GASSER ELBANNA

Doctoral student in the Speech and Hearing Bioscience and Technology program at Harvard University and MIT. I am interested in studying speech/voice processing and perception in the human brain through the lens of deep learning models.

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EDUCATION

Ph.D. in Speech and Hearing Bioscience and Technology (SHBT)

September 2023 – ongoing

Harvard University and MIT, USA

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

MSc. in Neuroscience & Neuro-engineering

September 2020 – April 2023

EPFL, Switzerland

Average 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 University/MIT, USA)* and Dr. Antoine Bosselut *(EPFL, Switzerland)*.

BSc. (Honors) in Systems and Biomedical Engineering

September 2015 – August 2020

Cairo University, 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)*.

EXPERIENCE

Speech Research Intern

April 2023 – August 2023

IDIAP Research Institute

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 handcrafted and self-supervised audio features on predicting heart activity features.

Graduate Research Student | Bertarelli Fellow

March 2022 – February 2023

MIT/Harvard Medical School

Cambridge, MA, USA

- Exploring the invariances and equivariances of self-supervised speech models on speaker identity-related 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.

Voice AI Intern

August 2021 – February 2022

Logitech Europe SA

EPFL Innovation Park, Switzerland

- Improving a self-supervised speech model (BYOL-S) by designing a hybrid training protocol to learn from data-driven and handcrafted features simultaneously (Hybrid BYOL-S) using **PyTorch Lightning**.
- Benchmarking speech models (e.g. BYOL-A, TRILL, YAMNET, VGGish,...etc) on voice stress detection tasks (Cognitive & Physical Load).
- Exploring hyperbolic representational spaces and its performance on 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*.

ML & Data Visualization Research Assistant
March 2021 – October 2021

Machine Learning and Optimization Laboratory

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 paper in *Emerging microbes & infections* with title **Blood virosphere in febrile Tanzanian children**.

Computer Vision Intern
May 2020 – August 2020

Advintic

Cairo, Egypt

- Training a U-Net based architecture to detect and segment main heart coronaries using **Keras with TensorFlow**.

Research Intern
August 2019 – October 2019

Opto-Nano-Electronics Lab

Cairo University, Egypt

- Building a text to speech keyboard for autistic children by installing Linux image on a **Raspberry Pi** and using an open source TTS client (**Festival**) to automate the process of speech generation.

PROJECTS

Me Too Quotes Analysis
September 2021 – 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 2021 – 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 2021 – 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 2021 – 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 2020 – 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.

Wireless Data Transfer September 2019

- Generating pseudo random numbers that simulate patient data and transfer it wirelessly to a server using **BLE chip**.
- Visualizing the data acquired from the server in a web app developed using **Django** to simulate real-time vital signal tracking.

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.

ACHIEVEMENTS & AWARDS

Best Poster Award in the Bridge2AI Voice Symposium 2024

May 2024

- Best 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"*.

Logitech Publication Award 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).

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 bachelor's thesis.

PUBLICATIONS AND TALKS

Journal and Conference Publications

- El Hajal, K., Wu, Z., Scheidwasser-Clow, N., **Elbanna, G.**, & Cernak, M. (2023, June). 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, December). 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.

Conference Abstracts

- **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.

In-progress Publications

- **Elbanna, G.**, Catania, F., & Ghosh, S. Investigating Emergent Properties in Speech SSMs for Speaker Identity Recognition.
- Chen, Y., Zada, Z., **Elbanna, G.**, Ashby, G., Nastase, S. Belief-dependent Narrative Features Reconfigure Cortical Network Dynamics.

Invited Talks

- *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*. Pindrop Company Talk (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*. Harvard-MIT Speech Biomarker Group Talk (2022).
- *SERAB BYOL-S Model*. HEAR Competition Submission Talk at NeurIPS (2021).
- *Impact of Motivation on Performance and Neuronal Activity in Mice Engaged in a Sensory Detection Task*. Lab Talk (2021).

Blogs

- *Discrimination in Artificial Intelligence for Voice Applications*.

SKILLS

Technical Development
Python and MATLAB

Desktop Development
C and C++

Deep Learning Frameworks
Tensorflow, Keras, Pytorch, 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