Masters Project in Life Sciences Engineering Program at EPFL
May 2023

- Masters project with title *"Evaluating Speaker Identity Coding in Self-supervised Models and Humans"*.

Awarded Logitech Publication Prize
July 2022

- Received 1,000 CHF to attend and present at Interspeech 2022 Conference. Paper with title *"Hybrid Handcrafted and Learnable Audio Representation for Analysis of Speech Under Cognitive and Physical Load"*.

HEAR Competition at NeurIPS 2021
December 2021

- Ranked 1st on LibriCount task (9% improvement) and Ranked 3rd overall (19 downstream audio tasks).

Awarded Bertarelli Fellowship in Translational Neuroscience and Neuro-engineering
February 2021

- An EPFL-Harvard Medical School one-year fellowship to carry out a Masters thesis in Sensible Intelligence lab.

3D Printed motor neuron registered at ModelDB
April 2020

- 3D printing a cat motor neuron (vemoto6 Neuron Model) using NeuroMorphoVis as part of my undergraduate thesis.

PUBLICATIONS AND TALKS

Journal and Conference Publications

- **Elbanna, G.**, Mostaan, Z., & Magimai Doss, M. (2024). Predicting Heart Activity from Speech using Data-driven and Knowledge-based features. In Proc. Interspeech.
- El Hajal, K., Wu, Z., Scheidwasser-Clow, N., **Elbanna, G.**, & Cernak, M. (2023). Efficient Speech Quality Assessment Using Self-Supervised Framewise Embeddings. In ICASSP 2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP) (pp. 1-5). IEEE.
- **Elbanna, G.**, Scheidwasser-Clow, N., Kegler, M., Beckmann, P., El Hajal, K., & Cernak, M. (2022). Byol-s: Learning self-supervised speech representations by bootstrapping. In HEAR: Holistic Evaluation of Audio Representations (pp. 25-47). PMLR.
- **Elbanna, G.**, Biryukov, A., Scheidwasser-Clow, N., Orlandic, L., Mainar, P., Kegler, M., ... & Cernak, M. (2022). Hybrid handcrafted and learnable audio representation for analysis of speech under cognitive and physical load. In Proc. Interspeech (pp. 386-390).
- Cordey, S., Laubscher, F., Hartley, M. A., Junier, T., Keitel, K., Docquier, M., ... **Elbanna, G.**, Tapparel, C., Zanella, M., Xenarios, I., Fellay, J., D'Acremont, V.,& Kaiser, L. (2021). Blood virosphere in febrile Tanzanian children. Emerging microbes & infections, 10(1), 982-993.

Pre-prints and In prep Papers

- **Elbanna, G.**, Catania, F., Govindarajan, L., & Ghosh, S. Investigating Speaker Identity Coding in Speech Artificial Neural Networks. In prep.

Conference Abstracts

- **Elbanna, G.**, & McDermott, J. (2025). Artificial Neural Networks Generate Human-like Patterns of Phoneme Responses and Confusions. In ARO 2025.
- Magaro, A., Shook, E., Kell, A., Saddler, M., **Elbanna, G.**, & McDermott, J. (2025). Optimization Under Ecological Realism Reproduces Signatures of Human Speech Recognition. In ARO 2025.
- **Elbanna, G.**, & McDermott, J. (2024). Artificial Neural Networks Generate Human-like Continuous Speech Perception. In NeurIPS 2024 UniReps Workshop.
- **Elbanna, G.**, & McDermott, J. (2024). Modeling Continuous Speech Perception Using Pseudo Supervised Learning. In SANE Meeting 2024.
- **Elbanna, G.**, Catania, F., & Ghosh, S. (2024). Speaker Identity Coding in Speech Artificial Neural Networks. In Voice AI Symposium Bridge2AI 2024.
- Catania, F., **Elbanna, G.**, & Ghosh, S. (2024). The Voice Anonymization Challenge: Achieving Privacy without Compromising Utility. In Voice AI Symposium Bridge2AI 2024.
- **Elbanna, G.** & Ghosh, S. (2024). Predicting Brain Responses in Auditory and Language Regions using Speech Self-supervised Models. In Organization for Human Brain Mapping (OHBM) 2024.
- **Elbanna, G.**, Catania, F., & Ghosh, S. (2023). Towards Understanding Speaker Identity Coding in Data-driven Speech Models. In NeurIPS 2023 MusiML Workshop.

Invited/Contributed Talks

- *Investigating Speaker Identity Representations in Artificial Neural Network Models*. Contributed Talk at VoiceID Conference, Marburg (2024).
- *The Voice as a Window to The Mind: Opportunities and Challenges*. Invited Talk at SLS Group, CSAIL, MIT (2024).
- *Towards Understanding Speaker Identity Coding in Data-driven Speech Models*. Spotlight Talk at MusiML workshop at NeurIPS (2023).
- *Learning Self-supervised Speech Representations via Hybrid Training*. Invited Talk at Pindrop Company (2023).
- *Speaker Identity Coding in Self-supervised Models*. CogLunch Talk at BCS MIT (2023).
- *Speech Processing Lecture*. SHBT-200 graduate course at Harvard (2022). *Co-lectured with Dr. Satrajit S. Ghosh*.
- *What do Machines Hear? Overview of deep learning approaches for representing voice*. Invited Talk at Harvard-MIT Speech Biomarker Group (2022).
- *SERAB BYOL-S Model*. HEAR Competition Submission Talk at NeurIPS (2021).

Blogs

- *Discrimination in Artificial Intelligence for Voice Applications*.

TEACHING AND MENTORING

Teaching Fellow for SHBT 205 Course
Spring 2025

- *SHBT 205* - Audition: Neural Mechanisms, Perception and Cognition.

ARC Peer Tutor at Harvard University
Spring 2025

- Tutoring Harvard students in the following courses: *COMPSCI 181*, *PSY 14*, *PSY 1903*, *SHBT 201*, and *SHBT 202*.

UROP Mentor at MIT
Spring 2025

- Mentoring three MIT undergraduate students on projects related to audio signal processing, speech ML, and auditory neuroscience.

B.Sc. Thesis Advisor at Cairo University
August 2024-Present

- Advising an undergraduate thesis related to studying the invariance problem in speech and voice encoding in the brain using artificial neural networks.

Mentor at Fatima Fellowship
July 2024-Present

- Fatima fellowship is a pre-doctoral fellowship providing research oppotunities to students from the global south interested in applying for graduate school.
- Mentoring a Fatima Fellow on studying voice similarity judgments in humans and artificial neural networks.

PROFESSIONAL SERVICE

Reviewer for MENA ML Winter School
November 2024

- Review applicants from the Middle East and North Africa regions for a machine learning winter school sponsored by Google Deepmind, DELL, and QCRI.

Core Organizer of Muslims in ML Affinity Workshop at NeurIPS
August 2024-Present

- Organizing an affinity workshop dedicated to amplifying the voices of Muslim researchers in the fields of machine learning and artificial intelligence and addressing challenges and research topics that are particularly relevant to Muslims.

Co-leading ISWG at Harvard Union
September 2023-Present

- Co-leading the International Scholar Working Group (ISWG) at HGSU which involves advocating for issues pertaining international students and workers at Harvard University.

Non-resident Tutor at Harvard Housing
September 2023-Present

- NRT at the Leverett House at Harvard which involves tutoring undergraduate students with their graduate applications, organizing scientific activities, and fostering an inclusive environment for all students in the house.

SKILLS

Technical Development
Python and MATLAB

Desktop Development
C and C++

Deep Learning Frameworks
Pytorch Lightning, Pytorch, Tensorflow, Keras, RLlib, Ray and VoxelMorph

Modeling
NEURON, NMODL and HOC Language

Graphics and Visualization
OpenGL, VTK and Tableau

Embedded Systems
Raspberry Pi, ESP and Arduino

Miscellaneous
Git, LaTeX, Linux, Qt Designer, fMRIPrep, Prolific, and GORILLA

HIGHLIGHTED PREVIOUS PROJECTS

Me Too Quotes Analysis

September – December 2021

Course Project at Data Science Lab

- Analyze Quotebank data in addition to twitter dataset to study the impact of traumatic/non-traumatic incidents on resurrecting the #MeToo movement using NLP in **Python**.
- Build a web blog with the data story to illustrate the results.

Predict Breathing Patterns from Speech

July – September 2021

Semester Project at IDIAP

- Train a CNN-based model using **Pytorch** for estimating breathing patterns from voice samples.
- Experiment with different model architectures, loss functions and hyper-parameters to optimize performance.

Learning Adaptive Behavior Through Competition

July – September 2021

Semester Project at Mathis Group for Computational Neuroscience and AI

- Design a training procedure which allows an agent to succeed in a progressively larger and more complex set of environments by implementing PAIRED algorithm.
- Changing dynamics due to environmental perturbations and generating unsupervised curriculum for adaptation using **RLlib**.

Impact of Motivation on Performance and Neuronal Activity in Mice Engaged in a Sensory Detection Task

February – June 2021

Semester Project at Laboratory of Sensory Processing

- Analyze behavioral parameters (Engagement, Performance and Cumulative Reward) and Psychometric functions in mice whisker-deflection detection task.
- Analyze neural parameters (Firing Rate and PCA) recorded from S1, mPFC and tjM1 brain regions.
- Correlation analysis between neural and behavioral parameters.

Applying VoxelMorph Framework to C. Elegans Brain Data for image regisration

October – December 2020

Course Project at Laboratory of Physics of Biological Systems

- Apply image registration on 3D volumes of brain data in **TensorFlow**.
- Create a deformation field for each 3D volume in a specific time frame relative to first frame.

Analytical Surface EMG Model connected to Motoneuron Model for ALS Early Detection

August 2019 – August 2020

BSc. Graduation Project

- Building a motoneuron model using **NEURON** simulating early ALS biophysical features and a sEMG model using **Python**.

Computer Vision GUI

May 2020

- Building user-friendly GUI to implement Hough Transform, Harris Corner Detector, Template Matching and SIFT Algorithms on given images using **openCV** and **PyQt5**.

Mini Autonomous Car

October 2019

- Building a self-driving car which detects lanes using **OpenCV** (Hough transform & Contouring).
- Detecting obstacles using ultrasonic sensor connected with **Arduino** that overrides the steering control in case avoiding obstacles.

Volume Rendering Application for Head and Ankle Images

April 2019

- Loading DICOM images for ankle and head then apply Surface Rendering using adjustable ISO value and Ray Cast Rendering using adjustable transfer function using **VTK and Qt Designer**.

MRI Simulator Software

March 2019

- Implement a generalized MRI simulator with the preparation sequences (IR, T2 Prep. and Tagging) and pulse sequences (GRE, SSFP and SE) in a GUI using **PyQt5**.
- Implement a computational shepp-logan for testing and validation.