Experiences using TinyML Tools in Teaching Biomedical Engineering

Msc. Eng. Moises Meza

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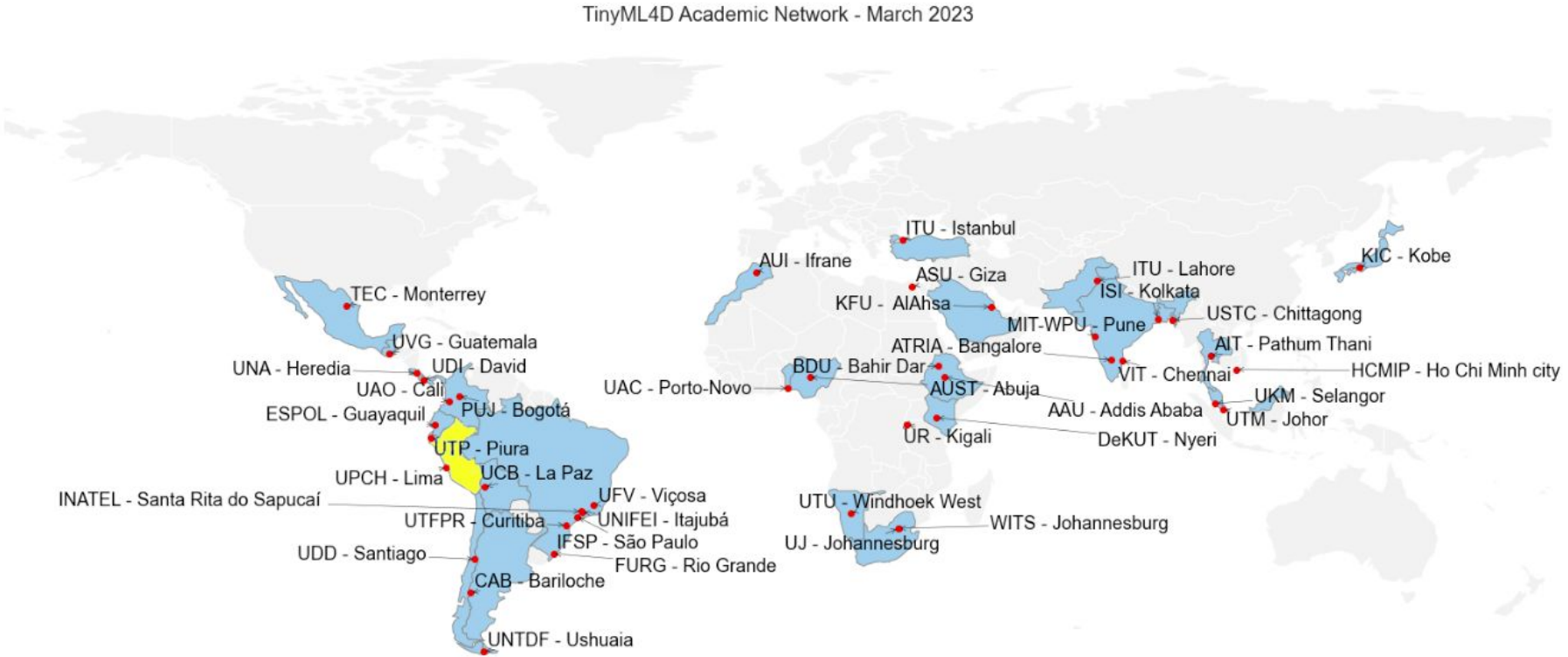
North Atlantic Ocean
Caribbean Sea
North Pacific Ocean
EQUATOR
SOUTH AMERICA
Peru
South Pacific Ocean
South Atlantic Ocean
1000mi
1000km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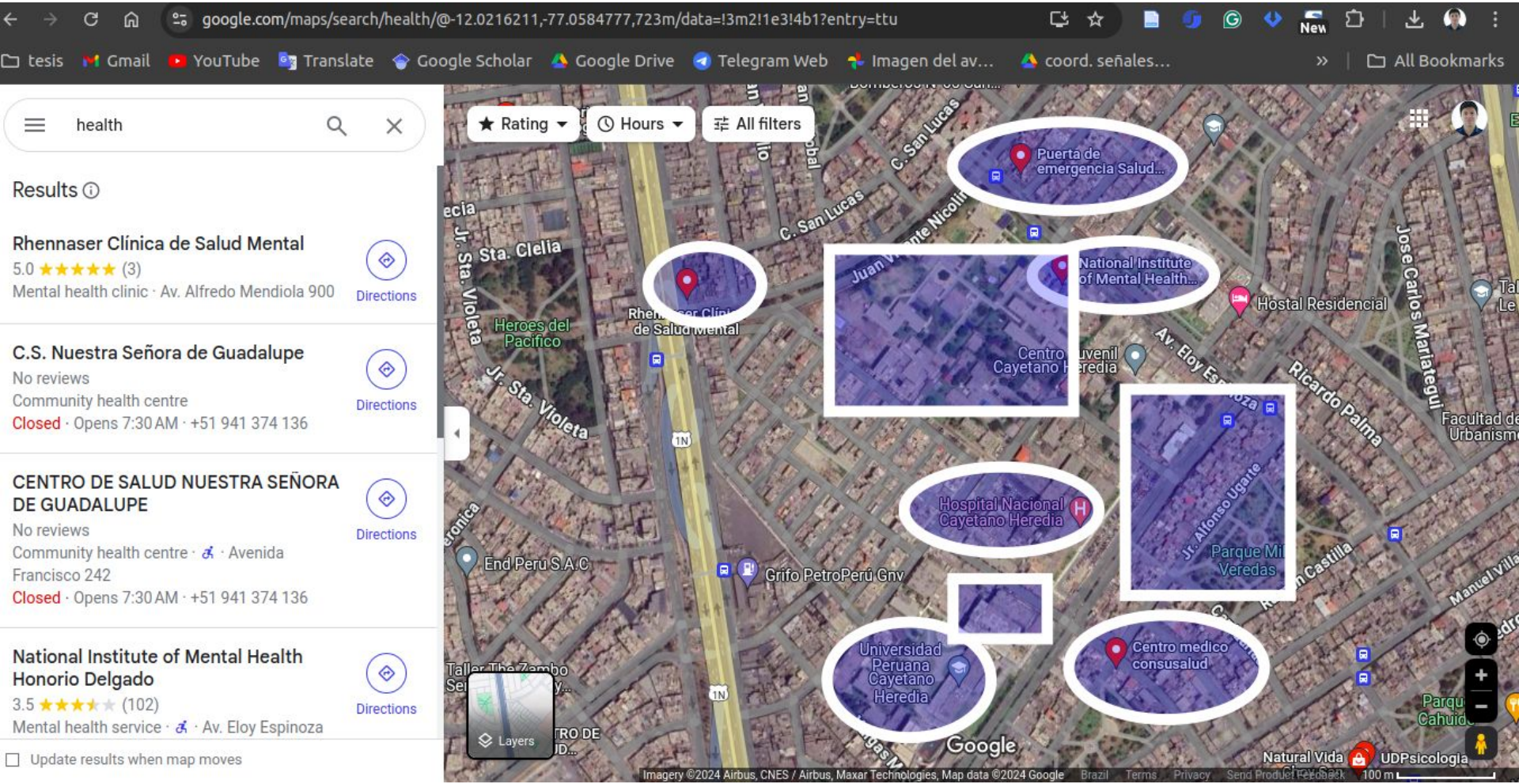
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Rhennaser Clínica de Salud Mental
5.0 ★★★★★ (3)
Mental health clinic · Av. Alfredo Mendiola 900
Directions
C.S. Nuestra Señora de Guadalupe
No reviews
Community health centre
Closed · Opens 7:30 AM · +51 941 374 136
Directions
CENTRO DE SALUD NUESTRA SEÑORA DE GUADALUPE
No reviews
Community health centre · · Avenida Francisco 242
Closed · Opens 7:30 AM · +51 941 374 136
Directions
National Institute of Mental Health Honorio Delgado
3.5 ★★★½☆ (102)
Mental health service · · Av. Eloy Espinoza
Directions
Update results when map moves
Rating
Hours
All filters
Puerta de emergencia Salud...
National Institute of Mental Health...
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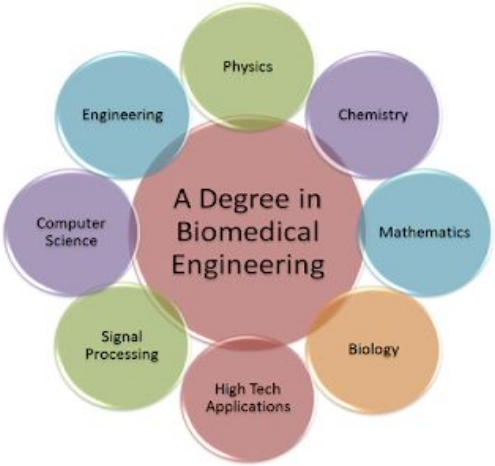
Biomedical Engineering

Biomedical engineering is the branch of engineering that applies principles of engineering to the medical field. It can encompass a wide range of topics, from developing new medical devices to improving healthcare delivery systems.

Competencies required on each student's profile: Analytical skills, Communication skills, advanced mathematics techniques, creativity, programming, and problem-solving skills.



So, here is a little bit about me before becoming part of Cayetano University!

ROBOTICS & AUTOMATION
SOCIETY

baxter
rethink robotics

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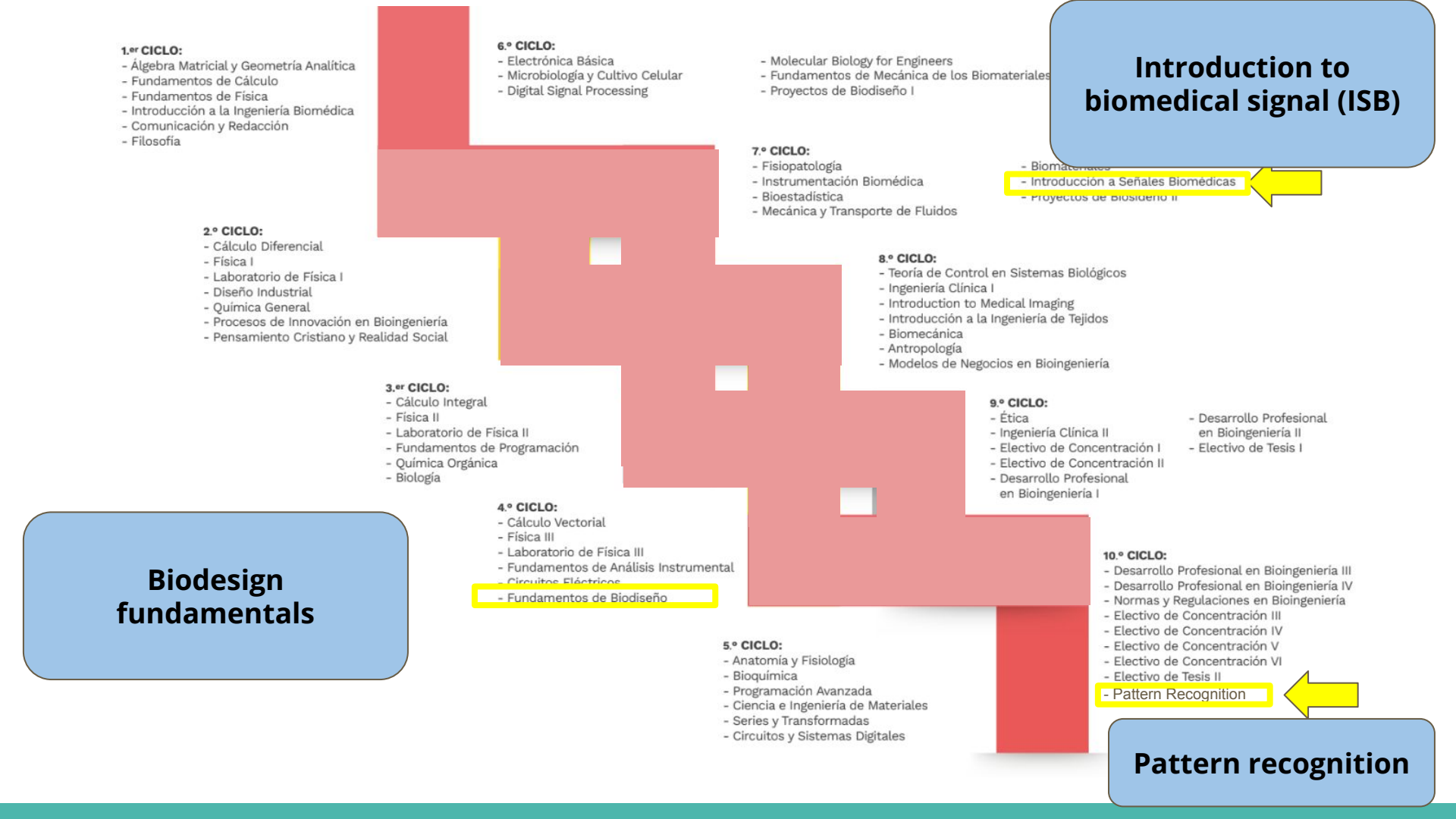
well it was a lot of me, it's time to talk about the main topic!
:)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- Álgebra Matricial y Geometría Analítica
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- Fundamentos de Física
- Introducción a la Ingeniería Biomédica
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2.º CICLO:
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- Introducción a Señales Biomédicas
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- Ingeniería Clínica I
- Introduction to Medical Imaging
- Introducción a la Ingeniería de Tejidos
- Biomecánica
- Antropología
- Modelos de Negocios en Bioingeniería
9.º CICLO:
- Ética
- Ingeniería Clínica II
- Electivo de Concentración I
- Electivo de Concentración II
- Desarrollo Profesional en Bioingeniería I
- Desarrollo Profesional en Bioingeniería II
- Electivo de Tesis I
10.º CICLO:
- Desarrollo Profesional en Bioingeniería III
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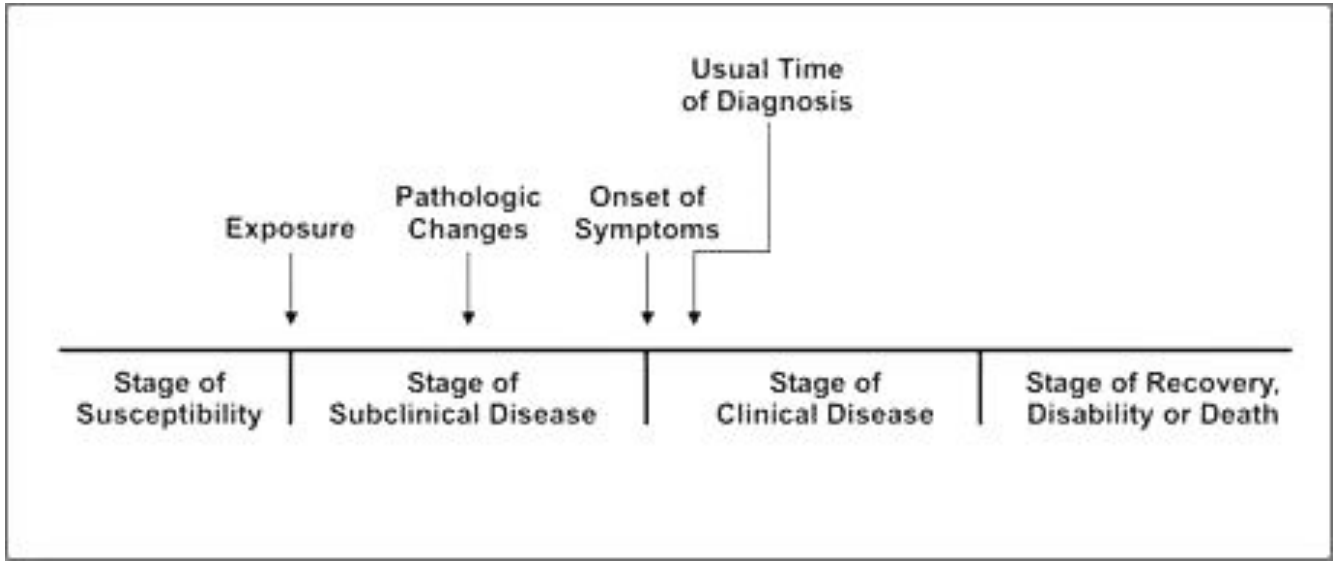
- Normas y Regulaciones en Bioingeniería
- Electivo de Concentración III
- Electivo de Concentración IV
- Electivo de Concentración V
- Electivo de Concentración VI
- Electivo de Tesis II
- Pattern Recognition
Introduction to biomedical signal (ISB)
Biodesign fundamentals
Pattern recognition

Natural history of disease



Introduction to biomedical signals

UNIT 1: INTRODUCTION, ACQUISITION AND PHYSIOLOGICAL PRINCIPLES OF BIOMEDICAL SIGNALS

↓

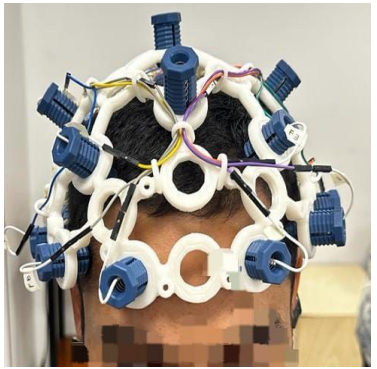
UNIT 2: ECG, EMG, AND EEG ANALYSIS

↓

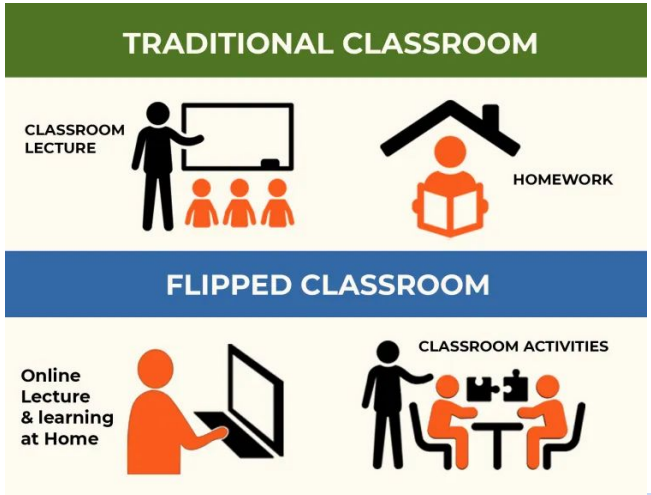
UNIT 3: INTRODUCTION TO DIGITAL SIGNAL PROCESSING

↓

UNIT 4: BIOMEDICAL COMPUTING AND INTRODUCTION TO ARTIFICIAL INTELLIGENCE IN BIOMEDICAL SIGNALS



METHODOLOGY

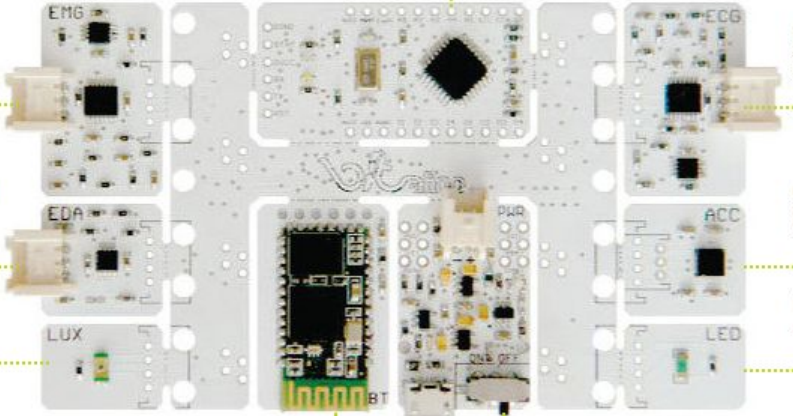


On flipped classrooms, students encounter information before class, freeing class time for activities that involve higher order thinking.

1 week before is sent these materials:

- laboratory guide.
- Scientific papers.
- Short videos.
- Manual of use from Bitalino/UltraCortex.

Anatomy of a Bitalino



Micro-Controller Unit
up to 1000Hz sampling rate
6 analog inputs (4@10-bit + 2@6-bit)
4 digital inputs, and 4 digital outputs

Electromyography (EMG)
measures the electrical activity produced by your muscles

Electrocardiography ECG
tracks the electrical changes associated with your heartbeat

Electrodermal Activity (EDA)
senses your sympathetic nervous system reactions

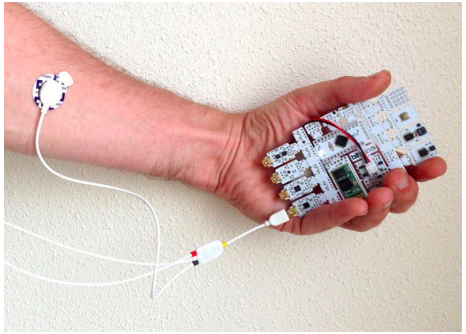
Accelerometry (ACC)
know your physical activity and movement related information

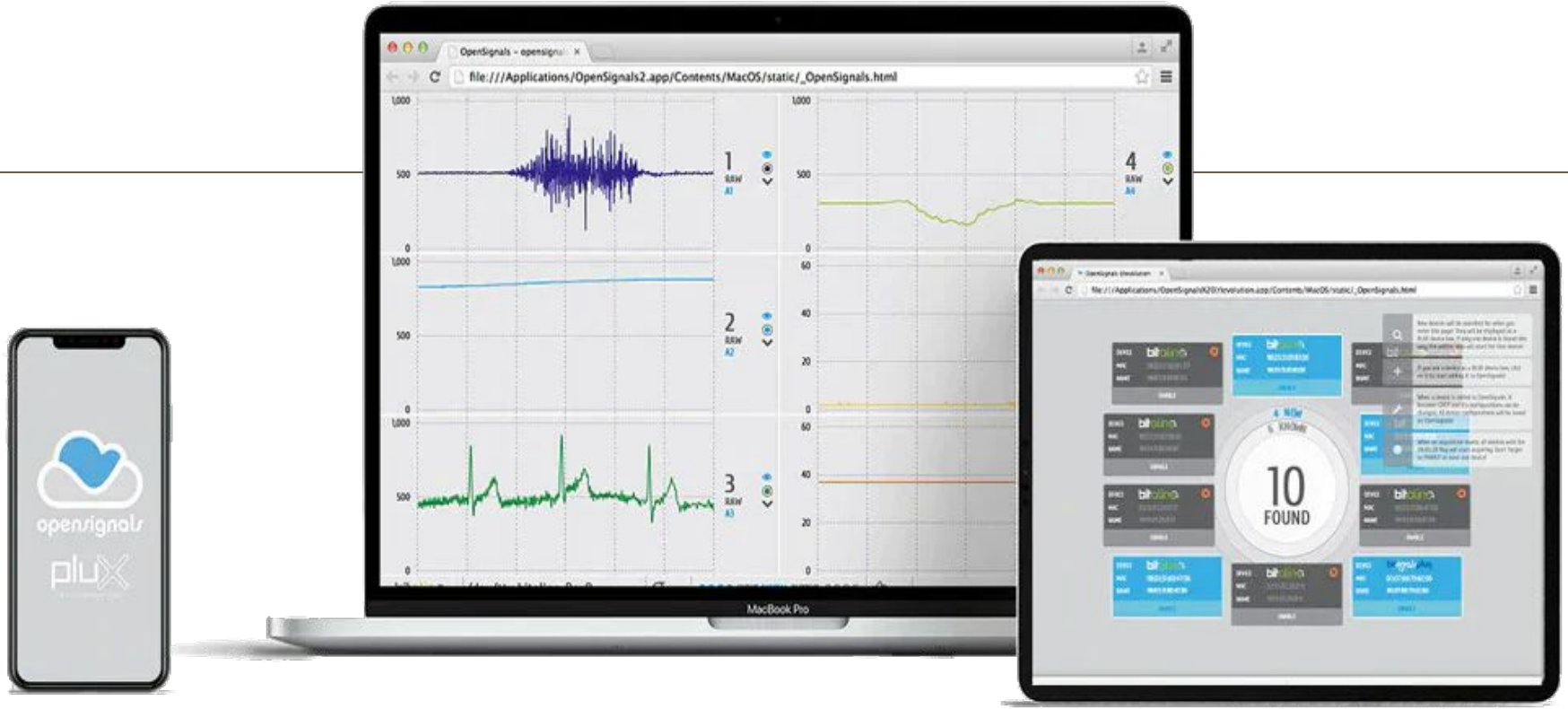
Light-Emitting Diode (LED)
make your BITalino shine

Light (LUX)
know the changes in ambient light or other light sources

Bluetooth
a widespread standard for short-range wireless connectivity

Power
so that you can operate your creations

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FOUND

OPENBCI
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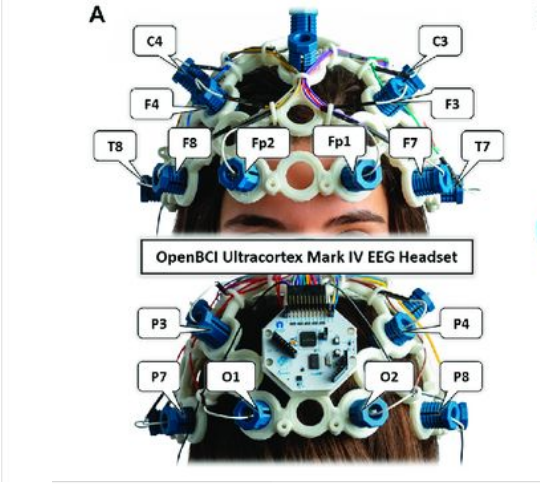
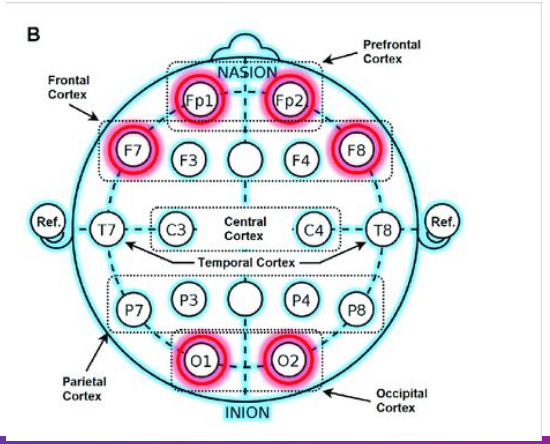
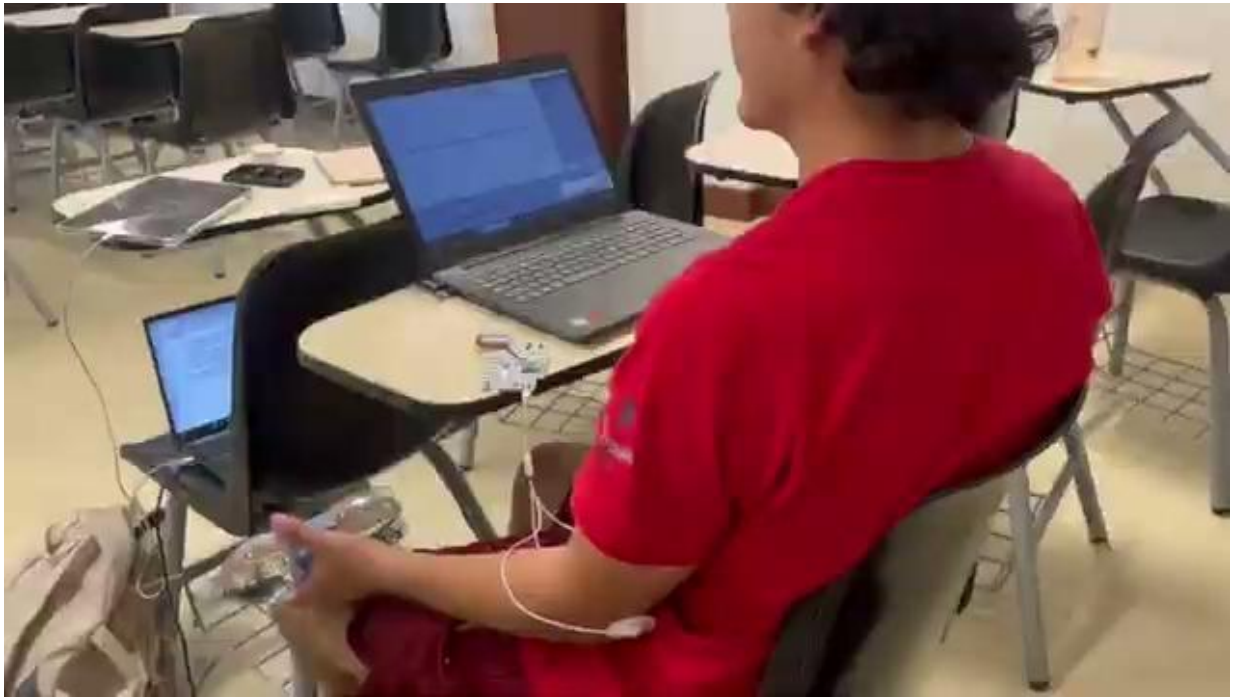
BIOSENSING HEADSET
OPENBCI.COM


A
C4
C3
F4
F3
T8
F8
Fp2
Fp1
F7
T7
OpenBCI Ultracortex Mark IV EEG Headset
P3
P4
P7
O1
O2
P8


B
Prefrontal Cortex
Frontal Cortex
NASION
Fp1
Fp2
F7
F3
F4
F8
Ref.
T7
C3
Central Cortex
C4
T8
Ref.
Temporal Cortex
P7
P3
P4
P8
O1
O2
Parietal Cortex
Occipital Cortex
INION

Tiny Machine Learning Kit

El Arduino Tiny Machine Learning Kit es una herramienta completa para principiantes interesados en aprender sobre el aprendizaje automático embebido, al incluir desde una placa Arduino hasta una cámara y varios sensores. Con este kit, los usuarios pueden desarrollar proyectos de aprendizaje automático embebido, como detectores de gestos, clasificadores de imágenes o monitores de temperatura.



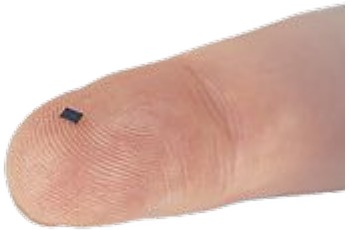
Link of courses

https://linktr.ee/csimbio

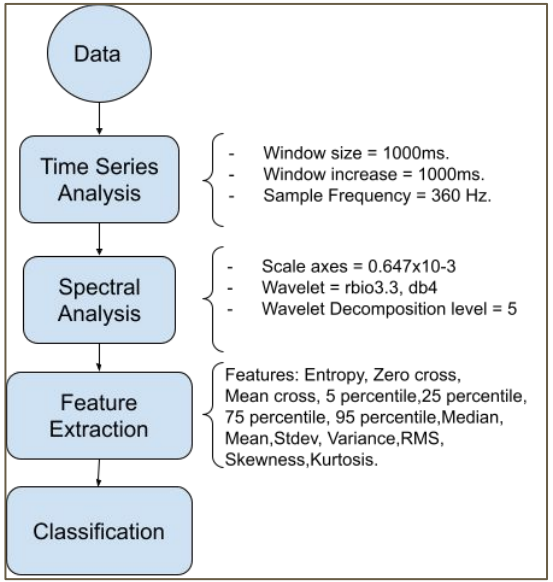
https://github.com/sofia-is-a-panda/ISB_2024_G3/tree/main/ISB/Laboratorios/Laboratorio%204

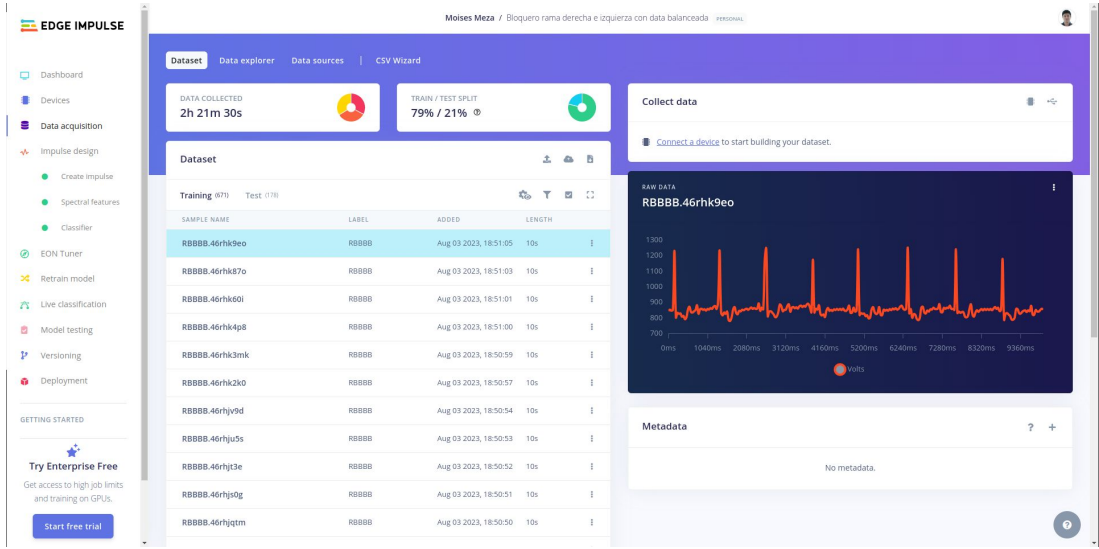
https://github.com/Melanyccb11/Intro_senales/blob/main/ISB/Laboratorios/3.%20Adquisi%C3%B3n%20de%20Se%C3%B1ales%20EMG/3.%20Adquisi%C3%B3n%20de%20Se%C3%B1ales%20EMG.md

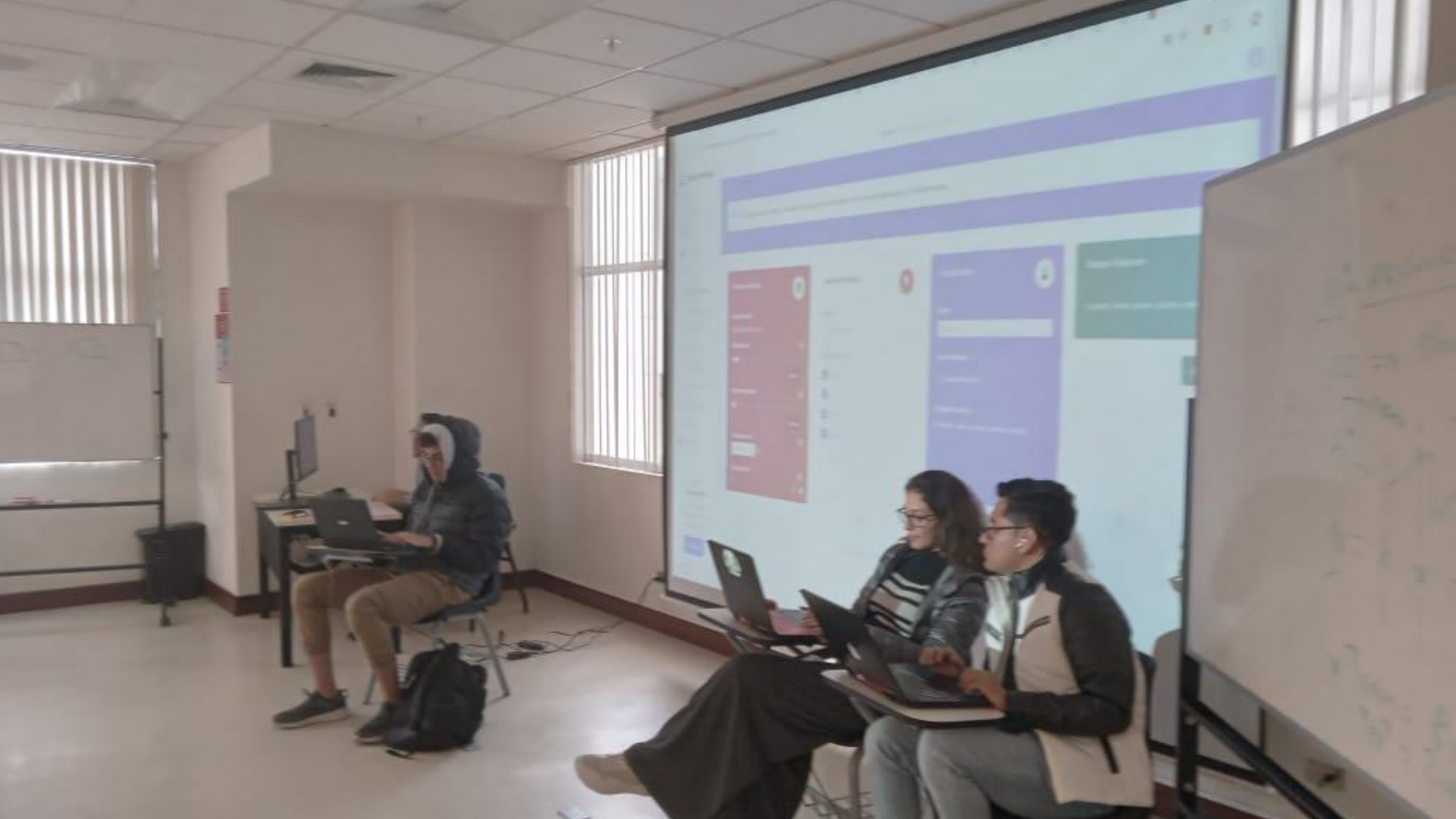
The Future of ML is Tiny and Bright

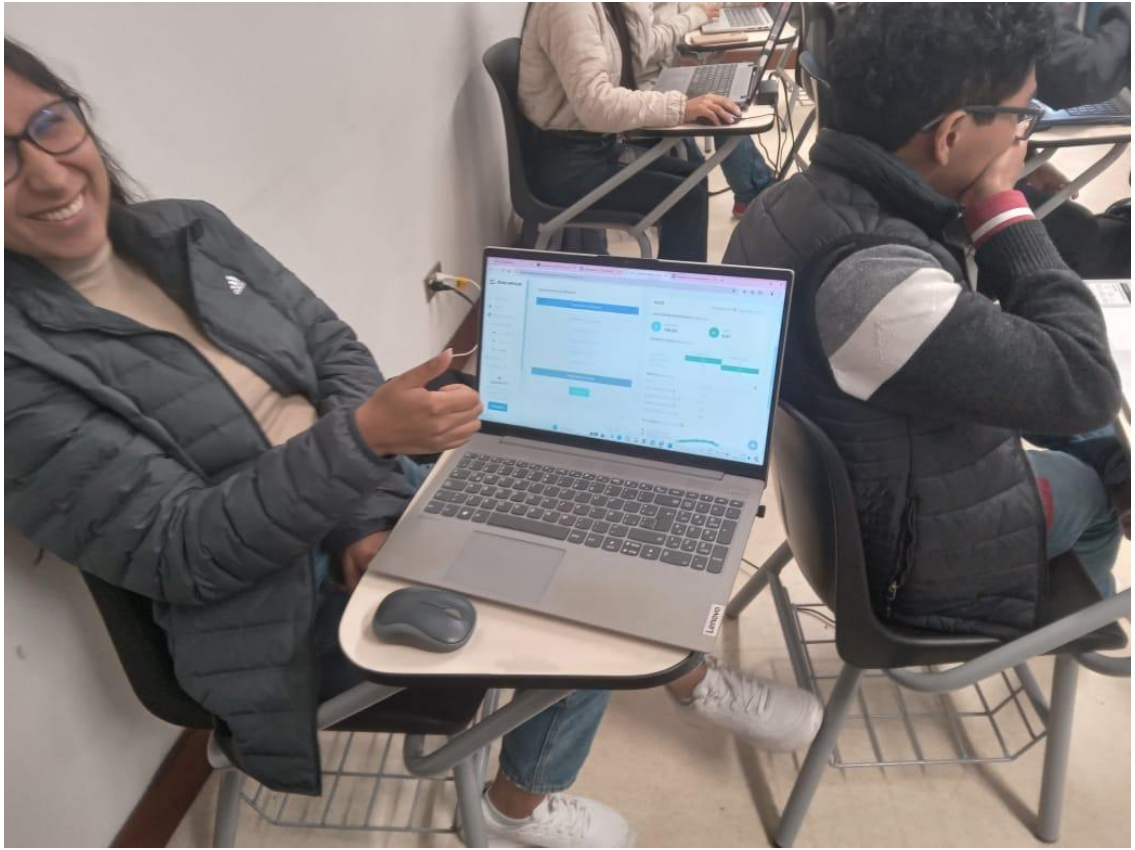


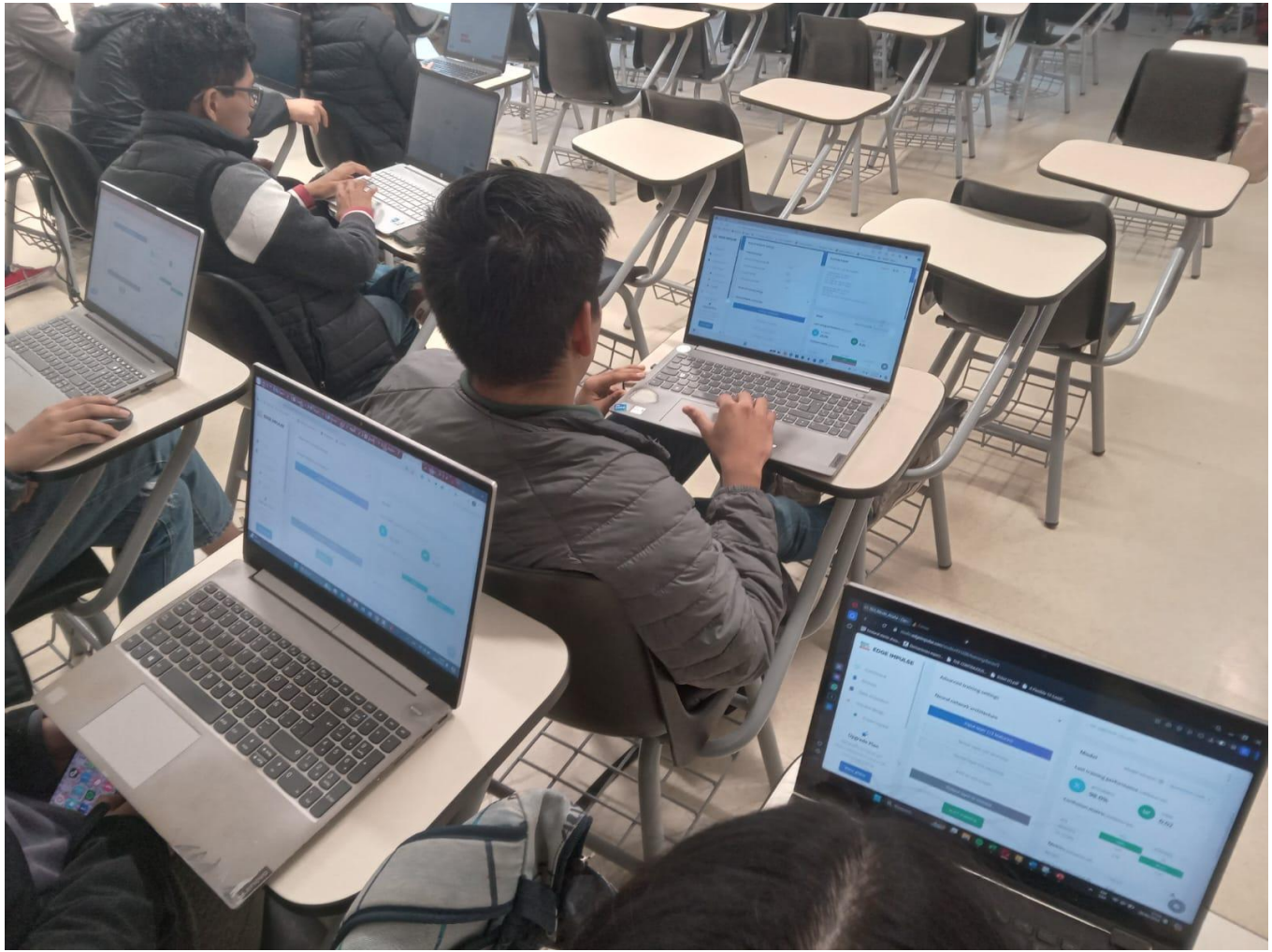
Edge impulse





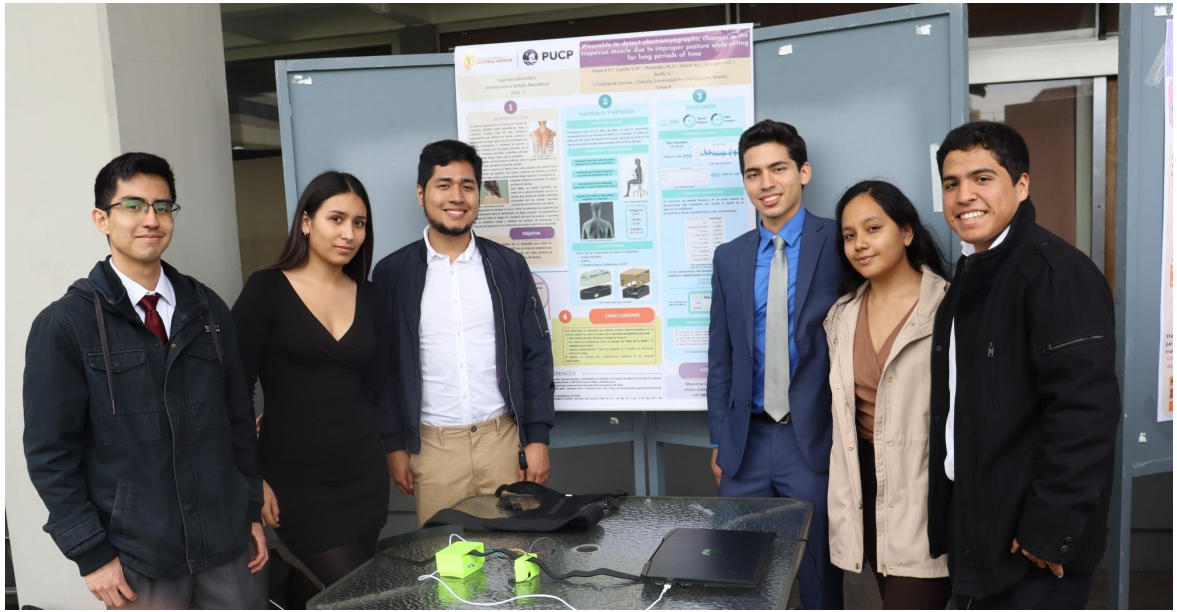






Feria de pósteres del curso Introducción a Señales Biomédicas

#SOYCAYETANO



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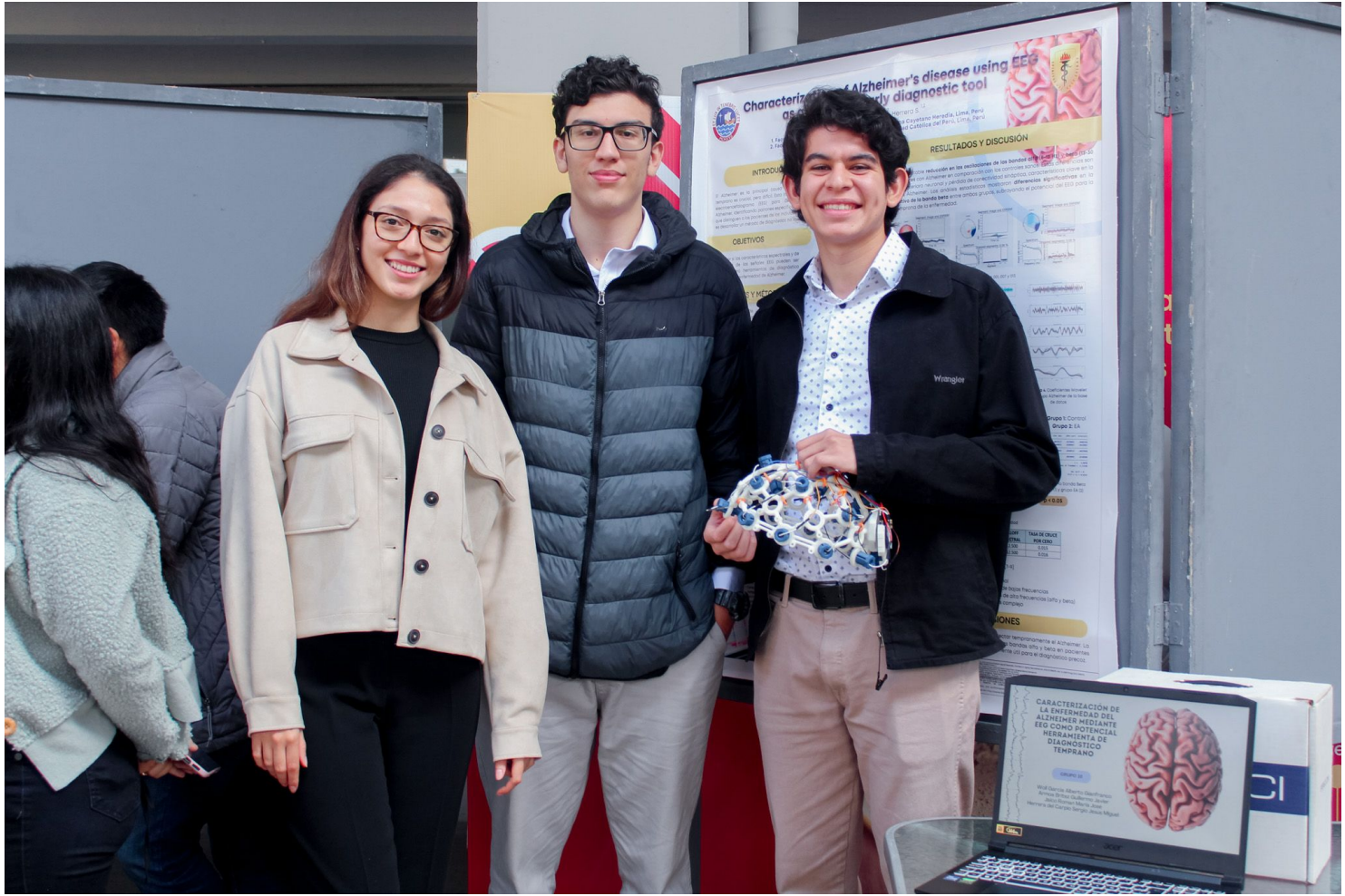
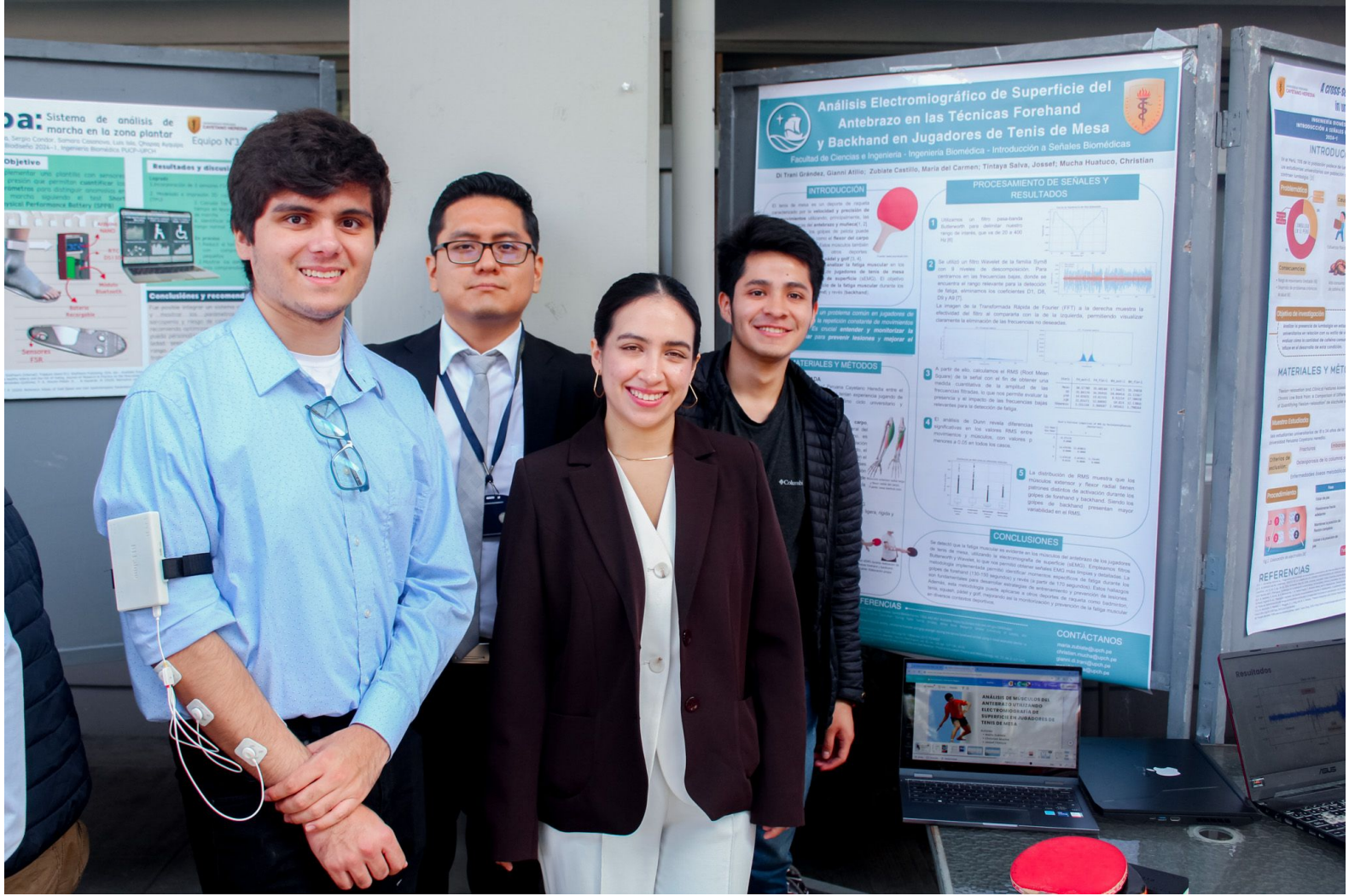

RESULTADOS Y DISCUSIÓN
OBJETIVOS
CARACTERIZACIÓN DE LA ENFERMEDAD DEL ALZHEIMER MEDIANTE EEG COMO POTENCIAL HERRAMIENTA DE DIAGNOSTICO TEMPRANO


Análisis Electromiográfico de Superficie del Antebrazo en las Técnicas Forehand y Backhand en Jugadores de Tenis de Mesa
Facultad de Ciencias e Ingeniería - Ingeniería Biomédica - Introducción a Señales Biomédicas
INTRODUCCIÓN
PROCESAMIENTO DE SEÑALES Y RESULTADOS
CONCLUSIONES
CONTÁCTANOS
REFERENCIAS

The didactic experience in a biomedical engineering course at a Peruvian university

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Lewis De La Cruz ; Moises Meza-Rodriguez ; José Alonso Cáceres-DelAguila ; Paulo Vela-Anton **All Authors**

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Abstract

Document Sections

I. Introduction

II. About the Course "Introduction to Biomedical Signals"

III. Methodology

IV. Results

V. Discussions

Authors

Figures

References

Keywords

Abstract:
The systematization of the didactic experience, delivered in a university course on the processing of biosignals, becomes relevant for continuous improvement in its subsequent editions. This applies both at the structural level and for enhancing the content of the course, not only in the theoretical aspect but also in practical aspects. The following study describes the experiences under a flipped learning approach obtained from questionnaires related to the student's perception of the delivery of the course "Introduction to Biomedical Signals", which is part of the biomedical engineering program offered by a Peruvian University during the 2023-I semester from March to July 2023. The course showed an overall evaluation over the average, demonstrating its adequate implementation and satisfaction of students. Qualitative questions captured the perception of students regarding how to improve the course experience as well.

Published in: 2023 IEEE 3rd International Conference on Advanced Learning Technologies on Education & Research (ICALTER)

Date of Conference: 13-15 December 2023

DOI: 10.1109/ICALTER61411.2023.10372910

Date Added to IEEE *Xplore*: 29 December 2023

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I. Introduction

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Development of an electrocardiographic signal classifier for bundle branch blocks, applying Tiny Machine Learning

Meza-Rodriguez, Moises; De La Cruz, Lewis; Caceres-Delaguila, Jose Alonso

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[a] Universidad Peruana Cayetano Heredia, Laboratorio de Ingenieria Biomédica, Lima, Peru

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Abstract

cardiovascular diseases are still the pathologies that generate the highest mortality and economic costs globally. In Latin America, low-income populations are the most vulnerable. Singularly, this population has an incidence of endemic diseases that can lead to blocks of the bundle branch of His. The following study seeks to develop a cardiac abnormality detection system using machine learning techniques and microcontrollers with limited resources to benefit populations with limited access to health environments. The Arduino Nano 33 BLE Sense is employed as the hardware platform due to its ARM Cortex M4 processor and support for TensorFlow Lite. An electrocardiogram (ECG) database is processed using oversampling and under-sampling techniques to address class imbalance. Spectral features are extracted using wavelet transforms, and a multilayer neural network is implemented for classification. Two class balancing approaches are compared: oversampling and undersampling. Results indicate notable improvements in the model's ability to identify instances of minority classes with the oversampling approach, while undersampling may lead to information loss. The system's performance is evaluated using key metrics such as precision, recall, and F1-Score. Additionally, computational resources required to implement the model on the Arduino Nano 33 BLE Sense are estimated, with an assessment of Flash and RAM consumption. This analysis is essential to ensure the feasibility of implementation on resource-constrained devices. This work contributes to the advancement of early detection of cardiac anomalies in resource-limited settings, with significant implications for healthcare in underserved communities and rural areas. © 2023 IEEE.

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ECG-based identification and classification of myocardial infarction | 基于心电图的心肌梗死识别分类研究
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(2022) Chinese Journal of Medical Physics

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Fabricante:

Roberto Edu Joao Marin Vera

Moises Stevend Meza Rodriguez

Fecha de revisión del manual del usuario:

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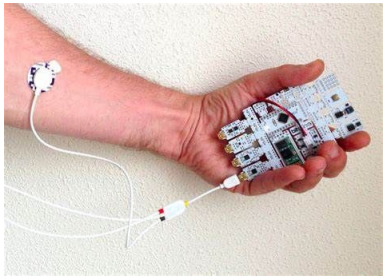
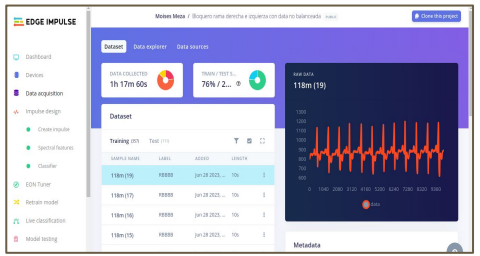
Lima - Perú

2024





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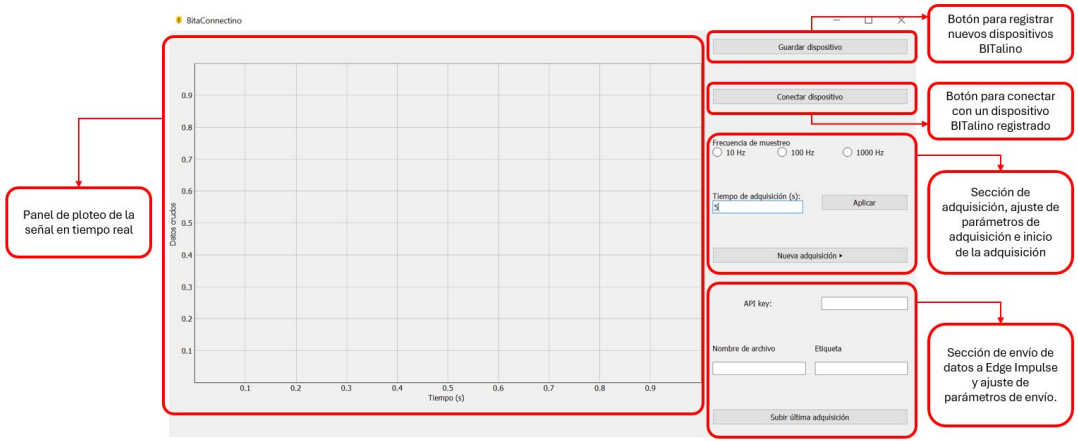
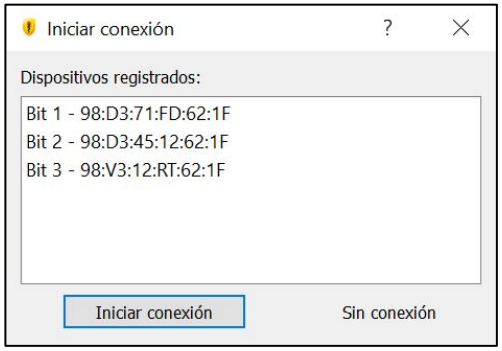
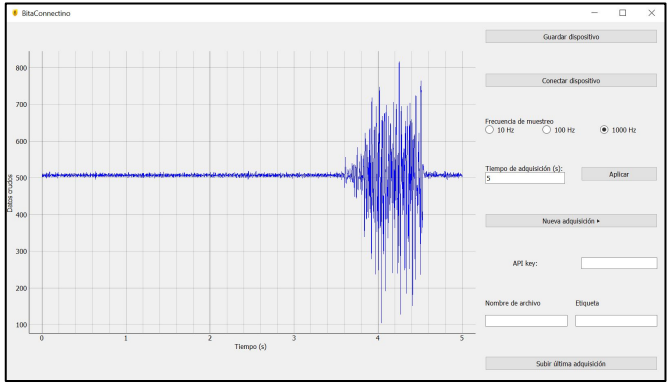
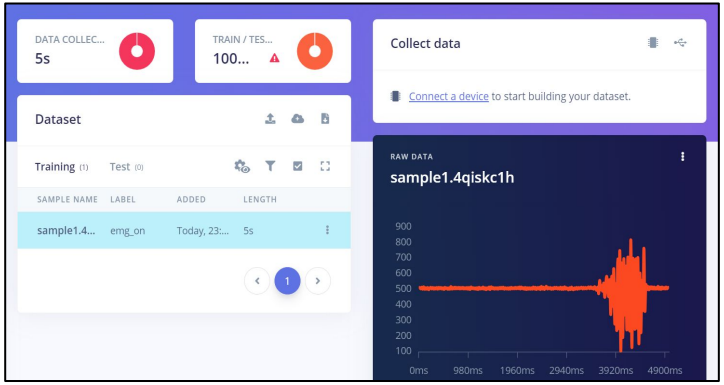








What's more?

Estudiantes de la carrera de Ingeniería Biomédica PUCP-UPCH expusieron su proyecto de curso en evento del TinyML4D, red académica internacional a la cual Cayetano pertenece

#SOYCAYETANO

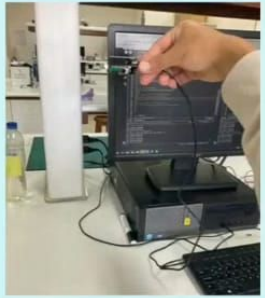
TinyML4D Show and Tell

The TinymML4D Academic Network Show and Tell is an opportunity for students from around the globe to share all of your exciting TinyML projects!

Recordings of Past Show and Tells

All Show and Tell Videos can be found at this playlist or this playlist

Date	Topics	Video Link
March 28th, 2024	1. **Enhancing poultry health management through Tiny machine learning-based analysis of bird sounds** by Abdul Moshen, Abdul Aziz, Saleh Jabe, Abdul Rahman, Ramasamy of King Faisal University, Saudi Arabia 2. **Advancing TinyMLOps: Robust Model Updates in the Internet of Intelligent Vehicles** by Thommas Kevin Sales Flores of Federal University of Rio Grande do Norte Brazil	Video
Feb 29th, 2024	1. **Revolutionizing Bee Keeping** by Rahul Mangharam of University of Pennsylvania, USA 2. **Artficial Visual Aid for the Blind** by Collins Bett of Multimedia University of Kenya 3. **TinyML and lung sound disease detection** by Abadade Youssef of IBN Tofail University Morocco	Video
October 26th, 2023	1. **ML self driving RC car** by William, Andrew of GearbotsBC STEM Academy 2. **Spiking Perception and processing for Intelligent Detection of Pedestrians on urban Roads** by Cristian Axenie of Nuremberg Institute of Technology, Germany	Video
September 28th, 2023	1. **LoRa interactions with the SeedStudio LoRa module Grove-Wio-E5 ready for ML Data Transfer** by Andres Oliva Trevisan of Argentina, Instituto Balseiro and ICTP 2. **TinyML model for fault classification of solar photovoltaic modules** by Adel Mellit of University of Jijel, Algeria	Video
August 31th, 2023	1. **Innovative Waste Classification through Tiny Machine Learning Recognition Approach** by Juan Manuel Mena Carrillo of Universidad Peruana Cayetano Heredia, Perú 2. **An AI powered device that detects seizures and alerts caretakers in real time** by Nickson Kiprotich of Dedan Kimathi University of Technology, Kenya 3. **Deploying a fetal heart rate classification model on RP2040 Microcontroller** by Shahzaib Ali of National Universit of Science and Technology, Pakistan	Video
May 25, 2023	1. **Inference With TinyML On Ghana Radio Astronomy Observatory (GRAO) 32-m Antenna: Track Level Profile Anomaly for Predictive Maintenance** by Joseph Akubire Kojo of Ghana 2. **A Multiply-And-Max/min Neuron Paradigm for Aggressively Prunable Deep Neural Networks** by Philippe BICH of Italy	Video Coming Soon!
March 30, 2023	1. **Automation of Coloring Process in Fashion Design Using Arduino Color Sensor** by Fatmaliza Zaki Abdad, Syafiga Arinda of Sampoerna University, Indonesia 2. **Anomaly detection for faulty motor using the arduino board Nano 33 BLE sense** by Hilal Al-Libawy of University of Babylon, Iraq 3. **First Time TinyML Experience** by Edwin Marte of Universidad Tecnologica de Santiago, Dominican Republic 4. **Voice Activated LED Voice control lighting** by Muhammad Annas Zahid of Usman Institute of Technology University, Pakistan	Video
February 23, 2023	1. **Artificial Intelligence in Point-of-Care Medical Equipment** by Hellen Cristina Ancelmo of Instituto Carlos Chagas & Universidade Tecnológica Federal do Paraná, Brazil 2. **Weep Scope: Recognizing the Unique Cries of Infants** by Gohel Amit Chandrakantbhai of Gujarat Technological University, India 3. **Crops Disease Detection with TinyML** by James Adeola of Université d'Abomey Calavi, Benin 4. **Implementation of Deep Learning on a Chick Counter** by Muhammad Suzaki Zahran of Universitas Raharja, Indonesia 5. **Identification of Cashew Nut Diseases using TinyML** by Dr. Bala Murugan MS of Vellore Institute of Technology, India	Video
January 26, 2023	1. **Personal Trainer** by Ricardo Magno do Carmo Junior of Universidade Federal de Itajubá (UNIFEI), Brazil 2. **Irrigation prediction for crops using machine learning at the edge** by Carlos Rodríguez of Pontificia Universidad Javeriana, Colombia 3. **EYE TO EYE: non-invasive anemia detector using machine learning** by Kimberly Cristel Soto Concha of Universidad Peruana Cayetano Heredia 4. **Estimating the shelf life of date palm fruit using TinyML** by Abdulrahman Fayez of King Faisal University Saudi Arabia	Video



Output Serial Monitor

Message (Enter to send message to 'AI Thinker ESP32-CAM' on 'COM5')

```
No objects detected
No objects detected
No objects detected
No objects detected
No objects detected
```

Message (Enter to send message to 'AI Thinker ESP32-CAM' on 'COM5')

```
 > BBox of label bottle at (8, 16), size 8 x 16
Found 1 objects in 188 millis
 > BBox of label bottle at (8, 16), size 8 x 16
Found 1 objects in 188 millis
 > BBox of label bottle at (8, 16), size 8 x 16
```

UNIVERSIDAD PERUANA CAYETANO HEREDIA

25/28

Google Meet

Juan Manuel Mena Camilo

web.telegram.org/k/#@TinyML_Peru

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June 12, 2024

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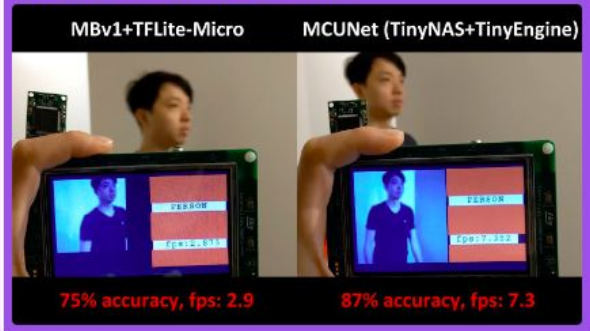
A live visual wake word demo using MCUNet on a $10 microcontroller. MCUNet with TinyNAS and TinyEngine achieves 12% higher accuracy and 2.5× faster sp...



18:51

Most of them use OpenMV board *edited* 18:51

Хайзенберг
and I have money no, I 1K rubles rest on the internet, and such fee like 15K rubles worth

Message

Group Info

TinyML Perú
76 members

Comunidad peruana orientada al estudio y difusión del Embedded Machine Learning/TinyML.
Info

t.me/TinyML_Peru
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Intro

Difusión de avances en el área del Embedded Machine Learning/TinyML.

Page · Science & Tech

Ugartino, Vargas Machuca 503, Lima 15102

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June 9

🌟 Nuevo articulo sobre TinyML y LLMs 🌟

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🌟Recomendación de "Fundamentals of Tiny

...

SPECIAL THANKS

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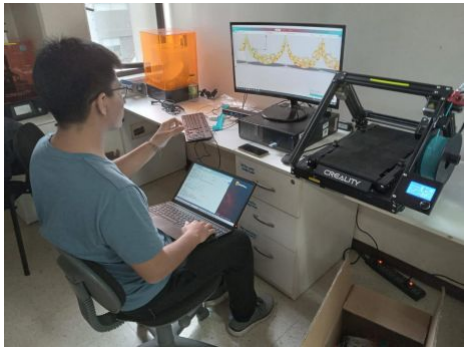
Laboratorio de ing. Biomédica



THANKS