

life.augmented

Artificial Intelligence Solutions

Raphael Apfeldorfer - Jan 2021

MDG/MCD/AI Solutions



Artificial Intelligence at the Edge

Moving part of intelligence closer to the data acquisition



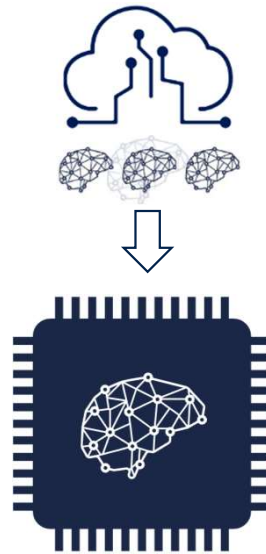
Better user experience



Realtime, no latency



Reliable



Add new functions and services with **Embedded AI**

Optimized Cloud usage



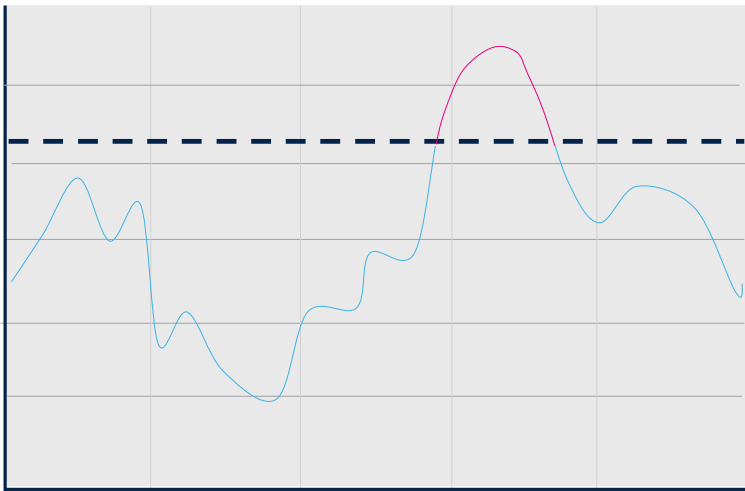
Privacy by design (GDPR compliant)



Sustainable on energy

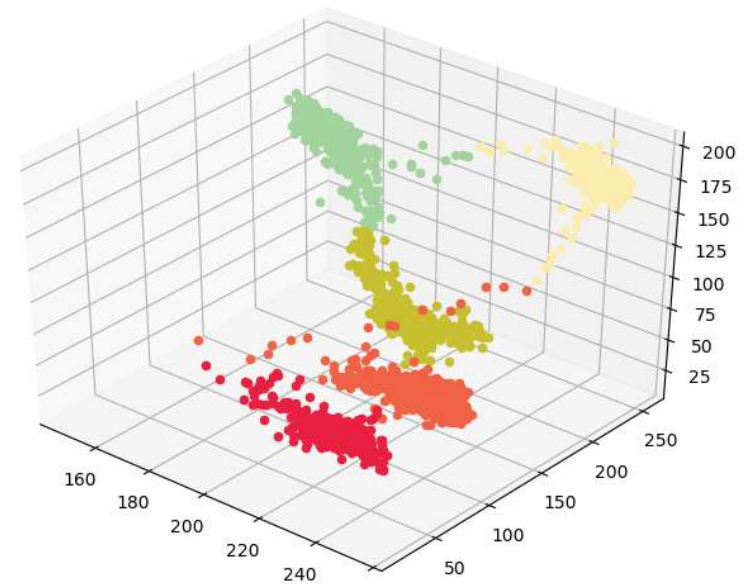


Benefits of AI VS traditional approach



Handcrafted rule based on
experience in the field

Procedural programming



Rules learnt automatically
from data base

Learn from example

Computer Vision for STM32

Give vision to your STM32 product for new features and add-on services



Food classification

FP-AI-
VISION1 v1.0



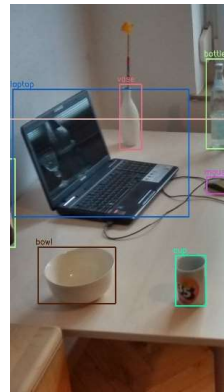
Person presence detection

FP-AI-
VISION1 v2.0



Face recognition

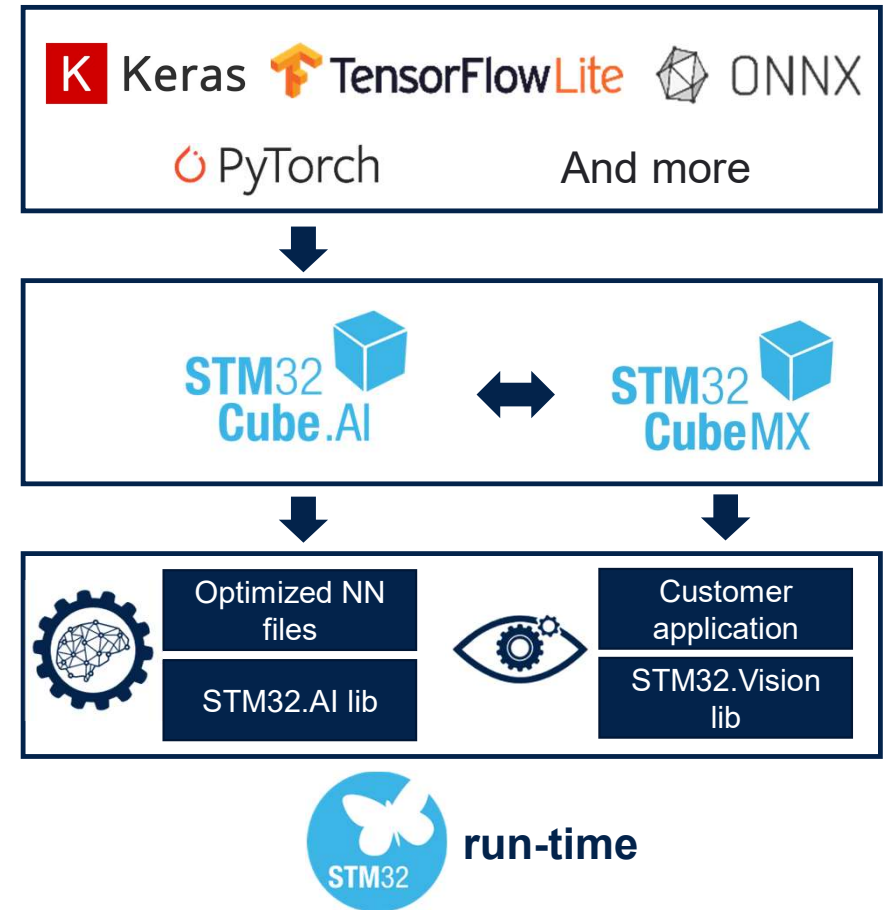
FP-AI-
FACEREC v1.0



Multiple object detection

Q2 2021*

*available for alpha customers



Condition monitoring for STM32

Monitor STM32 equipment health for improved uptime and lower maintenance cost



Vibration monitoring for In-field retrofit of existing systems

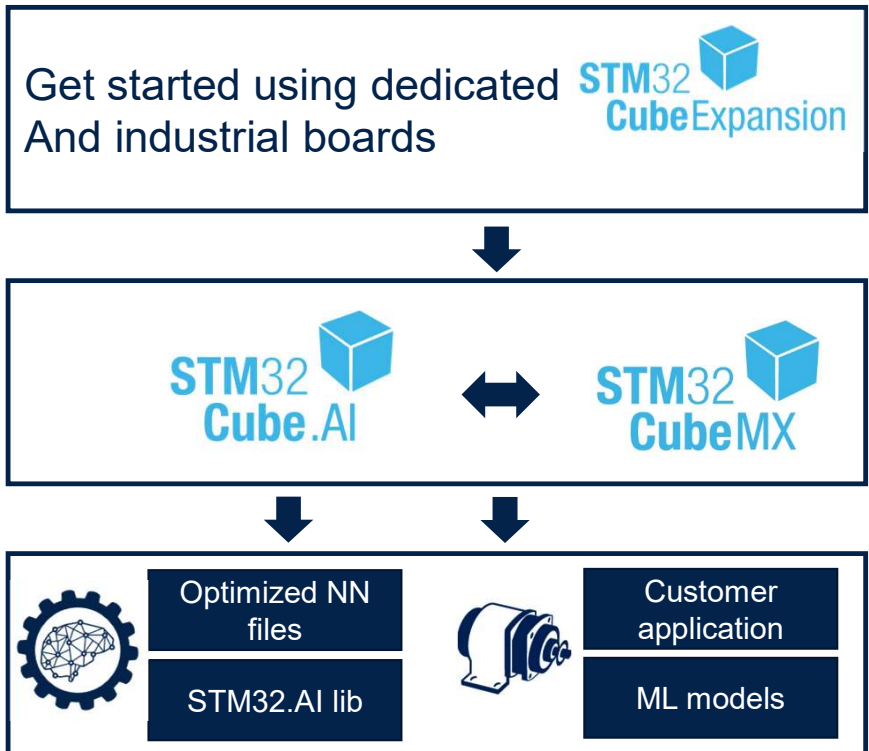


Condition monitoring with current for build-in systems

FP-AI-NANOEDG1
v1.0

Q1 2021*

*available for alpha customers



run-time

AI tools for STM32



The key steps behind Neural Networks



Neural Network (NN) Model Creation



Operating Mode

Capture data



1

2



Clean, label data
Build NN topology

Train NN Model



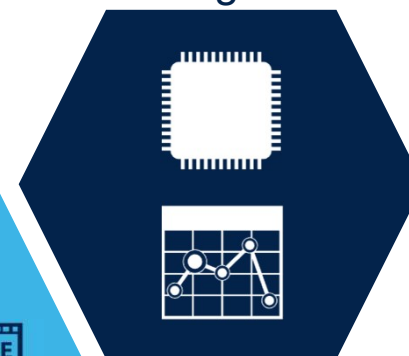
3

4



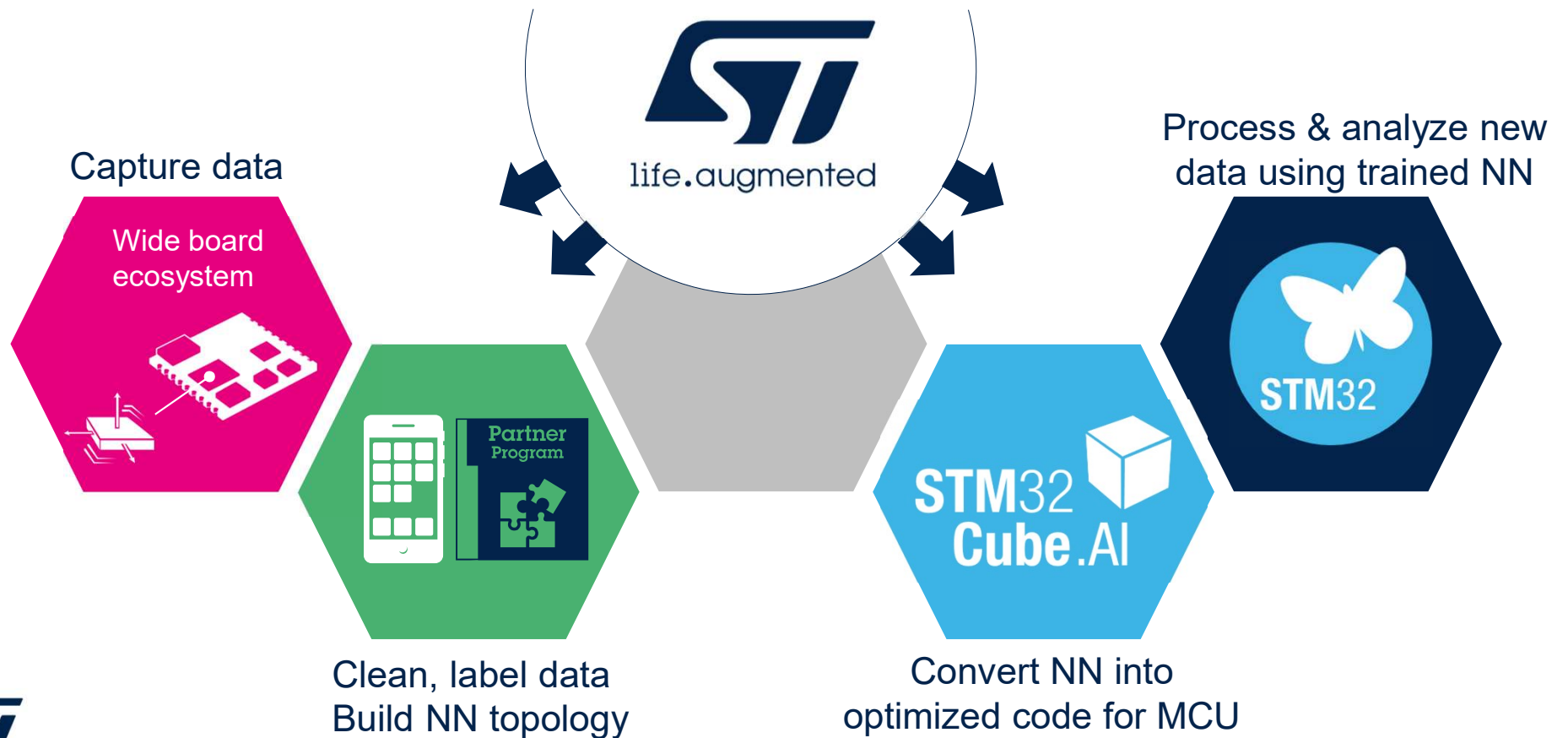
Convert NN into
optimized code for MCU

Process & analyze new
data using trained NN



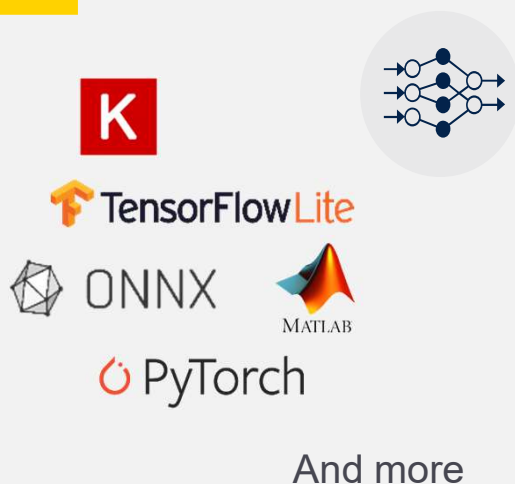
5

ST toolbox for Neural Networks



Easily implement Neural Networks on STM32

Train Neural Network using
any major AI frameworks



Convert NN into optimized
code



Select most appropriate MCU
Review computation and memory
consumption per layer

Run on optimized runtime



Validate code directly on target
Get accuracy and inference time
Optimize memory usage

Convert models from any AI framework

Input your framework-dependent, pre-trained Neural Network into the **STM32Cube.AI** conversion tool

Automatic and fast generation of an STM32-optimized library

STM32Cube.AI offers interoperability with state-of-the-art Deep Learning design frameworks

Any framework that can export models in **ONNX** open format can be imported

Train NN Model



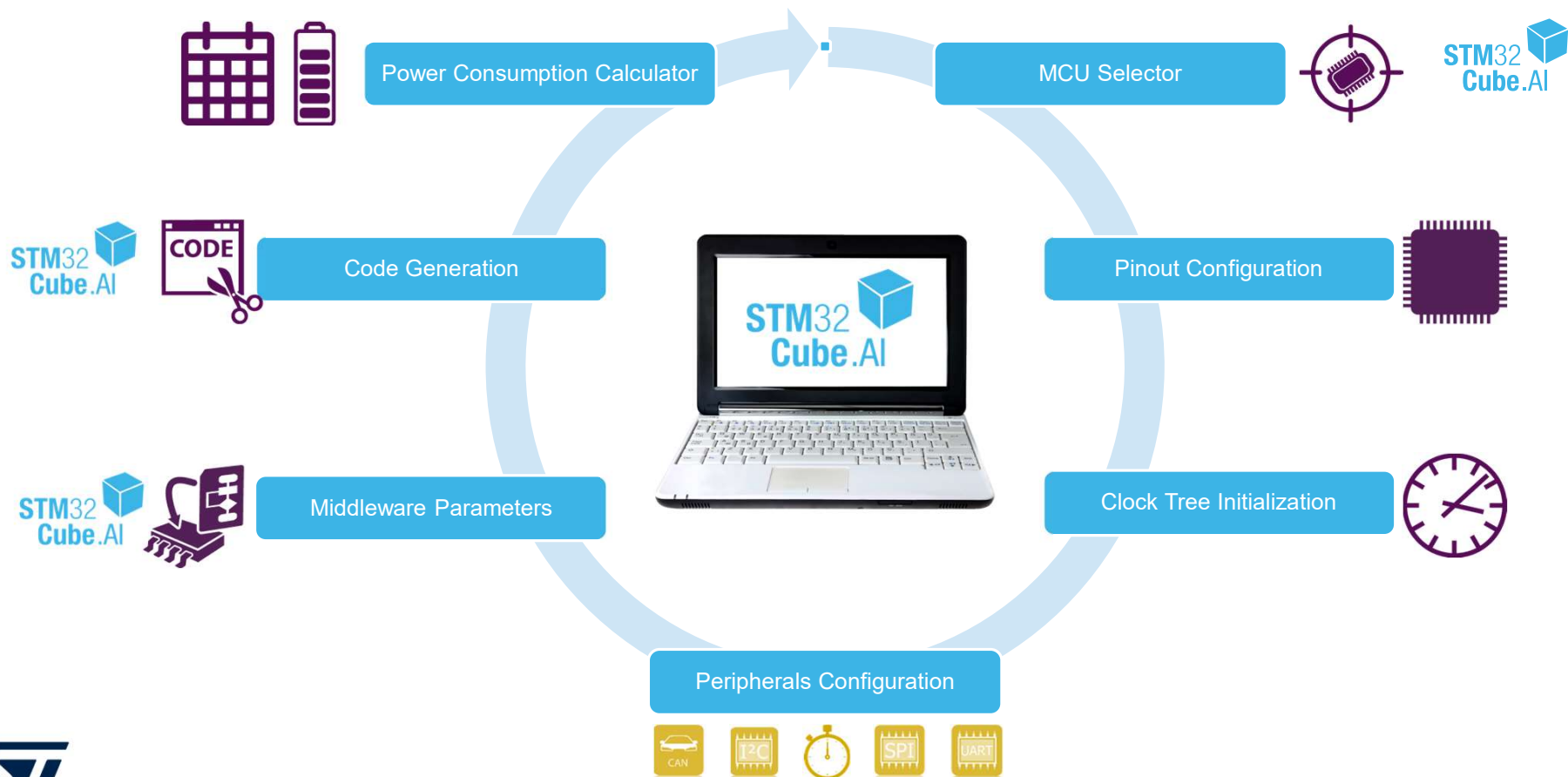
Convert NN into optimized code for MCU



Process & analyze new data using trained NN



STM32Cube.AI, an STM32CubeMX expansion



Collecting data & architecting a NN topology

Services provided by Partners

ST tools to support

Capture data



Clean, label data
Build NN topology



ST BLE Sensor mobile phone application

Collect and label data from the SensorTile.



ST BLE
Sensor

**Partner
Program**



Selected partners

Neural Networks engineering services support.

Data scientists and Neural network architects.

Wireless Industrial node to capture data at industrial grade

STWIN

Capture Data



Inference on STM32L4R9



Industrial-grade sensors

- Industrial scale 9-DoF motion sensors including accelerometer, gyrometer and an ultra wide-bandwidth vibrometer with ultra low noise
- Very high frequency audio and ultrasound microphone
- High precision temperature and environmental monitoring
- Micro SD card for standalone data logging
- BLE5.0 connectivity and WiFi expansion board
- USART

www.st.com/stwin

STM32H7 discovery boards with camera

STM32H747I-DISCO
with B-CAMS-OMV

Capture Data



Inference on STM32H747



Computer Vision on microcontroller

- STM32H747 high-performance and DSP with DP-FPU, Arm Cortex-M7 at 480 MHz + Cortex-M4 MCU with 2MB internal Flash, 1MB internal RAM, Chrom-ART Accelerator
- External memory 2x64MB Quad-SPI NOR Flash and 32MB SDRAM
- 4" capacitive touch LCD display module with MIPI® DSI interface
- Camera module adapter board and camera module based on OV5640 5MPx 8b color rolling shutter
- ST-MEMS digital microphones
- Ethernet RJ45 and WiFi / cellular expansion boards



OpenMV integration

Fast machine vision prototyping

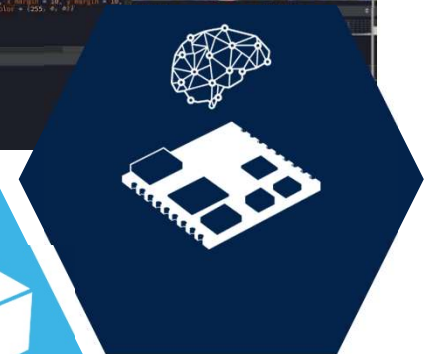


OpenMV CAM
Running MicroPython over STM32

Configure Machine Vision in
real-time over USB in Python



Run and validate optimized
Neural Network

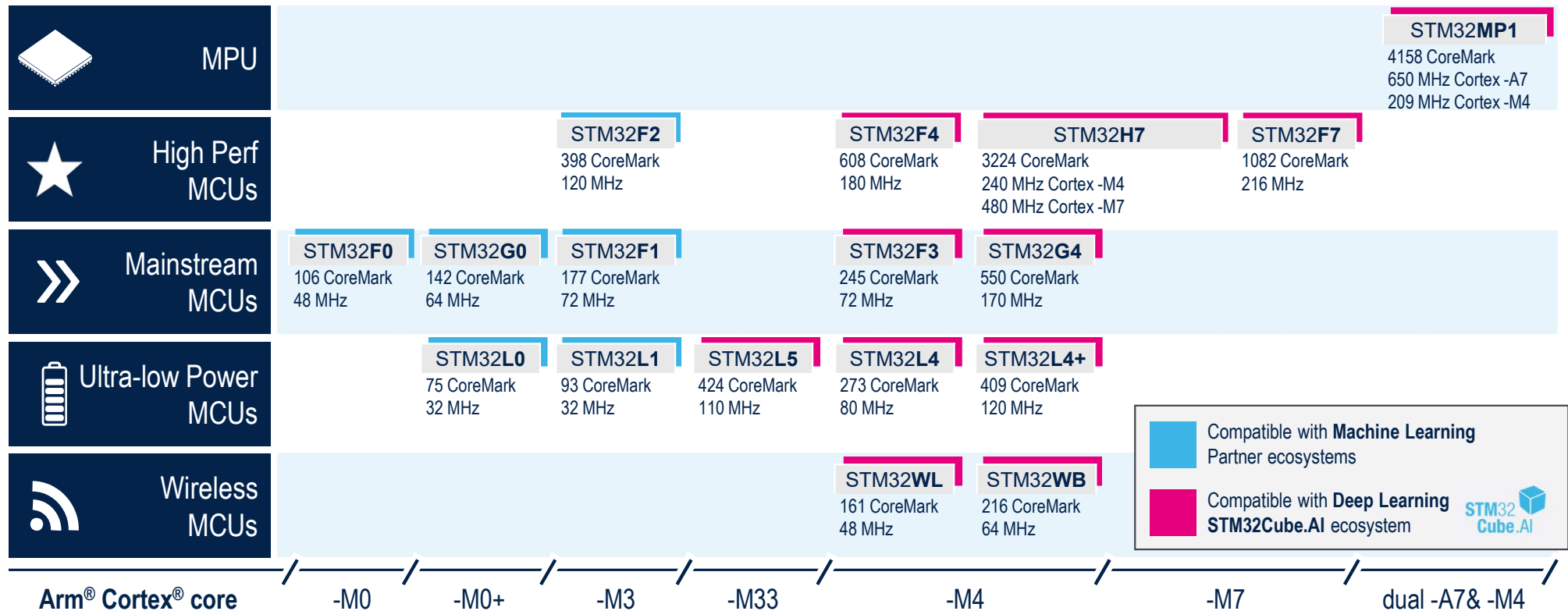


STM32
Cube.AI



Making AI Accessible Now

Leader in Arm® Cortex®-M 32-bit General Purpose MCU



Compatible with **Machine Learning** Partner ecosystems

Compatible with **Deep Learning** STM32Cube.AI ecosystem

Function Packs



AI Solutions on STM32

A full development ecosystem to create your AI application



AI extension for STM32CubeMX to **map pre-trained Neural Networks**



STM32 **Community** with dedicated Neural Networks topic and **AI expert partners**



Trainings, hands on, MOOCs and partners **videos**



FP-AI-VISION1



Person presence detection

Food classification



FP-AI-SENSING1



People activity recognition

Audio scene classification



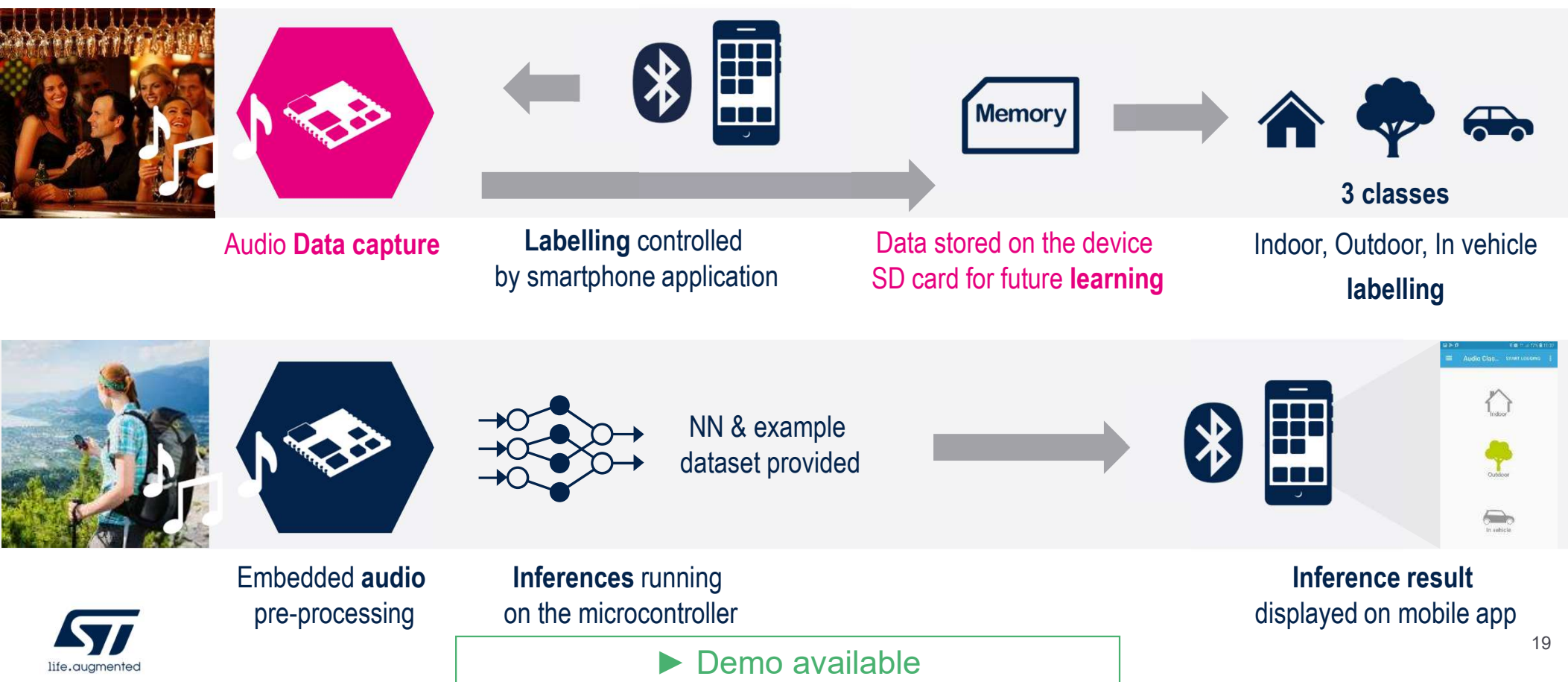
FP-AI-NANOEDG1



Condition-based monitoring



Audio scene classification (ASC)



Human activity motion recognition (HAR)

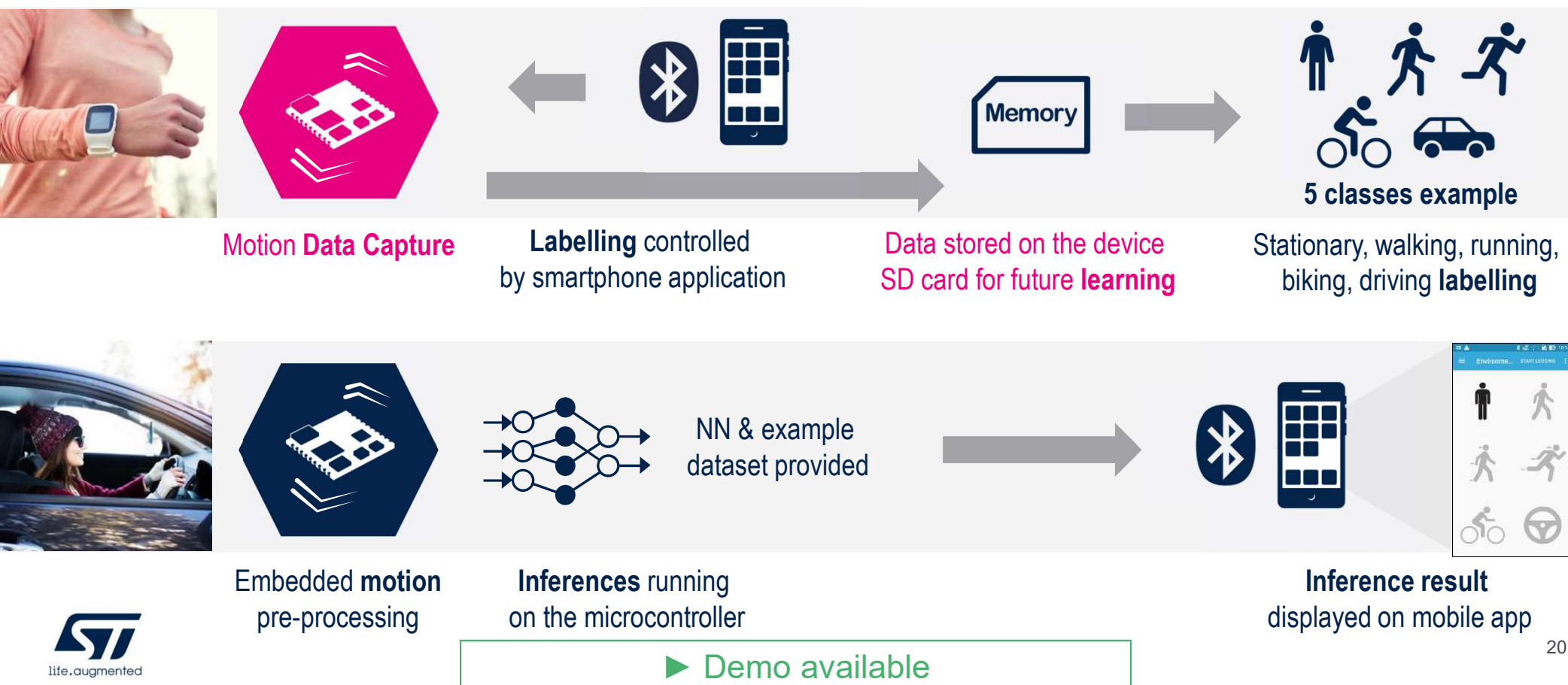


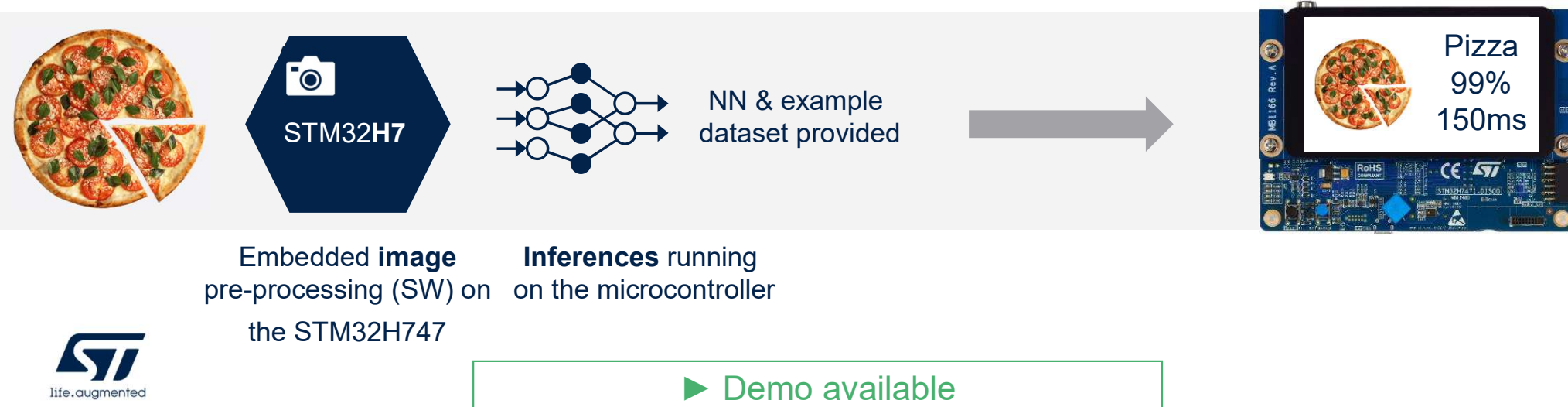
Image classification

Enjoy the food classification demo

- Default demo based on 18 classes (224x224 RGB pictures)
- Several camera image output size possible

Full end-to-end optimized software example

- from camera acquisition to image pre-processing before feeding the NN
- Multiple memory mapping possibilities to optimize and test impact on performances
- Retrain this NN with your own dataset
- Quantize your trained network to optimized inference time and memory usage



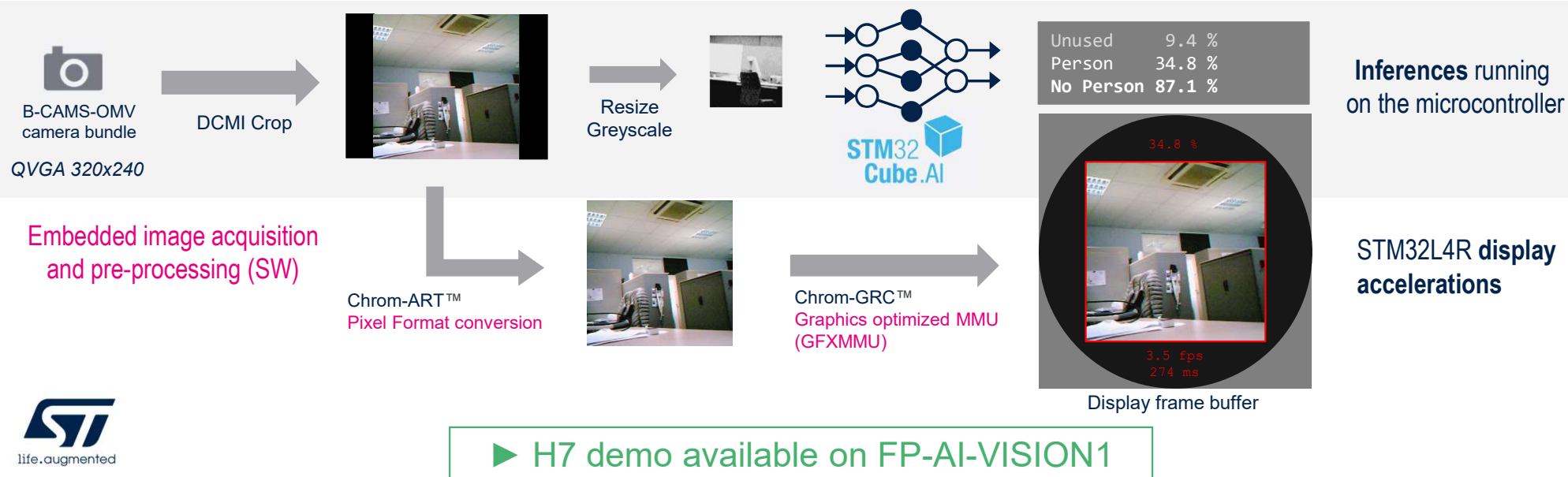
Person presence detection

One-class image classification demo

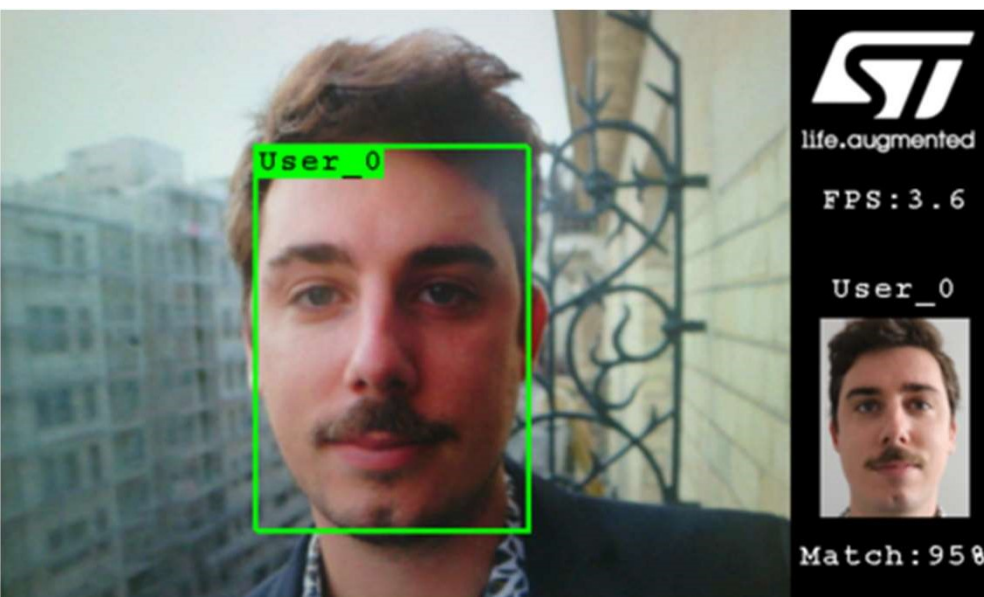
- Models from tensorflow.org (L4R and H7) and MobileNet v2 (H7 only)
- QVGA 320x240 color image on the LCD
- Can adapt camera flipping depending on which side camera is placed

Full end-to-end optimized software example

- from camera acquisition to image pre-processing before feeding the NN
- Multiple models fitting STM32L4R to STM32H7 depending on required performance and cost
- Visual wake word for Smart home or cities security cameras
- Reduce false alarms due to object movement detection



Embed face recognition in your IoT project



STM32H7

User-personalized services / features

Adjust automatically per user

- ✓ Device **preferred settings** or **ergonomics** per user
- ✓ Customized device **behavior** / action for registered user
- ✓ Customize **alerts**
- ✓ **Prevent child injury** with underage appliance lock
- ✓ Create user-specific **automations**

Features

- On-device face enrollment of multiple users
- Real-time face recognition, display enrolled image
- Displays match accuracy and inference speed



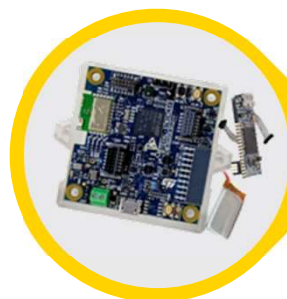
FP-AI-NANOEDG1



Condition monitoring on STWIN

Get straight to proof-of-concept with full anomaly detection system without deep Data Science knowledge

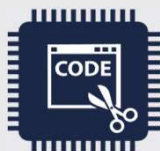
NANOEDGE AI
STUDIO 



Collect dataset from industrial-grade vibration sensor



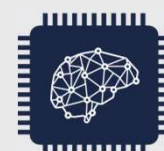
Generate **free** ML library



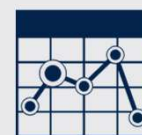
Integrate and deploy



Install on premise



Incremental learning on-target



Monitor anomalies on-target



Download the dedicated SW package

ST co-development and partnerships

Leverage the power of Edge AI

ST AI
Expert
team

AI co-development partnerships
Contact us at edge.ai@st.com



Multiple Object Detection with Thermal Imager

Partner
Program



Meet our expert AIS partners
Visit st.com/stm32cubeai



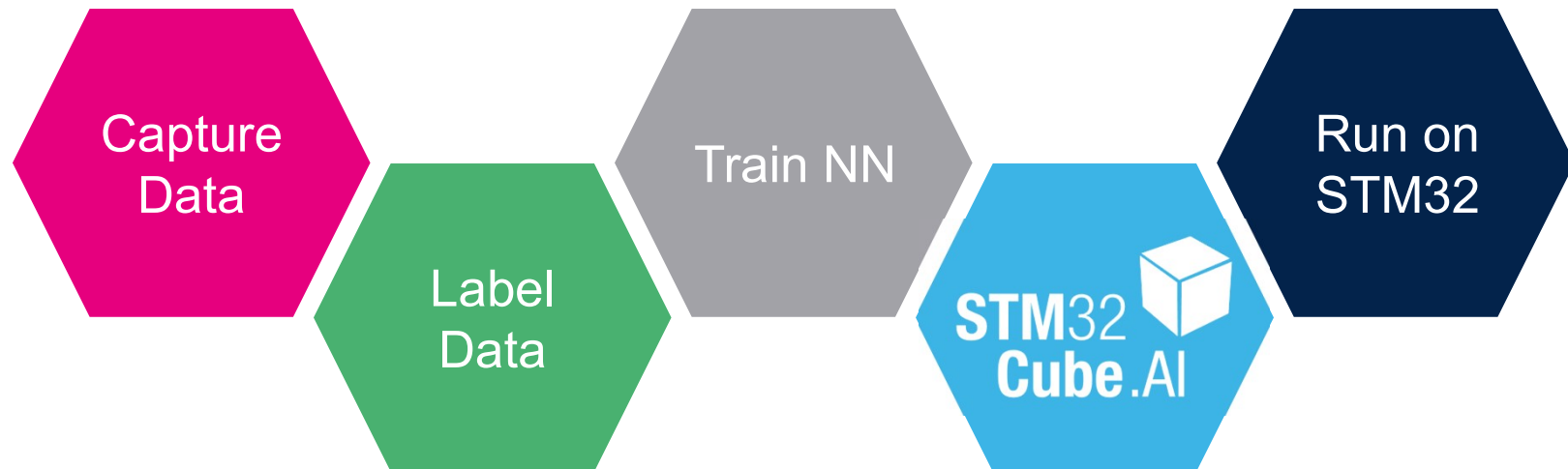
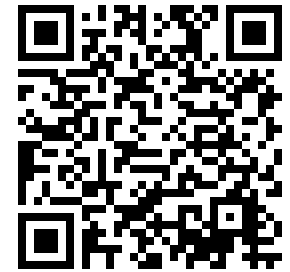
Predictive maintenance of reflow oven

https://www.st.com/content/st_com/en/campaigns/artificial-intelligence-at-the-edge.html

For more information



www.st.com/STM32CubeAI



Thank you

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