

# GASSER ELBANNA

Doctoral Student in Speech and Hearing Bioscience and Technology at Harvard University and MIT

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## EDUCATION

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

📅 September 2023 – ongoing

Harvard University and MIT, USA

MSc. in Life Sciences Engineering (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**.

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.

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.

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**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**.

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**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

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**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.

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**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.

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**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**.

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**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.

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**Applying VoxelMorph Framework to C. Elegans Brain Data for image registration**

📅 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.

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**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**.

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## 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**.

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## 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.

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## 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.

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## Wireless WiFi-based Indoor Localization for Elderly 📅 September 2019

- Indoor localize elderly people through **ESP** embedded in a bracelet using WiFi technology.

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## 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**.

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## 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.

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# ACHIEVEMENTS & AWARDS

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## 🏆 Top 3% Paper Recognition at ICASSP 2023 📅 June 2023

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

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## 🏆 Nominated for Best Masters Project in Life Sciences Engineering at EPFL

📅 May 2023

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

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## 🏆 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*".

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## 🏆 HEAR Competition at NeurIPS 2021 📅 December 2021

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

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## 🏆 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**.

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## 🏆 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

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## 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 Framework 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 2022 (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. (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. Towards Understanding Speaker Identity Coding in Self-supervised Models.
- Chen, Y., Zada, Z., **Elbanna, G.**, Ashby, G., Nastase, S. Belief-dependent Narrative Features Reconfigure Cortical Network Dynamics.

## Invited Talks


- *Learning Self-supervised Speech Representations via Hybrid Training* at Pindrop Company 2023. [!\[\]\(8d139a66f540002704b5c70b7fe6cc7a\_img.jpg\)](#)
- *Speaker Identity Coding in Self-supervised Models* CogLunch talk at MIT 2023. [!\[\]\(c209541a4bc5f45e44bd7791f9477320\_img.jpg\)](#)
- *Speech Processing* for the SHBT-200 graduate course at Harvard 2022. Co-lectured with Dr. Satrajit S. Ghosh. [!\[\]\(8fd54d112e752061b5361c5bdf346185\_img.jpg\)](#)
- *What do Machines Hear? Overview of deep learning approaches for representing voice* at Harvard-MIT Speech Biomarker Group 2022. [!\[\]\(3525fd0bd3680f905a850c70520e38c7\_img.jpg\)](#)
- HEAR Competition Submission Presentation at NeurIPS 2021. [!\[\]\(3c3fba180f5a473bd1cb3c114e029235\_img.jpg\)](#)

## Blogs


- *Gender and Racial Disparities in Voice Applications.* [!\[\]\(9bfa69b6b0f097b09744337d04f22d78\_img.jpg\)](#)

# SKILLS


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 **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