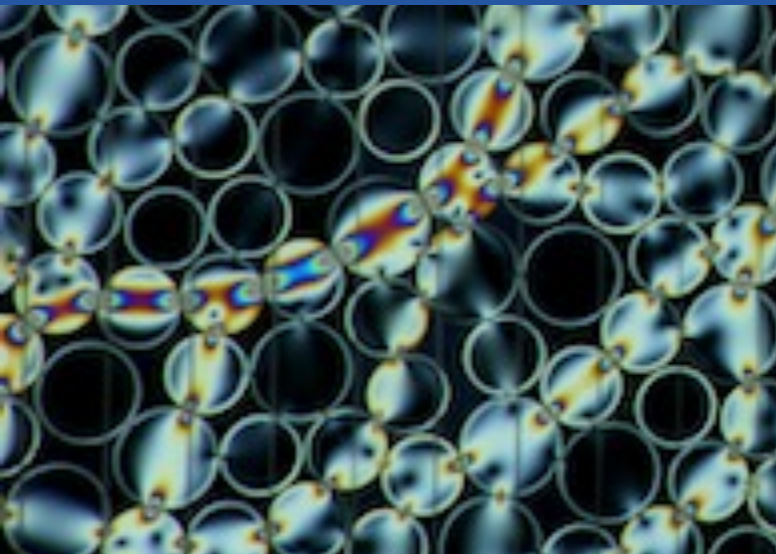


From TinyML to EdgeAI: A Network of 50+ Universities Building Local Intelligence



Marco Zennaro, PhD
Research Scientist
mzennaro@ictp.it



The Abdus Salam
**International Centre
for Theoretical Physics**



TinyML Academic Network

We aim to develop a **community of researchers** and practitioners focused on both **improving access to TinyML education** and enabling **innovative solutions** for the unique challenges faced by Developing Countries.

- Joint workshops and seminars on TinyML
- An online forum to consolidate the TinyML community
- Open exchange of student projects, lesson plans, real-world deployments and outreach materials

TinyML and Development

ICT4D researchers claim that there are four technological requirements for an ICT4D project to be successful:

Autonomous Connectivity → No connectivity needed!



Low-cost equipment → 10USD for a complete device



Power resilience → Extremely low power by design

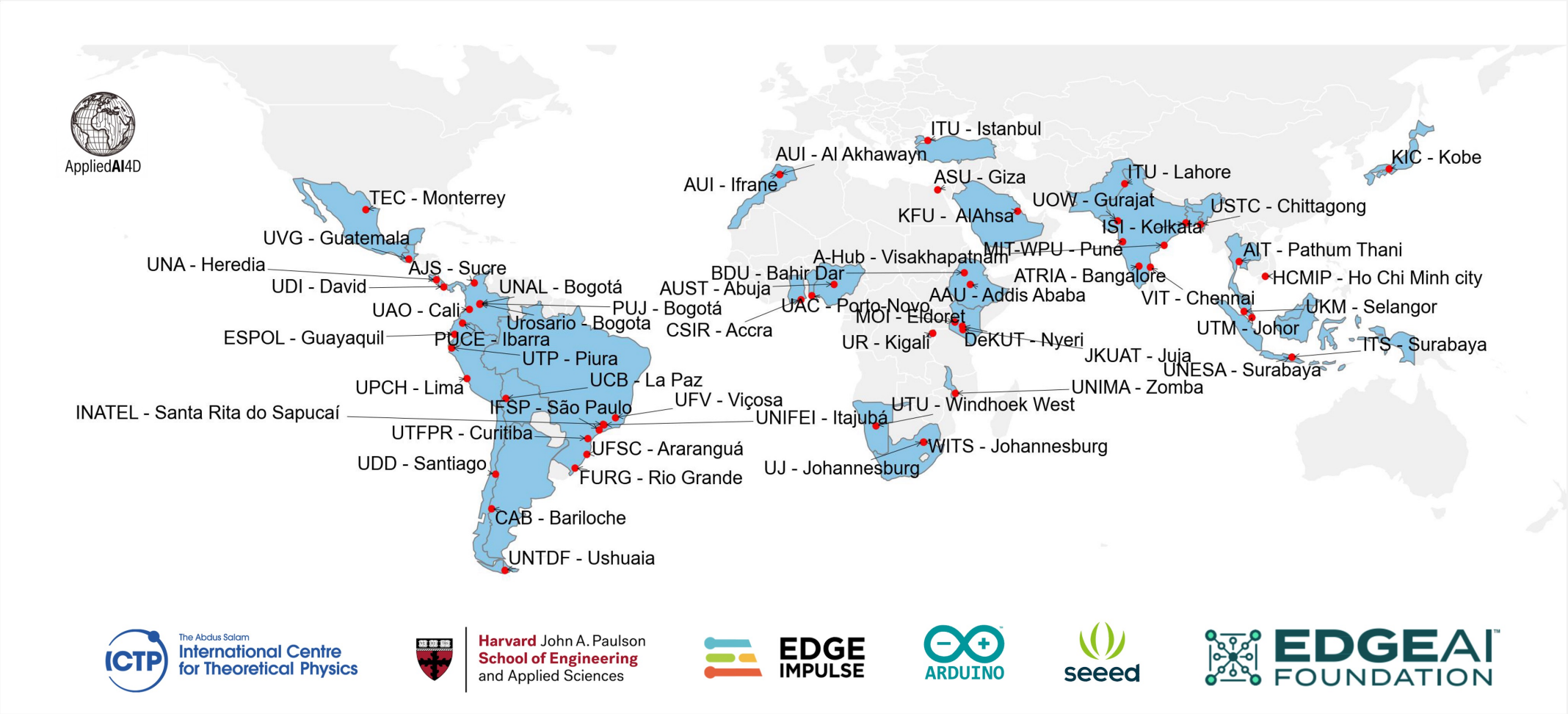


Appropriate User Interface → No interface



Brewer, Eric, et al. "The case for technology in developing regions." *Computer* 38.6 (2005): 25-38.

TinyML Academic Network



SciTinyML: Scientific Use of Machine Learning on Low-Power Devices

18 - 22 October 2021
An ICTP Virtual Meeting
Trieste, Italy

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Organiser:
A. J. J. J. J.

Speakers:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th October 2021.

Registration:
There is no registration fee.

Deadline:
8 October 2021

ICTP

African Regional Workshop on SciTinyML: Scientific Use of Machine Learning on Low-Power Devices

18 - 22 October 2021
Online

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th October 2021.

Registration:
There is no registration fee.

Deadline:
8 October 2021

ICTP

Asian Regional Workshop on SciTinyML: Scientific Use of Machine Learning on Low-Power Devices

18 - 22 October 2021
Online

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th October 2021.

Registration:
There is no registration fee.

Deadline:
8 October 2021

ICTP

Latin American Regional Workshop on SciTinyML: Scientific Use of Machine Learning on Low-Power Devices

18 - 22 October 2021
Online

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th October 2021.

Registration:
There is no registration fee.

Deadline:
8 October 2021

ICTP

Workshop on Scientific Use of Machine Learning on Low-Power Devices: Applications and Advanced Topics

17 - 21 April 2023
An ICTP Virtual Meeting
Trieste, Italy

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th April 2023.

Registration:
There is no registration fee.

Deadline:
7 April 2023

ICTP

ICTP-UNU Workshop on TinyML for Sustainable Development

AN ICTP 60th ANNIVERSARY SATELLITE EVENT

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
TinyML, a new technology that allows machine learning models to run on low-cost, low-power microcontrollers. This technology has a significant role in achieving the Sustainable Development Goals (SDGs) and in facilitating scientific research in areas such as environmental monitoring and the physics of complex systems.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th April 2023.

Registration:
There is no registration fee.

Deadline:
7 April 2023

ICTP

Workshop on Machine Learning on Low-Power Devices: Applications and Advanced Topics

17 - 21 April 2023
Online

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th April 2023.

Registration:
There is no registration fee.

Deadline:
7 April 2023

ICTP

Workshop on TinyML for Sustainable Development

17 - 21 April 2023
Online

ICTP

Directors:
• Prof. Vito Loia
• Prof. Massimo Di Lorenzo
• Prof. Roberto De Marco

Local Organiser:
Prof. Vito Loia

Description:
The TinyML, a subset of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed on an extremely low cost and of large scale.

Topics:
• Introduction to TinyML
• Scientific Applications of ML
• Research and Advanced Topics in TinyML

How to apply:
Online application is encouraged!
Please submit your application by 15th April 2023.

Registration:
There is no registration fee.

Deadline:
7 April 2023

ICTP

More than 2000 people trained!

Workshop on Scientific Use of Machine Learning on Low-Power Devices: Applications and Advanced Topics



17 - 21 April 2023
An ICTP Virtual Meeting
Trieste, Italy

Further information:
<http://indico.ictp.it/event/10166/emr2832@ictp.it>

TinyML is a subfield of Machine Learning focused on developing models that can be executed on small, real-time, low-power, and low-cost embedded devices. This allows for new scientific applications to be developed at an extremely low cost and at large scale.

Directors:

S. PLANCHER, Barnard College, USA
V. J. REDDI, Harvard University, USA
M. ROYAL, Federal University of Rio de Janeiro, Brazil

Description:

TinyML represents a collaborative effort between the embedded power systems and Machine Learning communities, which traditionally have operated independently.

TinyML has a significant role to play in achieving the SDGs and facilitating scientific research in areas such as environmental monitoring, physics of complex systems and energy management.

The TinyML process starts with collecting data from IoT devices, then training the collected dataset to extract knowledge patterns; these patterns are then packaged into a TinyML model that considers the target microprocessor's limited resources such as memory, processing power, and energy.

Through hands-on examples, this workshop will focus on both introductory and advanced topics in TinyML to pave the way to the development of real-world applications.

Topics:

- Introduction to TinyML
- Getting Started with the TinyML Kit
- Examples of TinyML Applications
- The TinyML Development Workflow
- Scientific Applications of ML
- Recent Research and Advanced Topics in TinyML

Local Organiser:

M. ZENNARO, ICTP Italy

How to apply:

Online application:
<http://indico.ictp.it/event/10166/>

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Deadline:

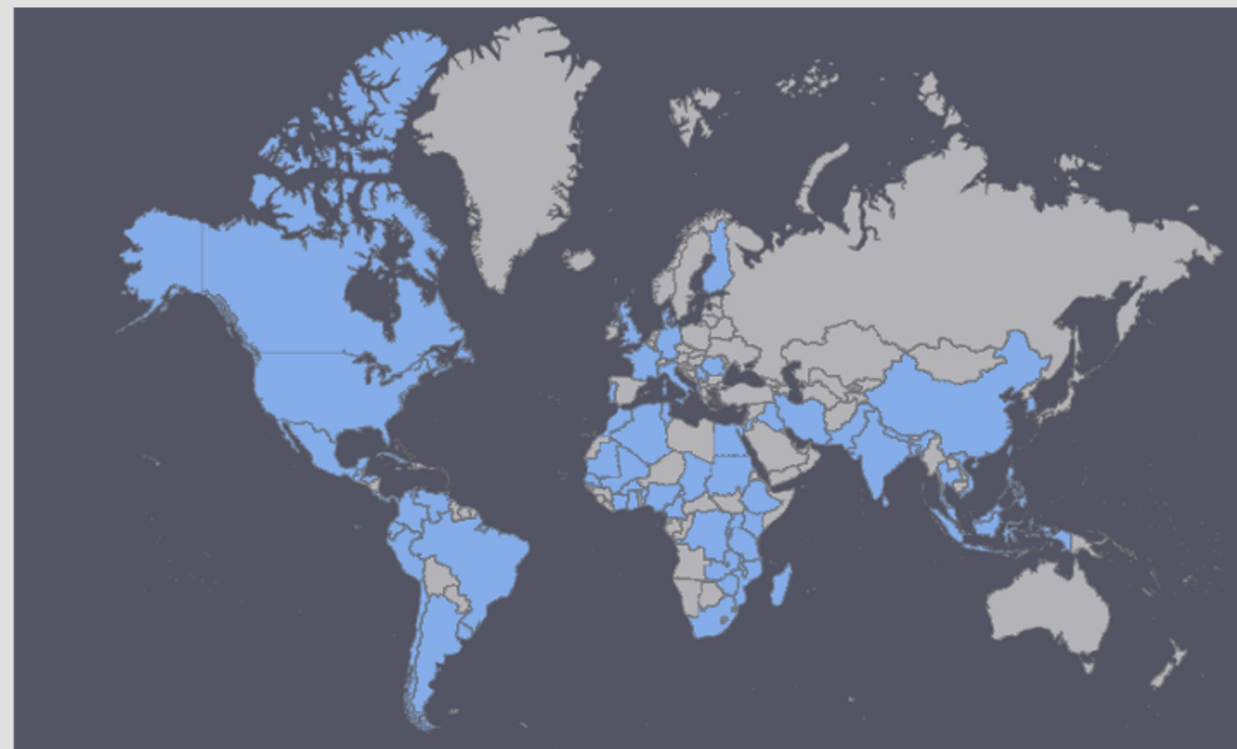
7 April 2023



Harvard John A. Paulson
School of Engineering
and Applied Sciences



The Abdus Salam
International Centre
for Theoretical Physics
www.ictp.it
Trieste, Italy



2023: 418 participants
from 72 countries

TinyML Academic Network

Timothy Kudzanayi Kuhamba

Thanx Marisa^{a*}, Munyaradzi Munochiveyi^{a*}, Wadzanai Julius Zondai^{a*}, Ramson Munyaradzi Nyamukondiwa^a, Isheanesu Newengo^b

Case Study Zimbabwe

A DEEP LEARNING BASED APPROACH FOR
FOOT AND MOUTH DISEASE DETECTION



VEGETABLE DISEASE AND INSECT PEST RECOGNITION BASED ON TINYML: Cotton Case in Benin

James O. ADEOLA
IMSP - UAC

Dr Marco
Zenaro
ICTP Italy

Dr Jules
DEGILA
IMSP Benin



TinyML Applications (Sound)

Classifying mosquito wingbeat sound using TinyML

Moez Altayeb
University of Khartoum, Sudan
ICTP, Trieste, Italy
mohedahmed@hotmail.com

Marcelo Rovai
Universidade Federal de Itajubá
Itajubá, Brazil
rovai@unifei.edu.br

Marco Zennaro
ICTP
Trieste, Italy
mzennaro@ictp.it

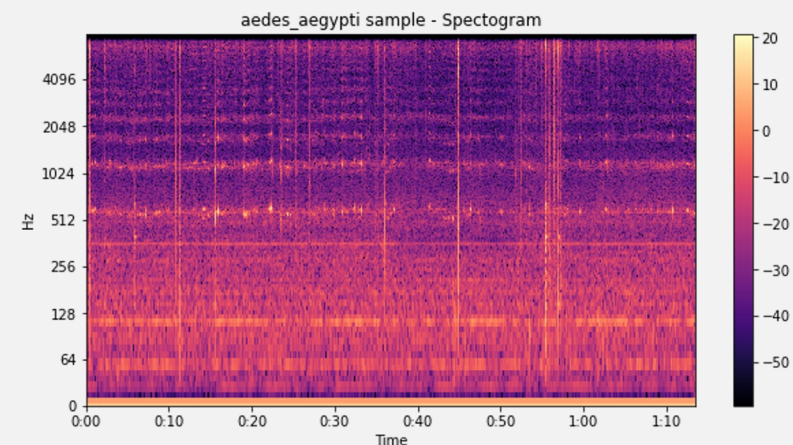
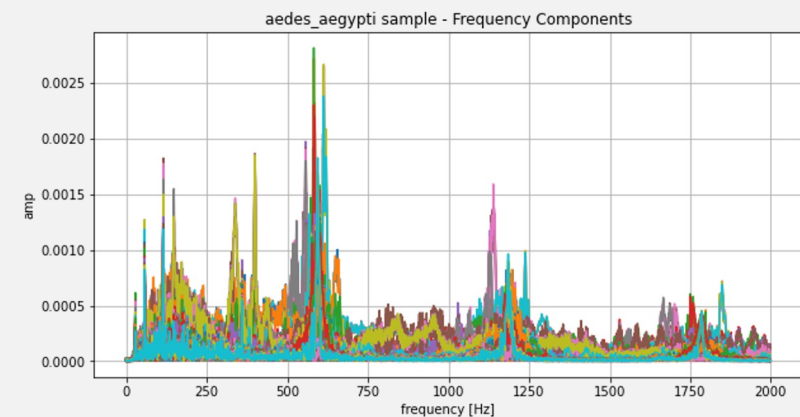
ABSTRACT

Every year more than one billion people are infected and more than one million people die from vector-borne diseases including malaria, dengue, Zika and Chikungunya. Mosquitoes are the best known disease vector and are geographically spread worldwide. It is important to raise awareness of mosquito proliferation by monitoring their incidence, especially in poor regions. Acoustic detection of mosquitoes has been studied for long and ML can be used to automatically identify mosquito species by their wingbeat. We present a prototype solution based on an openly available dataset, on the Edge Impulse platform and on three commercially-available TinyML devices. The proposed solution is low-power, low-cost and can run without human intervention in resource-constrained areas. This insect monitoring system can reach a global scale.

affected. People from poor communities with little access to health care and clean water sources are also at risk. Although anti-malarial drugs exist, there's currently no malaria vaccine.

Vector-borne diseases also exacerbate poverty. Illness prevents people from working and supporting themselves and their families, impeding economic development. Countries with intensive malaria have much lower income levels than those that don't have malaria.

Countries affected by malaria turn to control rather than eradication. Vector control means decreasing contact between humans and disease carriers on an area-by-area basis. It is therefore crucial to be able to detect the presence of mosquitoes in a specific area. This paper presents an approach based on TinyML and on low power embedded devices.



TinyML Applications (Vibration)

Open Access Article

Design and Development of a Family of Integrated Devices to Monitor Animal Movement in the Wild

by Laila Daniela Kazimierski^{1,*†}, Andrés Oliva Trevisan^{2,3,†}, Erika Kubisch⁴, Karina Laneri¹ and Nicolás Catalano^{2,3}

¹ Consejo Nacional de Investigaciones Científicas y Técnicas, Centro Atómico Bariloche (CONICET), Comisión Nacional de Energía Atómica (CNEA), San Carlos de Bariloche R8402AGP, Argentina

² Centro Atómico Bariloche, Comisión Nacional de Energía Atómica (CNEA), San Carlos de Bariloche R8402AGP, Argentina

³ Instituto Balseiro, Universidad Nacional de Cuyo, Comisión Nacional de Energía Atómica (CNEA), San Carlos de Bariloche R8402AGP, Argentina

⁴ Instituto de Investigaciones en Biodiversidad y Medioambiente, Consejo Nacional de Investigaciones Científicas y Técnicas (INIBIOMA, CONICET-Universidad Nacional del Comahue), San Carlos de Bariloche R8400AGP, Argentina

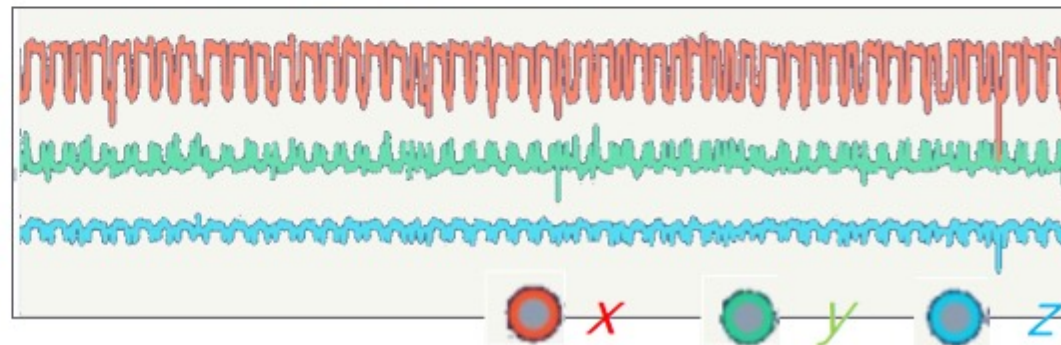
* Author to whom correspondence should be addressed.

† These authors contributed equally to this work.

<https://www.mdpi.com/1424-8220/23/7/3684>



**Example of
accelerometer
signal of a female
digging a nest to
lay eggs:**



TinyML Applications (Vision)

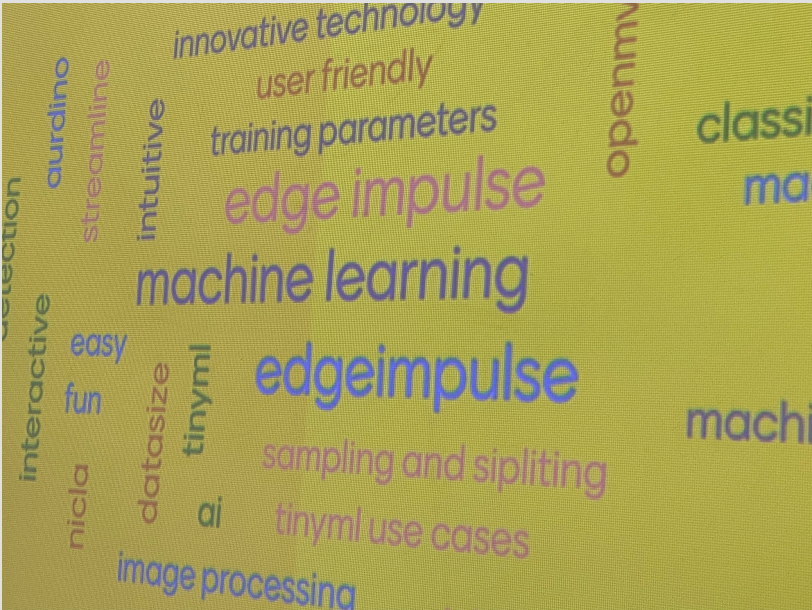
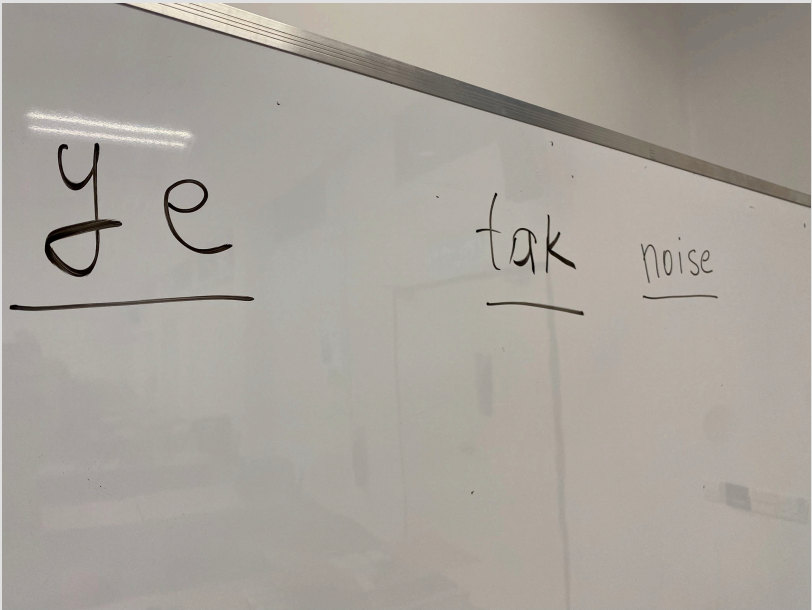


<https://www.hackster.io/Yukio/coffee-disease-classification-with-ml-b0a3fc>

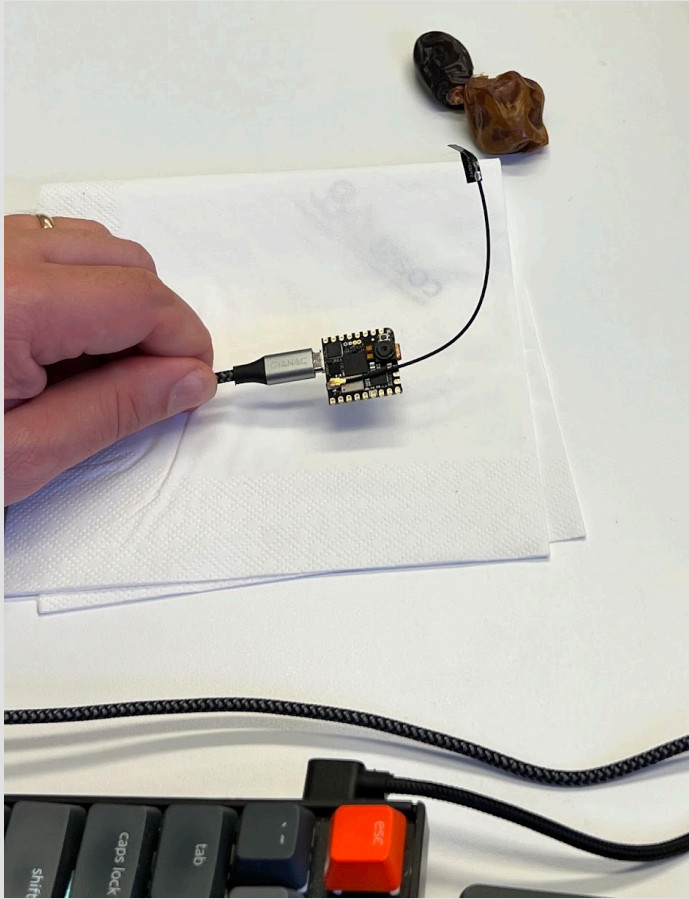
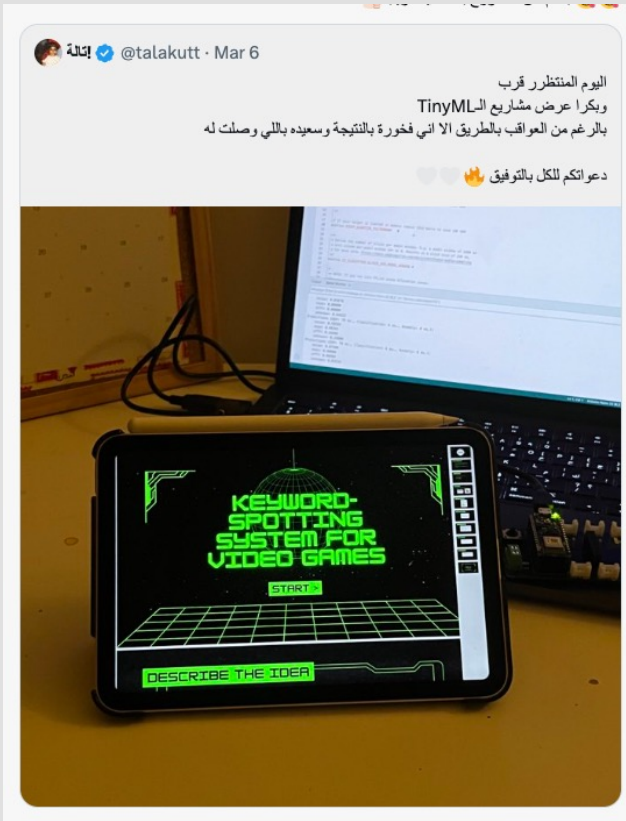
Workshops

“Tell me and I forget, teach me
and I may remember, involve me
and I learn.”

~~Benjamin Franklin~~
Xun Kuang

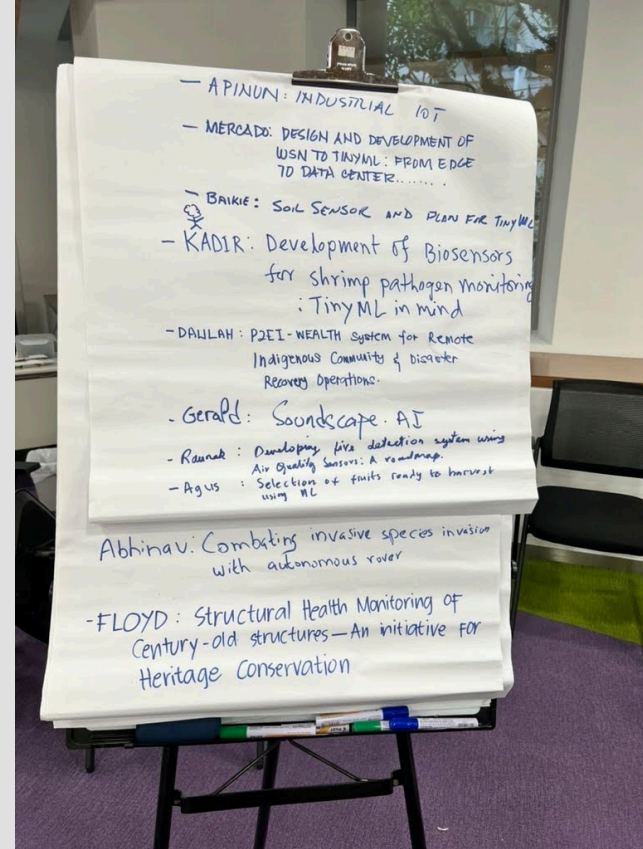


Malaysia 2023



KAUST 2023

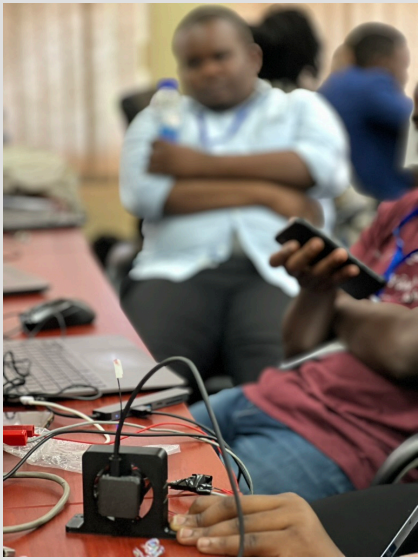
Macau 2024



Brazil 2024



Malawi 2025



Policy recommendations for TinyML

1. Invest in Local Capacity Building for Embedded AI

Support national and regional programs that develop local expertise in embedded AI through universities, vocational training, and continuing education. Prioritize funding for curricula co-developed with global partners like the TinyML Academic Network.

2. Promote Open, Low-Cost Infrastructure for TinyML Deployment

Subsidize access to open-source TinyML tools and low-power hardware for use in schools, research centers, and community projects. This lowers entry barriers and stimulates local innovation for SDG-related challenges.

Policy recommendations for TinyML

3. Integrate TinyML into National Digital and Innovation Strategies

Recognize TinyML as a key enabler of Edge AI for agriculture, health, climate monitoring, and education. Include TinyML in broader policies on digital transformation, AI governance, and smart infrastructure.

4. Fund Context-Aware Pilot Projects in Key Development Sectors

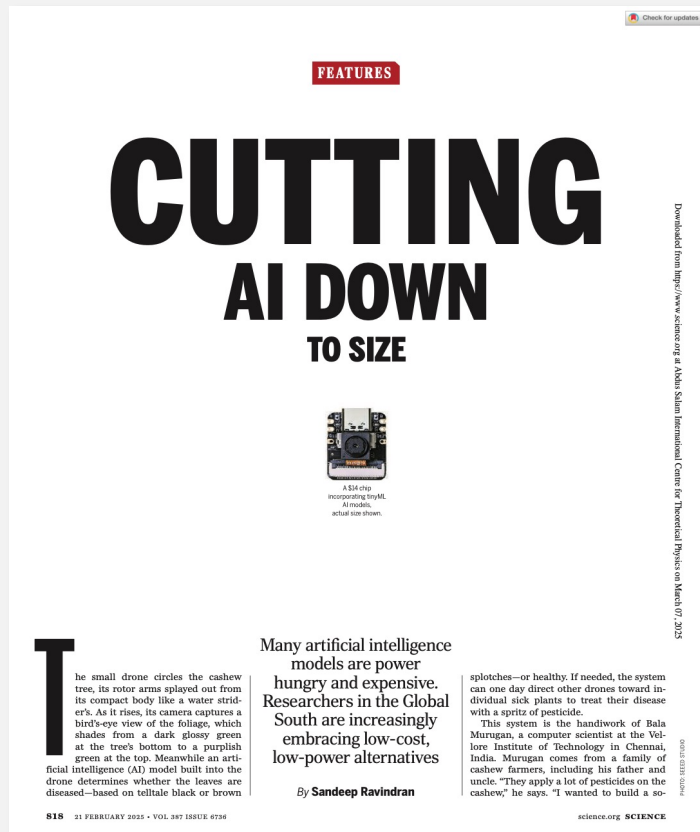
Support the scaling of pilot projects that apply TinyML to real-world needs—e.g., disease-vector monitoring, air quality sensing, or precision irrigation. Fund projects that demonstrate impact, replicability, and local ownership.

Policy recommendations for TinyML

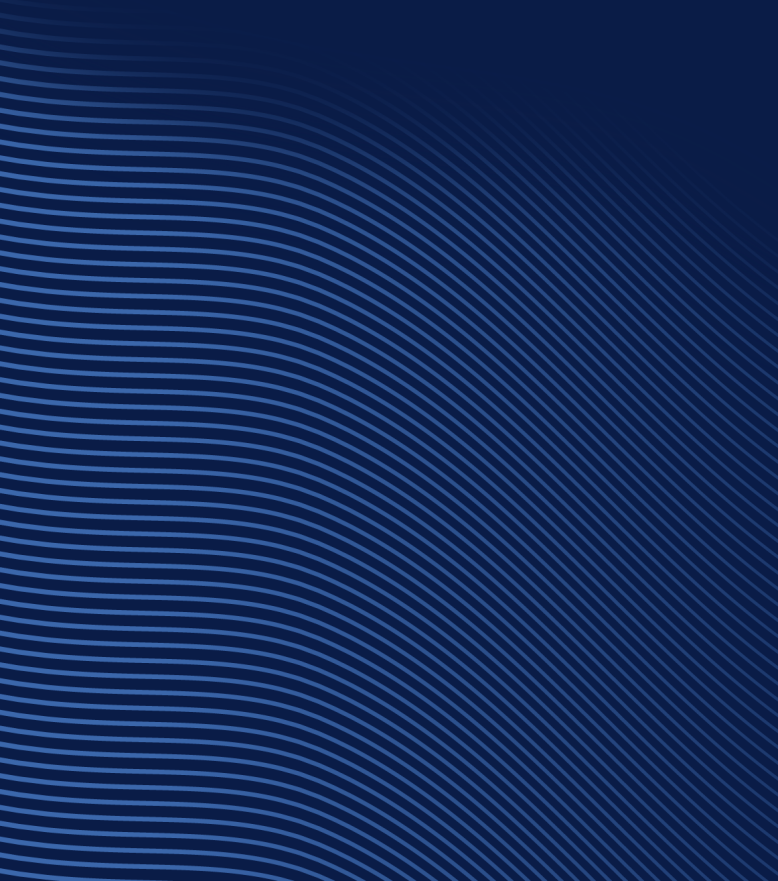
5. Facilitate Regional Collaboration and Knowledge Sharing

Encourage South-South cooperation by funding regional centers of excellence and networks that share training resources, datasets, and deployment best practices, building on the TinyML4D community model.

TinyML Academic Network in Science



<https://www.science.org/doi/epdf/10.1126/science.adw7713>



Thank you