TinyMLedu: The Tiny Machine Learning Open Education Initiative

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ABSTRACT

TinyML is a cutting-edge field that brings the transformative power of machine learning (ML) to the performance and power-constrained domain of embedded systems. This opens new avenues of opportunity for a smarter and cheaper internet of things (IoT). TinyML is also a great educational tool as it touches on topics from across the computer science curriculum, ranging from machine learning to embedded systems. TinyMLedu is working to build an international coalition of researchers and practitioners advancing TinyML in the developing world, and to develop and share high-quality, open-access educational materials globally. To date, we have helped launch two courses derived from our materials, taught in Portuguese in Brazil, held an outreach workshop for middle and high school teachers and students of the Navajo nation, and launched an Academic Network of over 20 universities from around the globe. Moving forward we want to grow our impact by helping develop more workshops and courses, in more languages, targeting an even broader audience, to introduce the world to TinyML.

CCS CONCEPTS

• **Social and professional topics → Computing education**.

KEYWORDS

Computing Education, TinyML, Applied Machine Learning, Embedded Systems, Open-Access Materials, Global Network

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1 BACKGROUND AND MOTIVATION

TinyML [2] is an application-driven field that explores deploying machine learning models on small, low-cost, low-power, devices like microcontrollers. This enables smarter IoT for all as ML models can now be used in remote locations to aid local populations regardless of their access to strong cellular networks or reliable electrical grids.

TinyML is also a great educational tool. By leveraging small models that can be trained on small datasets, it enables hands-on end-to-end applied ML classroom activities–from data collection to model deployment. These small models can be trained for free using services like Google Colaboratory or Edge Impulse and can be deployed onto low cost hardware. TinyML can also be integrated into courses and curricula as it touches on many computer science topics, ranging from machine learning to embedded systems.

To widen access to TinyML, we launched a free MOOC course series on the topic, open-sourced all of the course materials, and released a white paper describing its pedagogical approach [1]. However, feedback from the community revealed a need for further support to develop a wider range of locally-specific courses, seminars, and workshops, leading to the birth of TinyMLedu.

2 WORKING GROUPS AND EFFORTS

TinyMLedu is structured as a series of collaborative working groups, each making progress on different ways to widen access to TinyML.

TinyML4D develops content for, and a network of, researchers and practitioners focused on the unique challenges faced by Developing Countries. This year we launched an initial global network of 20 universities, arranged for sponsorship of microcontrollers for those universities, and ran an introduction to TinyML workshop with over 250 attendees from 46 countries.

TinyML4K12 explores ways to broaden the reach of TinyML education from universities to the K12 classroom. This spring we held an outreach workshop for middle and high school teachers and students of the Navajo nation, introducing them to the opportunities and challenges of AI, ML, and TinyML.

TinyML4STEM integrates TinyML into other STEM disciplines to develop exciting hands-on curricula. This summer we partnered with Backyard Brains to develop TinyML powered neuroscience activities for their summer program.

TinyML4Xlation works to translate materials for non-English speakers. We have already helped launch two courses taught in Portuguese in Brazil, and a third will be taught in Mozambique.

3 CONTRIBUTIONS AND FUTURE WORK

We developed an international coalition of academics and industry professionals to help widen access to TinyML educational resources. We hope to continue to expand our impact and reach and seek feedback on ways to improve, grow, diversify, and codify our efforts.

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REFERENCES

[1] Vijay Janapa Reddi, Brian Plancher, et. al. 2021. Widening Access to Applied Machine Learning with TinyML. arXiv:2106.04008 [cs.LG]
[2] Pete Warden and Daniel Situnayake. 2019. *Tinyml: Machine learning with tensorflow lite on arduino and ultra-low-power microcontrollers.* O'Reilly Media.

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