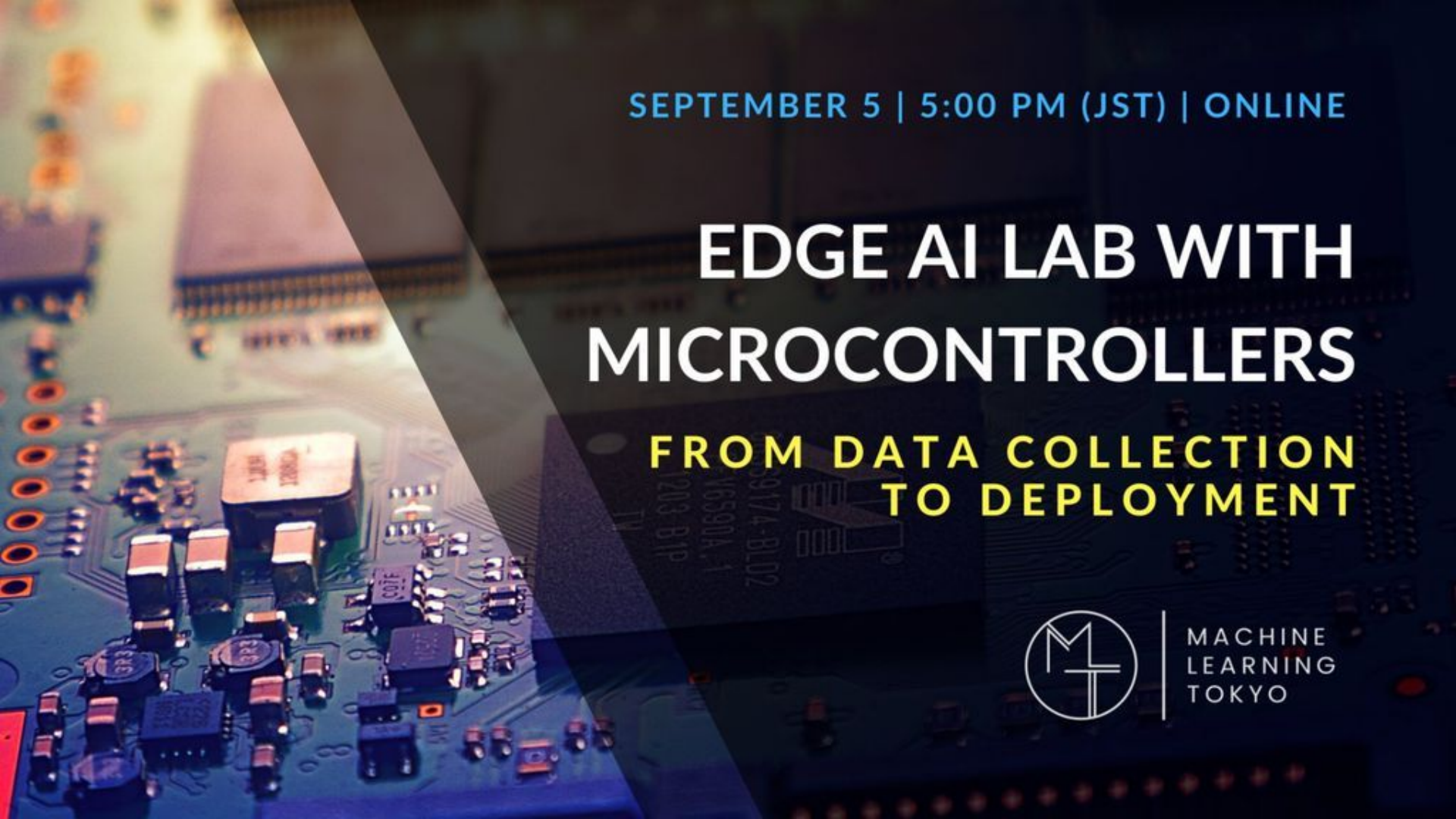
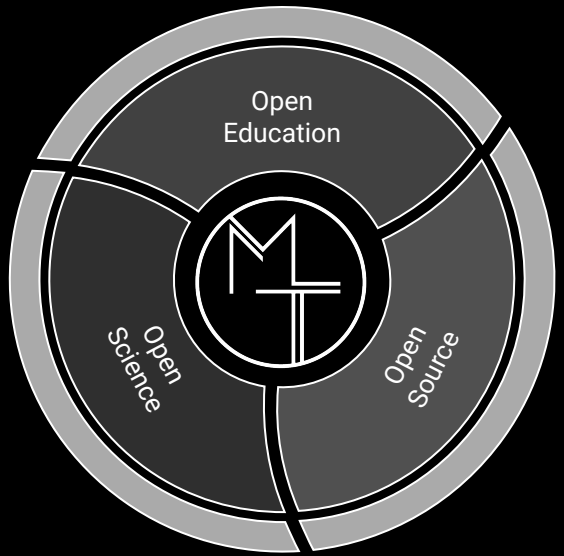

SEPTEMBER 5 | 5:00 PM (JST) | ONLINE
EDGE AI LAB WITH MICROCONTROLLERS
FROM DATA COLLECTION TO DEPLOYMENT
MACHINE LEARNING TOKYO

MLT

Machine Learning Tokyo (MLT) is an award-winning nonprofit organization 一般社団法人 based in Japan.

MLT is dedicated to democratizing Machine Learning through open education, open source and open science.

We support an international research- and engineering community of more than 9,500 members.



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TOKYO

Ref : https://machinelearningtokyo.com

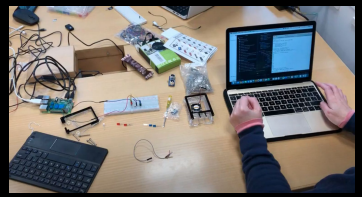
MLT EdgeAI Lab

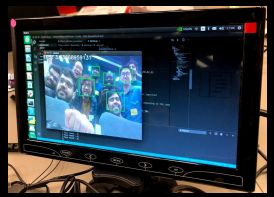
MLT Agritech team visiting Hacker Farm in Chiba

Signate 3rd AI Edge

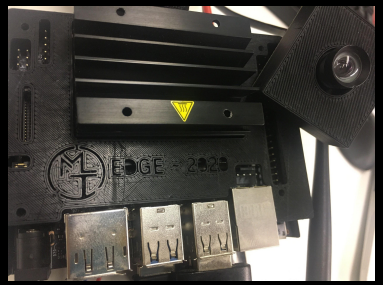
Final Rank	Teamname / Username	Private
1st	RailStar737A	0.62610
2nd	IRAFM-AI	0.61198
3rd	MLT	0.60545

EdgeAI Lab Hardware Working Session





Jetson Nano deployment on bicycle



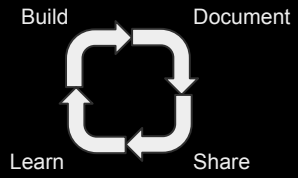
Join **#edge_ai_lab** on MLT Slack
https://machinelearningtokyo.slack.com

MACHINE LEARNING TOKYO

Introduction of Series

Goal is to help you build your Edge AI application by end of the series

- Build / Document / Share / Learn



Overview of entire Series

➔ Session #1 : Overview of Edge AI Applications
➔ Session #2 : Motion Based Application using IMU
➔ **Session #3 : Audio Based Application using Microphone**
➔ Session #4 : Wrap-up session

Today's Agenda (Session #3)

➔ 05:00 - 05:15: Introduction
➔ 05:15 - 05:45: Presentation, Walkthrough, and Demo of Audio Based Edge Application
➔ 05:45 - 06:15: Brainstorming
➔ 06:15 - 06:30: Sharing / QA

Join **#edge_ai_lab** on MLT Slack
https://machinelearningtokyo.slack.com

MACHINE LEARNING TOKYO

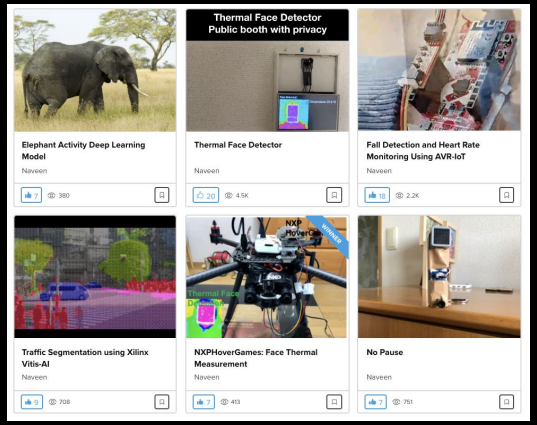
Introduction of Organizers

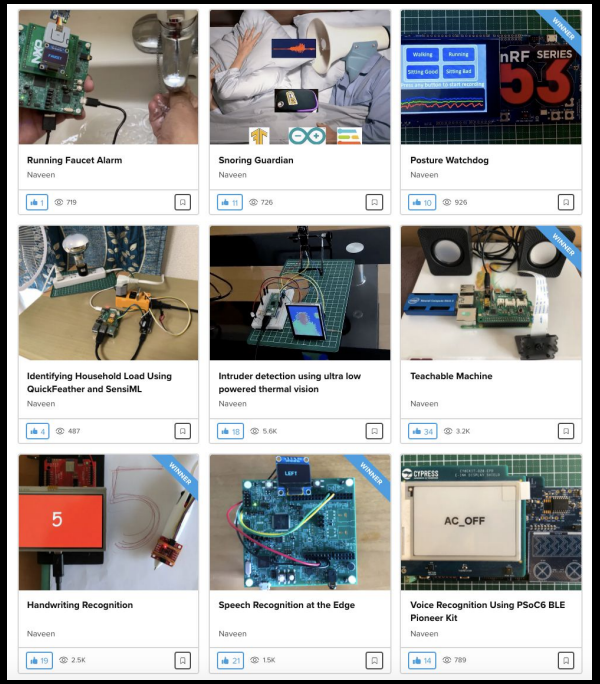
Naveen Kumar

- Watching movies
- Nature photography
- Playing with microcontrollers

@knaveen

My Edge AI projects at
hackster.io/naveenbskumar





MACHINE
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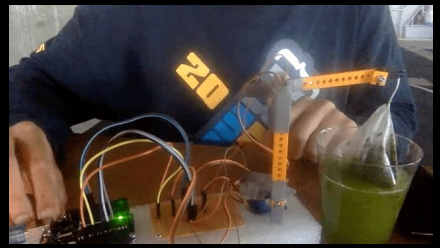
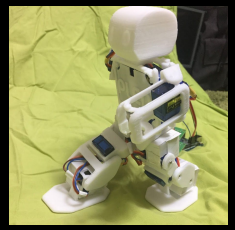
Introduction of Organizers

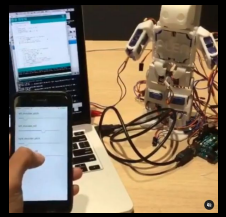
Yoovraj Shinde

- Love Eating Food
- Playing with robots



Past Projects





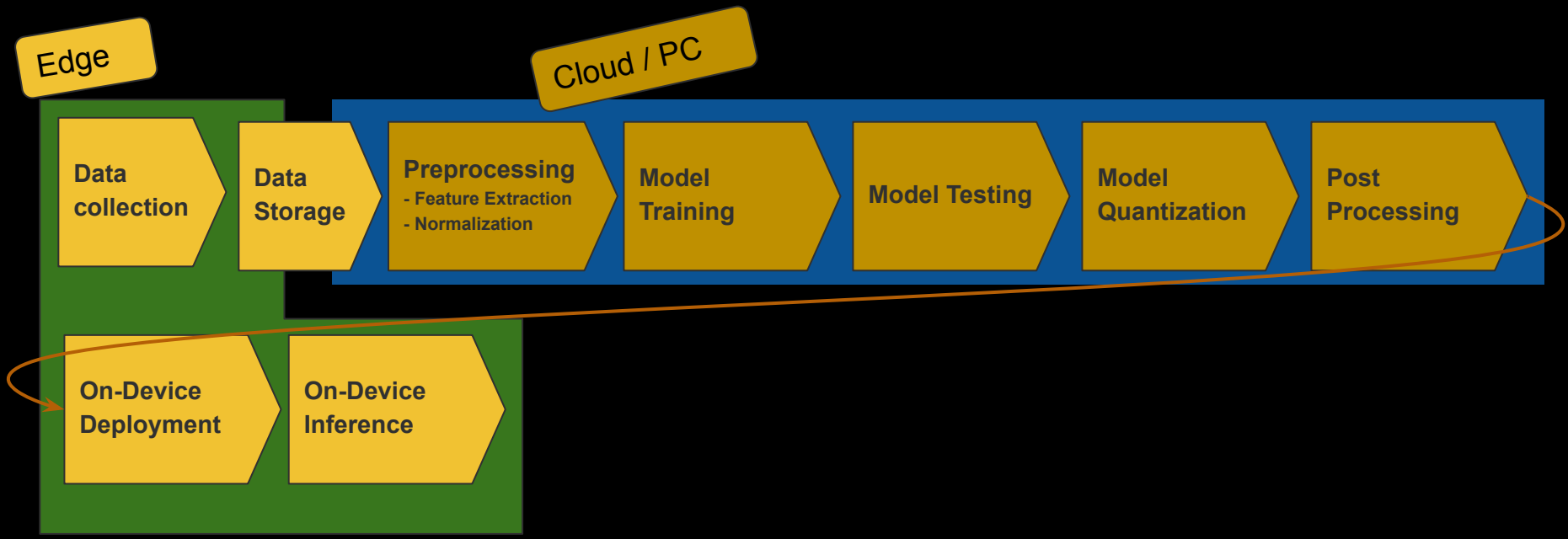
Personal Plen Robot

- 3d printed parts
- Arduino
- iOS App

Robot Car for Kids

- Tamiya Kits
- Raspberry Pi
- Scratch

Blocks of Edge AI Pipeline

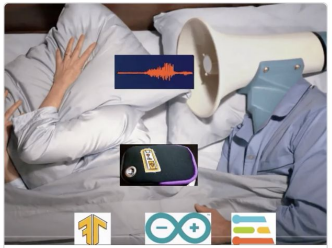


MACHINE LEARNING TOKYO

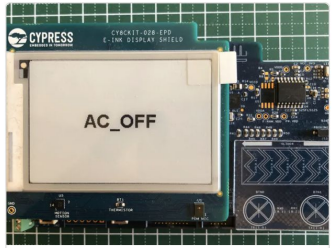
Example Edge AI Applications using Microphone

- ➔ Detect Audio Events
- ➔ Detect Human Voice
- ➔ Keyword Recognition
- ➔ Detect Respiratory Sound

Running Faucet Alarm

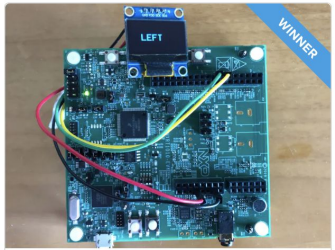


Snoring Guardian



Voice Recognition Using PSoC6 BLE Pioneer Kit

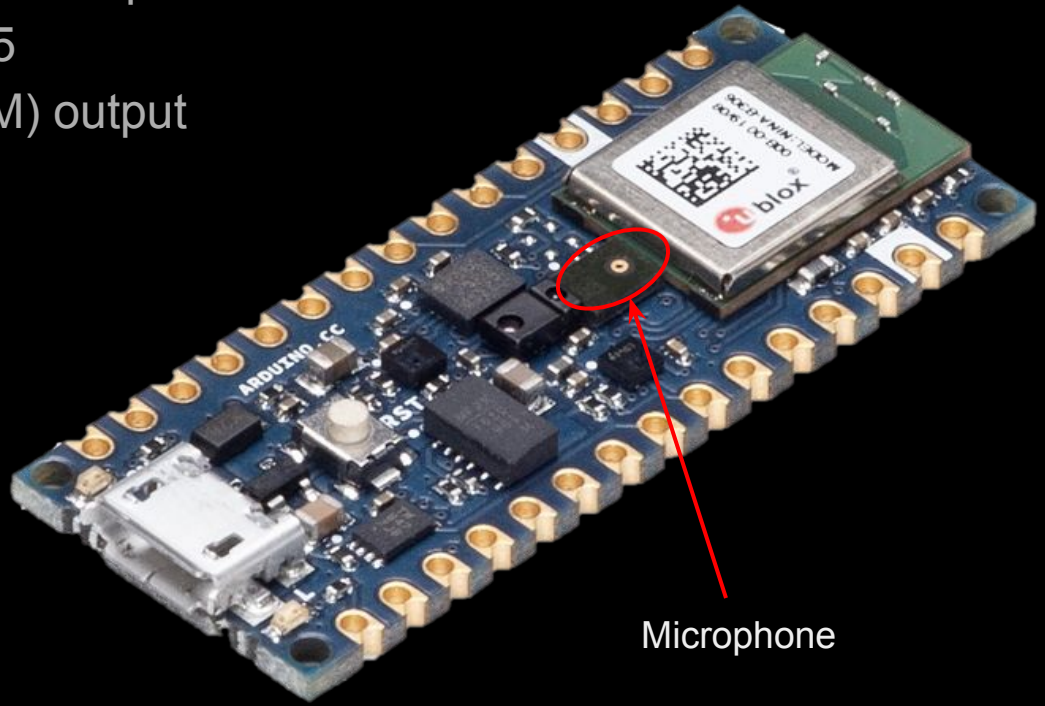
hackster.io/naveenbskumar



Speech Recognition at the Edge

Arduino Nano 33 BLE Sense on-board Microphone

- ➔ Omnidirectional, digital MEMS microphone
- ➔ STMicroelectronics MP34DT05
- ➔ Pulse-density modulation (PDM) output



MACHINE LEARNING TOKYO

Project: Snoring Sound Detection

- ➔ Snoring is caused by the rattling and vibration of tissues near the airway in the back of the throat.
- ➔ The aim of this project is to detect the snoring sound during sleep.
- ➔ Understanding data collection process and Digital Signal Processing to extract features
- ➔ Coding is not required for simple working demo but advanced users may customize the source code
- ➔ Rapid prototyping using Edge Impulse Studio

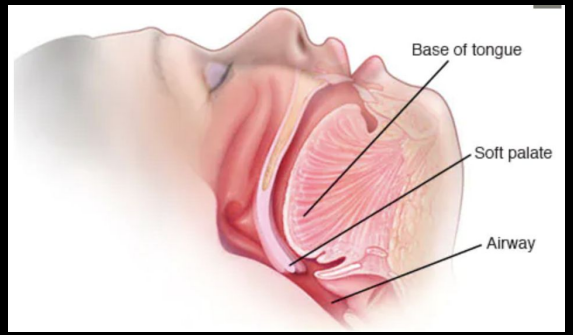


Image credit: Mayo Foundation for Medical Education and Research

What is Pulse Density Modulation (PDM)?

- ➔ From Sound Pressure to PDM, represent an analog signal with a binary signal
- ➔ PDM is the ‘3rd’ kind of microphone interface we can integrate with microcontroller, apart from analog or I2S.
- ➔ PDM is a little like 1-bit PWM.

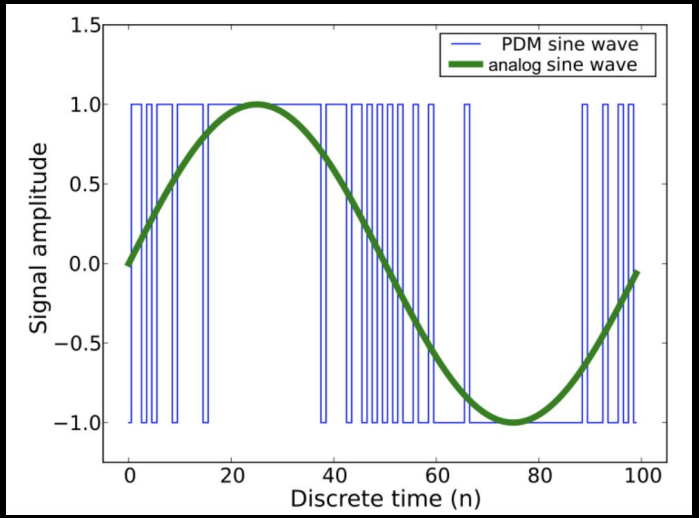
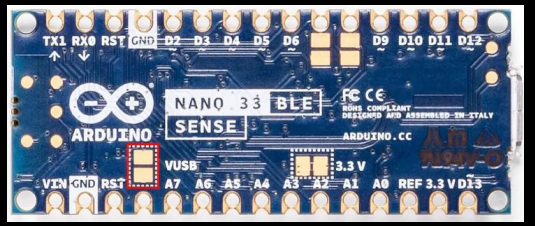
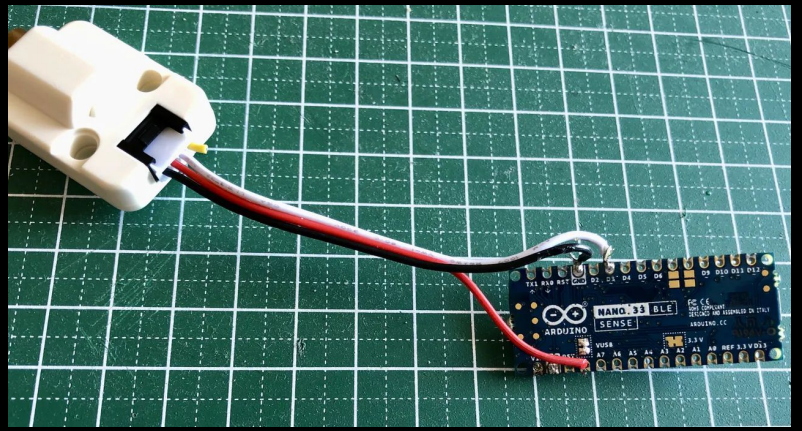


Image credit: learn.adafruit.com

Hardware Setup

- ➔ Requires soldering skills
- ➔ A vibration motor is used as an output and it starts vibrating if snoring sound is detected.
- ➔ To power it using 5V pin we need to make a solder bridge on the two pads marked as VUSB.





MACHINE LEARNING TOKYO

Data Collection

- ➔ Download Snoring and other nature sounds which may occur during night from Audioset, a large-scale dataset of manually annotated audio events.
- ➔ AudioSet consists of an expanding ontology of 632 audio event classes and a collection of human-labeled 10-second sound clips drawn from YouTube videos.
- ➔ The audio are extracted from the YouTube videos of the select events and converted into Waveform Audio file format (wav) with 16-bit depth mono channel at 16KHz sample rate.

Snoring
Vehicle
Toilet flush
Rain
Wind
Television
Radio
Silence
Insect
Tick-tock
Baby cry, infant cry

Dog
Sneeze
Cough
Sniff
Walk, footsteps
Humming
Squeak
Traffic noise
roadway noise
Human Voice
Chirp, tweet
Music

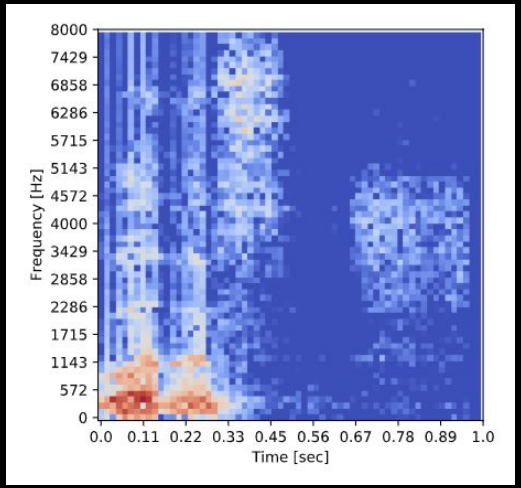
http://research.google.com/audioset

Data Storage

- ➔ Register a free account at edgeimpulse.com and create a new project.
- ➔ Install Edge Impulse CLI on your local computer.
  https://docs.edgeimpulse.com/docs/cli-installation
- ➔ Upload all wav files to Edge Impulse Studio using the command line:
  - ◆ edge-impulse-uploader --clean
  - ◆ edge-impulse-uploader --label **snoring** --category **split** snoring/ *.wav
- ➔ The datasets are automatically split into training and testing sets by using command above.

What is Spectrogram?

- ➔ Visual representation of the spectrum of frequencies of a non-periodic signal
- ➔ Extracts time and frequency features from a signal
- ➔ Performs well on audio data for non-voice recognition



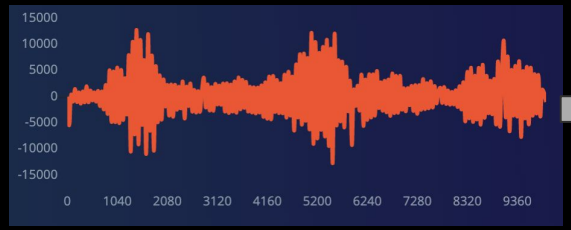
Spectrogram

MACHINE LEARNING TOKYO

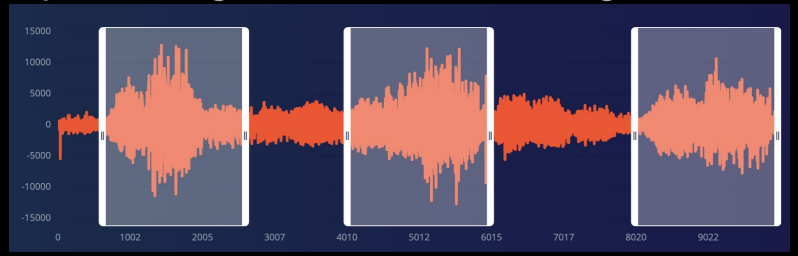
Digital Signal Processing

Audio raw data (16000 samples/sec)

[61, 204, 303, 198, 98, 178, 259, 307, 371, 279, -6, -208, -253, -320, -348, -251, -130, -42, 43, 10, -169, -277, -236, -251, -358, -261, -65, -63, -134, -151, -321, -577, -551, -312, -178, -75, -6, -186, -334, -186, -67, -157, -158, -22, 105, 207, 248, 126, -145, -320, -223, -14, 43, 30, 63, 30, -78, -164, -220, -175, -44, 2, …]

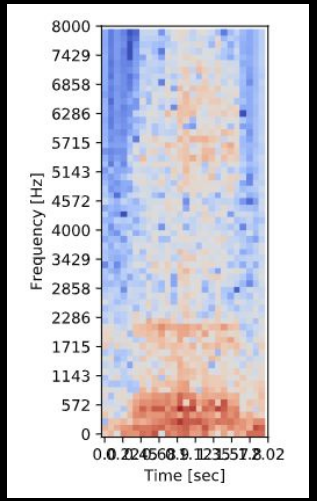


Split into segments to remove background noise



Signal to Spectrogram

2000 ms Window size
1000 ms Window Increase



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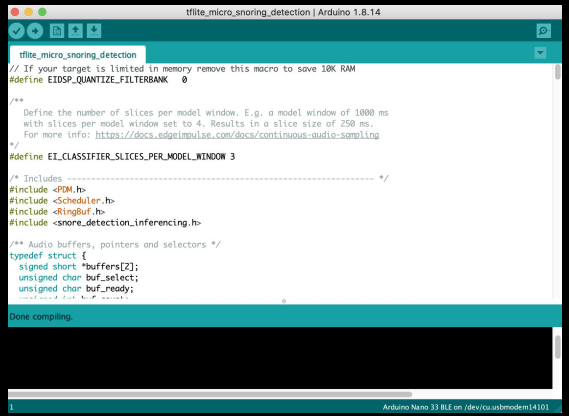
Demo: Data Collection/DSP/Training

Demo: On-Device Inferencing

All code and material of the session

- ➔ Walkthrough of the Arduino Inferencing sketch



- ➔ Github repository for the project source code and documentation
  - ◆ https://github.com/Machine-Learning-Tokyo/edgeai-lab-microcontroller-series

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Brainstorming Session

WhiteBoards for Brainstorming

Project Push Up Classification (and Counting)
https://app.mural.co/t/mltedgeailab3396/m/mltedgeailab3396/1629005216375/3e7cd6437df6ba9b5392b66fa2c490ab27c36a34?sender=u95ce3da66ee17f1954ba5414

Project Cat Activity Detection
https://app.mural.co/t/mltedgeailab3396/m/mltedgeailab3396/1629005197838/c71484addd603e0de284da41e7329682aafea500?sender=u95ce3da66ee17f1954ba5414

Motion Based Applications
https://app.mural.co/t/mltedgeailab3396/m/mltedgeailab3396/1629005207313/cfdd36833f34ff6db2cd9aaa5c2b76043c947933?sender=u95ce3da66ee17f1954ba5414

Audio Based Application
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Next Session

- ➔ Session #4 : Wrap up session September 19 (5:00 PM - 6:30 PM JST)
  - 2 weeks for all of us to create exciting projects
  - Sharing of projects you have worked on during this entire series
  - Will be announced soon on MLT Meetup page.

END

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