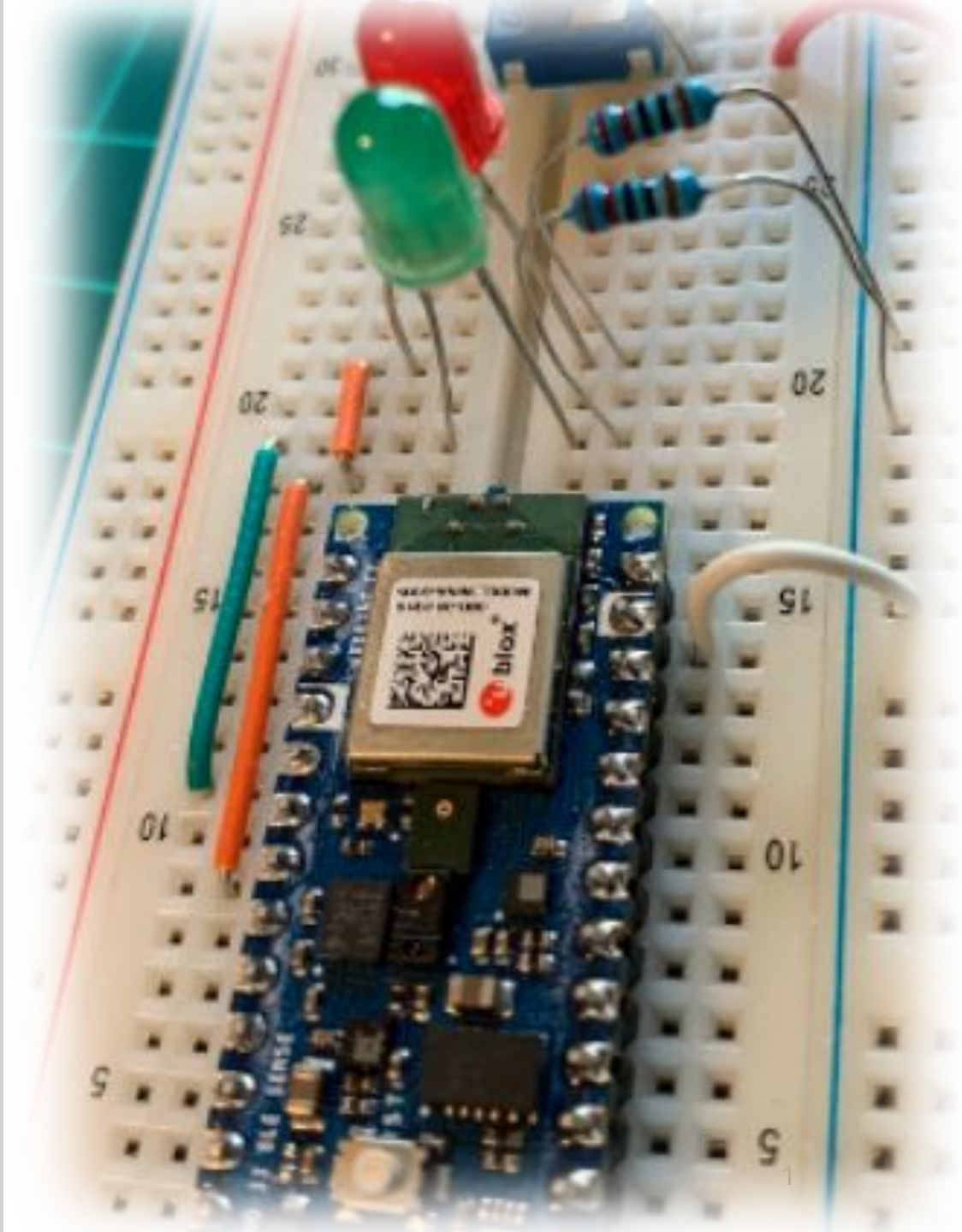
IESTI01 – TinyML

Embedded Machine Learning

Course Overview



Prof. Marcelo Rovai
UNIFEI

IESTI01 – TinyML course Overview

1. **Target**: Undergrad Engineering Students (mid to final semesters)
   - Electronics
   - Computing
   - Control & Automation
2. **Modality**: Hybrid -> Online classes + Self-Paced MOOC course at the platform: **Moodle**
3. **Capacity**: 30 students (Hybrid mode)
4. **Editions**: 4 (previous course editions in 2021 (2x) and 2022 were with online classes every week)
5. **Labs**: Students have the kits in their possession during all semester(*)
6. **Goal**: Course to give the basis, aiming to project development

(*) During Pandemic times, kits were sent to student's homes by mail

Part 1

Part 2

Fundamentals of TinyML

Applications of TinyML

Deploying TinyML

Background Requirements

Part 1

Part 2

- Python (own review)
- TensorFlow
- Google Colab
  - Jupyter Notebook

- Python
- TensorFlow (Lite)
- Google Colab
- Edge Impulse Studio

- Python
- TensorFlow (Lite-Micro)
- Google Colab
- Edge Impulse Studio
- IDE (as Arduino)
- C/C++

Challenge: The course combines **Computer Science** with **Engineering** (Electronics)

Hands-on Learning

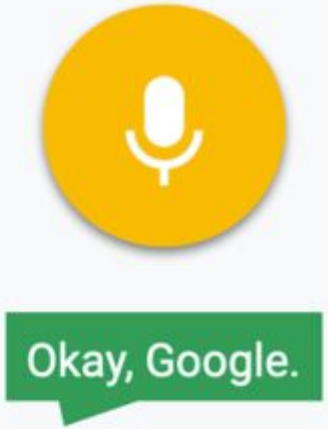
- Software
  - Python / C++
  - Machine Learning (TensorFlow)
  - Programming environments (Google Colab or Jupyter)
  - Edge Impulse Studio
- Hardware
  - Arduino Nano 33 BLE Sense
  - Seeed Wio Terminal
  - ESP / ESP-CAM (Optional)
  - Sensors

TinyML Arduino Kit

Wio Terminal Kit

Hands-on Activities

Speech



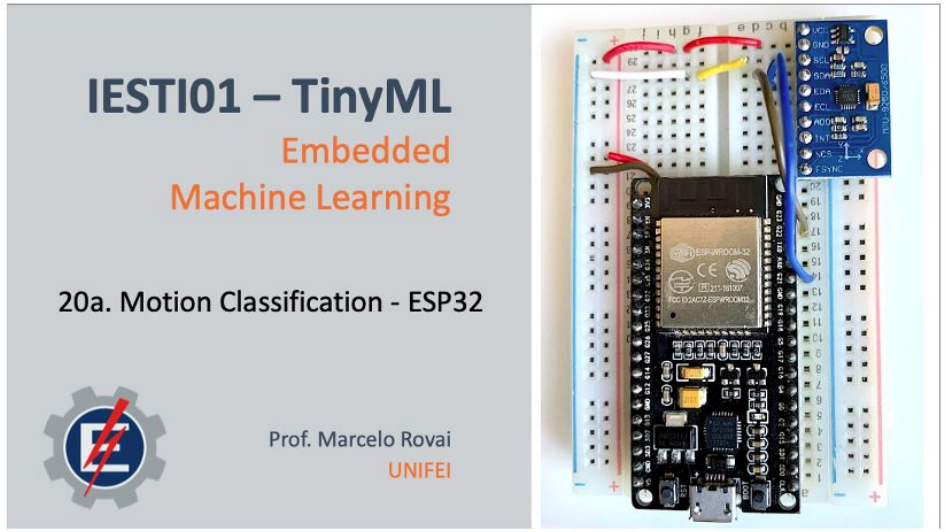
Vision

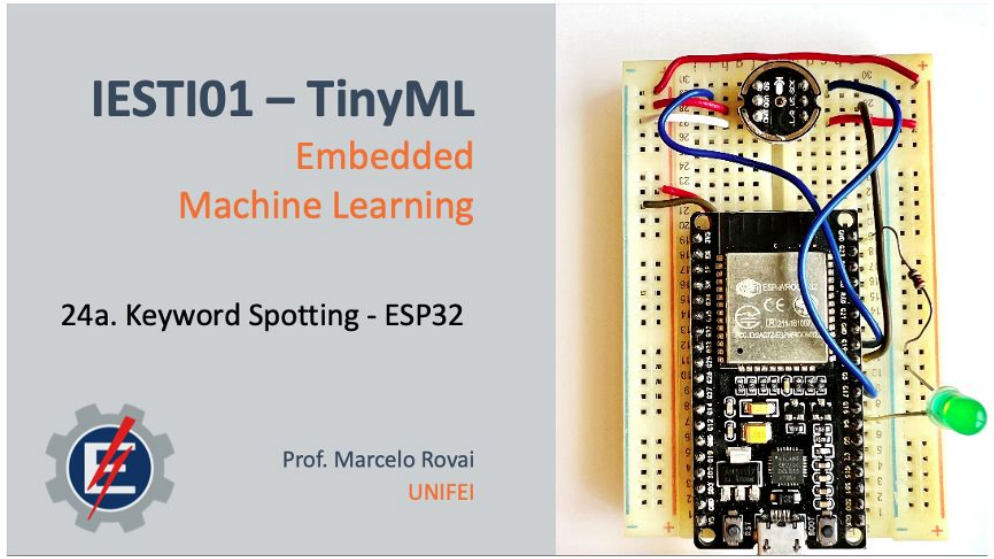
Cat – 0.92 Dog – 0.95

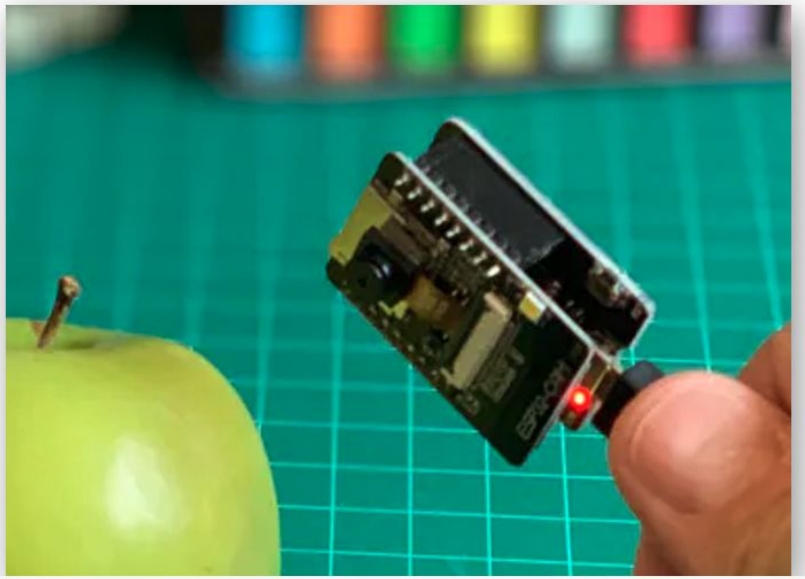
IMU

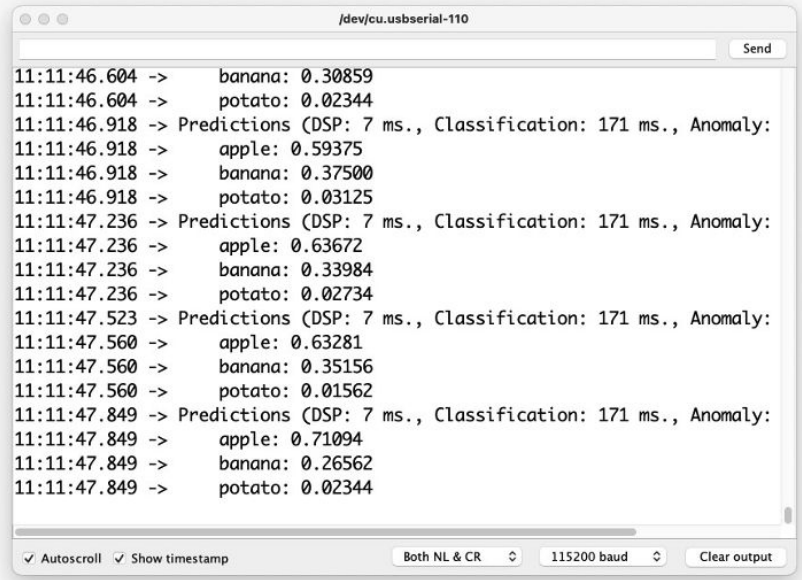
jupyter + CO +

Additional MCU examples

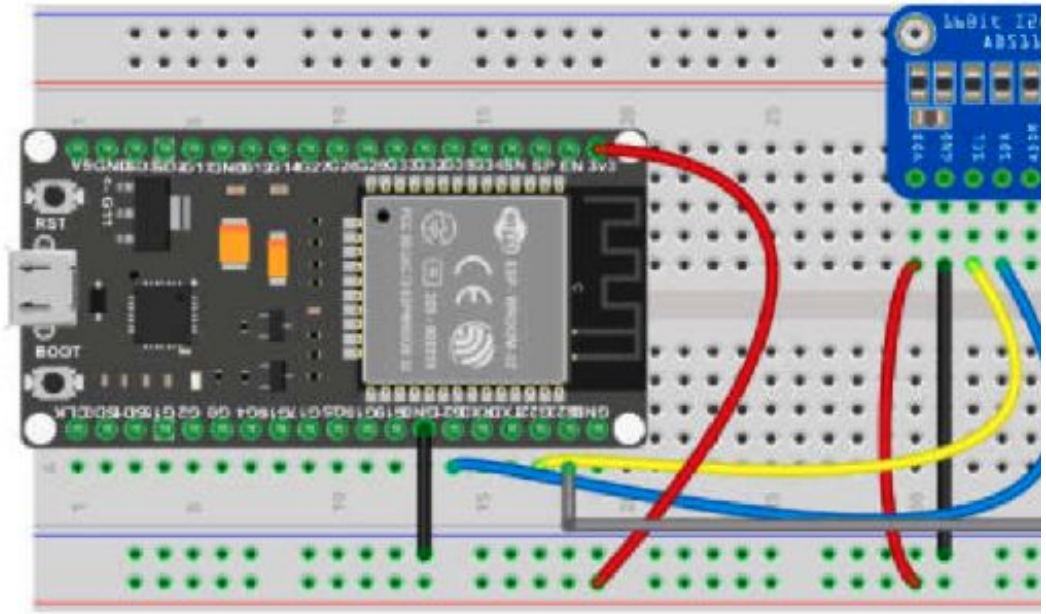


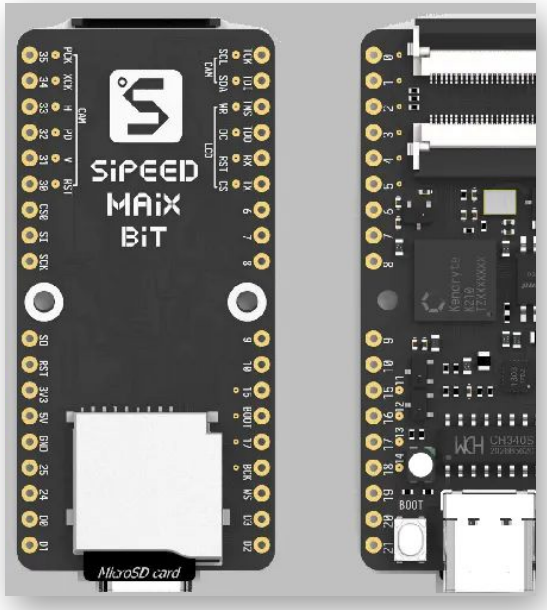


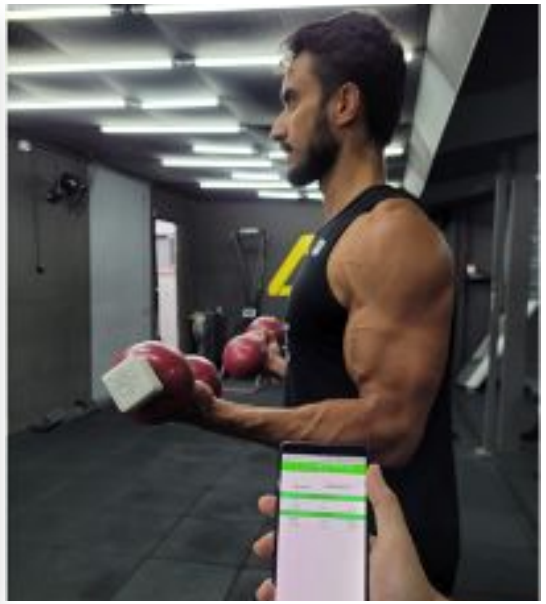


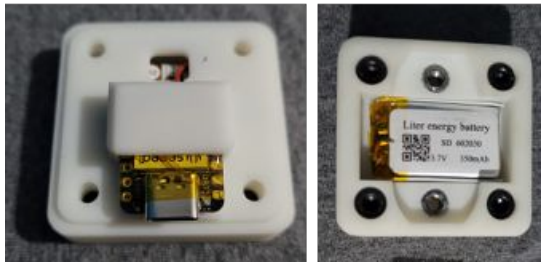


Goal: Innovative projects using other MCUs





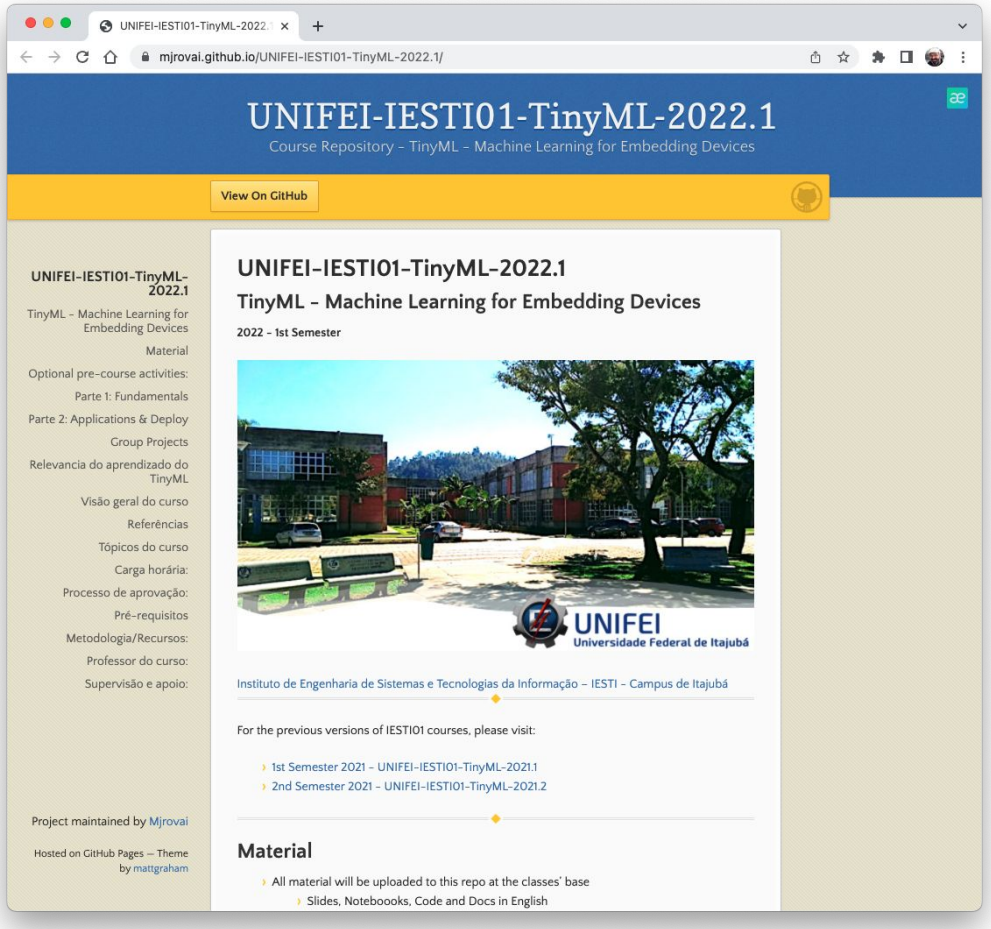




How is the course structured?

Course Structure

- Weekly video-recorded lectures (15 weeks)
  - Slides
  - Hands-on coding (by teacher & students)
- Weekly Additional Readings
- Possible Guest Lecturer (previous *)
- Assignments
  - Quizzes (Weekly)
  - Notebooks with codes (4)
  - Hands-on lab reports (4)
- Final Project (Groups of 3 or 4 students)
  - Report
  - Presentation



(*) IESTI01 2021.1 -> Daniel Situnayaki, Edge Impulse - US
IESTI01 2021.2 -> Dr. Marco Zennaro, ICTP - Italy

Previous IESTI01 Courses available for consultation

Class planning and approval process

- Minimal suggested Workload (4 hours per week):
  - 30 hours (Weekly recorded classes of about 2h, for 15 weeks)
  - 15 hours of assignments/coding/labs
  - 15 hours in research, individual studies, and final project (in a group)

- Approval process:
  - 1st Evaluation:
    - Individual **Quizzes**: 10%
    - Individual **Exercise Lists** (Notebooks): 25%
    - Group **Project Proposal**: 15%
  - 2nd Evaluation
    - Individual **Quizzes**: 10%
    - Individual **Practical Projects** (Lab reports): 25%
    - Group **Project Presentation (*)** and Final Report: 15%

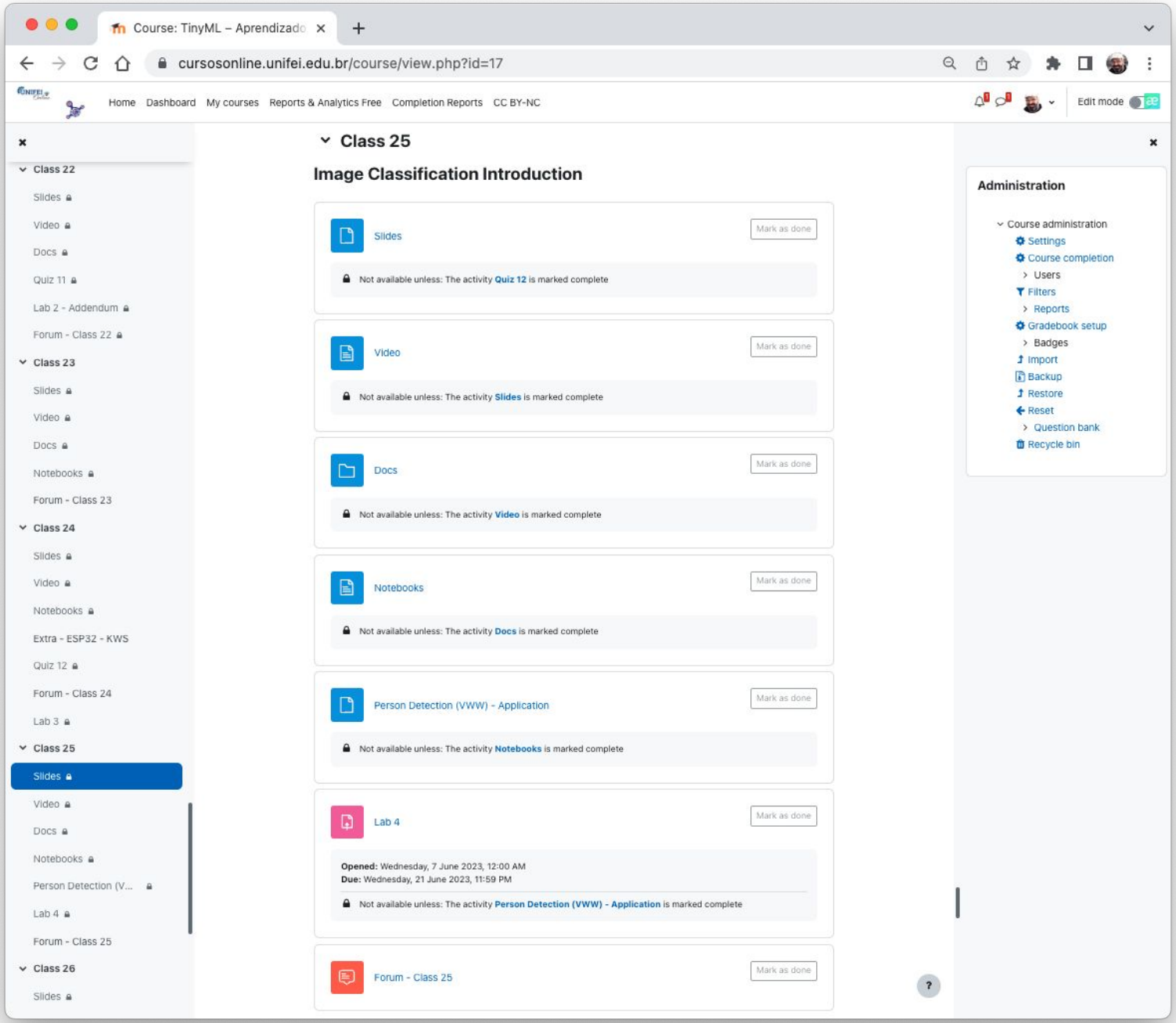
UNIFEI IESTI01 2021.1 – Final Projects
UNIFEI IESTI01 2021.2 – Final Projects
UNIFEI IESTI01 2022.1 – Final Projects

My courses

Course overview

All | Search

TinyML – Aprendizado de Máquina para ...
Extensão 2023



IESTI01 2023.1 - Course Schedule

	Date	Class	Content	Assigment Deadline
Fundamentals	15/03/23	1	About the Course and Syllabus	
		2	Introduction to TinyML	
	22/03/23	3	TinyML - Challenges - Embedded Systems	Pre-Survey / Quiz 1
		4	TinyML Challenges - Machine Learning	
	29/03/23	5	The Machine Learning Paradigm	Quiz 2
		6	The Building Blocks of Deep Learning (DL) - Introduction	
	05/04/23	7	The Building Blocks of DL - Regression with DSS	List 1 / Quiz 3
		8	The Building Blocks of DL - Classification with DSS	
	12/04/23	9	The Building Blocks of DL - DNN Recap, Datasets and Model Metrics	Lista 2 /Quiz 4
		10	Introducing Convolutions (CNN)	
	19/04/23	11	Image Classification using CNN	Lista 3 / Quiz 5
		12	Introduction to Edge Impulse – CNN with Cifar-10	
	26/04/23	13	Preventing Overfitting	Lista 4 / Quiz 6
		14	Fundamentals wrap-up and Application's preview	
Application & Deploy	03/05/23	15	ML Applications Overview - AI Lifecycle and ML Workflow	Project Proposal / Quiz 7
		16	Introduction to TFLite and TFLite-Micro	
	10/05/23	17	Lab 1 - TinyML Kit Overview - HW and SW Installation & Test	Quiz 8
		18	TFLite-Micro Overview & Hello World Code Walkthrough	
	17/05/23	19	Motion Classification - Introdution	Quiz 9
		20	Lab 2 - Motion Classification using MCU (Nano 33)	
	24/05/23	21	K-means Clustering & Anomaly Detection	Lab 1 / Quiz 10
		22	Lab 2a - Anomaly Detection Hands-On Lab & Pos-Processing	
	31/05/23	23	Keyword Spotting - Introduction	Lab 2 / Quiz 11
		24	Lab 3 - Lab KWS using MCU	
	07/06/23	25	Image Classification Introduction	Quiz 12
		26	Image Classification using Edge Impulse Studio	
	14/06/23	27	Collecting Data - Aternative ways	Lab 3 / Quiz 13
		28	Responsible AI & Course Wrap-up	
	21/06/23	29	Group Presentations	Lab 4 and Lab 4a
		30	Group Presentations	

Main references

- Harvard School of Engineering and Applied Sciences - CS249r: Tiny Machine Learning
- Professional Certificate in Tiny Machine Learning (TinyML) – edX/Harvard
- Introduction to Embedded Machine Learning - Coursera/Edge Impulse
- Computer Vision with Embedded Machine Learning - Coursera/Edge Impulse
- Fundamentals textbook: “Deep Learning with Python” by François Chollet
- Applications & Deploy textbook: “TinyML” by Pete Warden, Daniel Situnayake
- Deploy textbook “TinyML Cookbook” by Gian Marco Iodice
- Deploy textbook "AI at the Edge" book by Daniel Situnayake, Jenny Plunkett

I want to thank Shawn Hymel and Edge Impulse, Pete Warden and Laurence Moroney from Google, Professor Vijay Janapa Reddi and Brian Plancher from Harvard, and the rest of the TinyMLedu team for preparing the excellent material on TinyML that is the basis of this course at UNIFEI.

The IESTI01 course is part of the **TinyML4D**, an initiative to make TinyML education available to everyone globally.

Thanks

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