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AI solutions

August 4th, 2022

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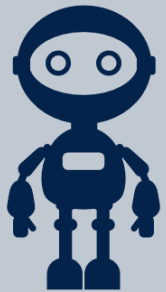
Senior Technical Marketing Manager

What is AI?

The evolution of AI

Artificial Intelligence (AI)

Early Artificial Intelligence stirs excitement



Machine Learning (ML)

Machine Learning begins to develop



Deep Learning

Deep Learning breakthroughs drive AI boom



Any technique that enables computer to mimic **human behavior**

Subset of AI. Algorithms and methodologies that improve over time through **learning from data**

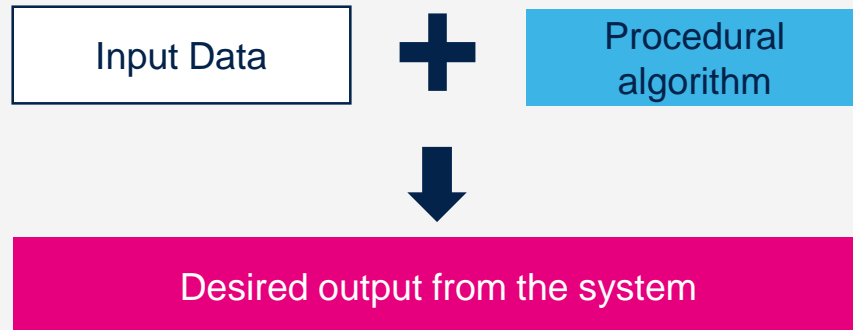
Subset of ML. Learning algorithms that derive meaning from a **huge amount of data**, by using a hierarchy of multiple layers that **mimic the neural networks of the human brain**

1950 1960 1970 1980 1990 2000 2010 2020

A new way to add environment awareness to your products

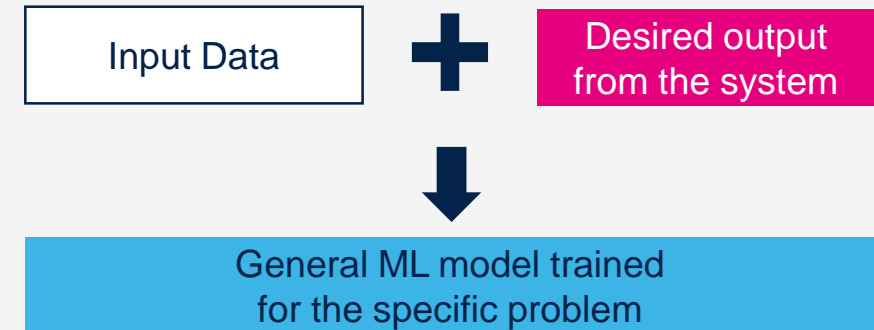
Create more robust software using Machine Learning on STM32

Standard programming Handcrafted rules based on experience



- Requires domain expertise to code
- Need to rewrite if environment evolves

Machine Learning Rules learnt from real-world data



- Generate code from real-world observations
- Re-learn from data if environment evolves

AI is used today in almost every market segment

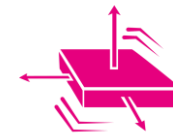
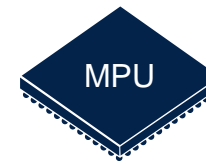
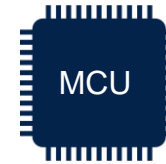


Embedded AI technology trend

**“Global Shipments of Deep Edge AI Devices
to Reach 2.5 Billion by 2030”**

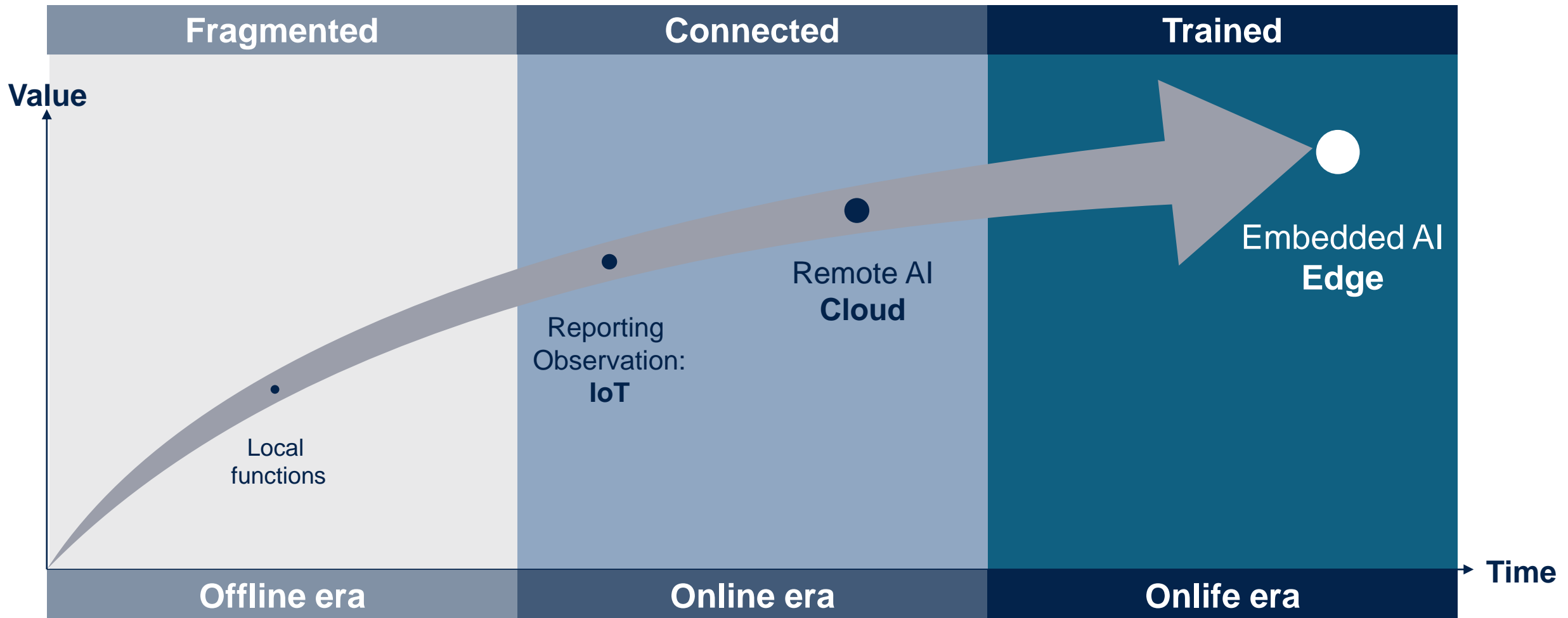
Source: [ABI Research](#)

AI technologies are now
embedded inside end devices
(MPU, MCU and sensors).



Growing community and ecosystem of **Deep Edge AI** technologies focusing on standalone, low-power and cost-efficient embedded solutions.

The quest for an ever-SMARTER infrastructure



Artificial intelligence at the Edge

Moving part of Artificial Intelligence closer to the data acquisition brings several benefits



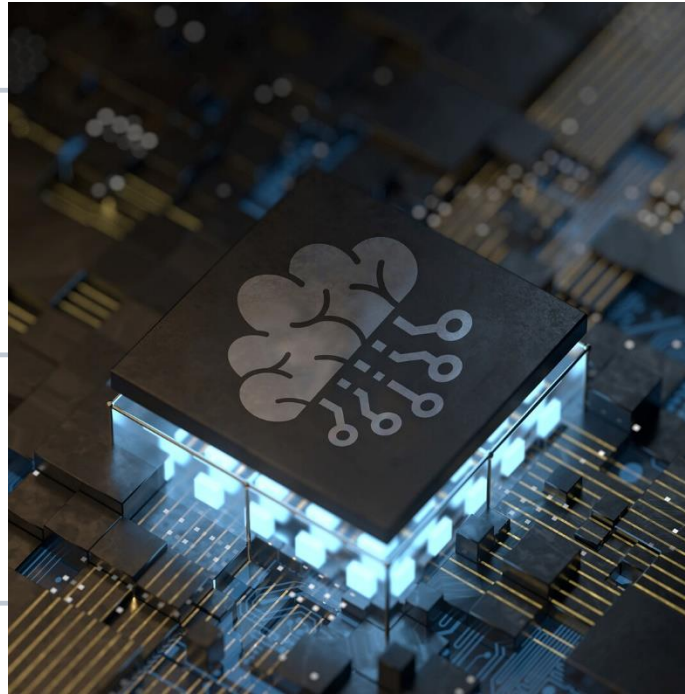
Ultra-low latency
Real-time applications



More reliability



Security of data
No sharing in the cloud



Privacy by design
GDPR compliant



Sustainable on energy
Low-power consumption



Better user experience

A step too big to climb

Organizations main challenges – AI Skills & datasets

FAILURE RATE FOR AI/OT PROJECTS

(Cisco Connected Research Futures)

74%

Lack of adequate data sets

15Months

Average time to collect & label data
(Mc Kinsey)

Lack of data scientists

130,000

Data Scientist shortfall in the US
(IBM Quant Crunch Report)

EMBEDDED DEVELOPERS

(IDC)

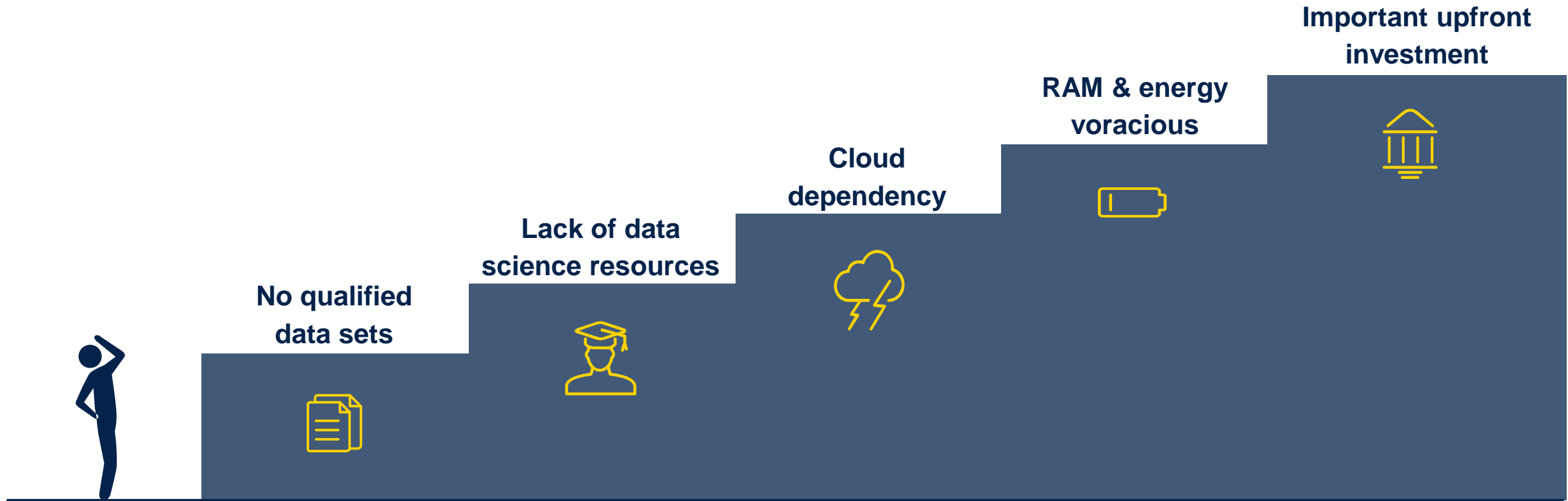
1.2Million

0.2%

With some AI skills

For most companies, creating an edge AI device is a long journey with extraordinary challenges

Investment, complexity and development time are often barriers to AI adoption













Start today with deep edge AI

**“ If only
I had solutions to overcome
AI design challenges**

**THIS IS WHERE WE COME
IN**

Whatever your company's profile, you will find an AI solution suited to your needs

COMPANY'S PROFILE	USE CASES		
	Anomaly detection	Classification	Deep Learning
  Embedded developers <ul style="list-style-type: none">▪ No dataset available▪ No dedicated AI Team			Engineering Services 
  Team with AI expertise <ul style="list-style-type: none">▪ Dataset available▪ AI Team		 	

For embedded developers

NanoEdge™ AI Studio, an automated ML design solution

NANOEDGE AI
STUDIO 



A unique solution thought from scratch

HOW DID WE DO IT?

We re-wrote, from the algebra, ML and signal processing algorithms so that they can **LEARN** and **INFER** inside STM32

- Patented technology
- Designed for embedded developers
- Ultra memory efficient (Flash and RAM)
- Unsupervised learning in the device
- No dataset need
- Superior security
- Small footprint, runs on any STM32 microcontroller
- Close to 100% accuracy and confidence
- For anomaly detection, classification and extrapolation problems

For teams with AI expertise

STM32Cube.AI helps you accelerate your embedded development



Easily evaluate, convert and deploy Machine Learning and Deep Neural Networks on STM32

An AI extension integrated with STM32Cube MCU development environment to **OPTIMIZE** and **TUNE** models, directly on target

- Develop and train your model with major AI frameworks



- Best ML performance on STM32 (MLPerf™ Tiny benchmarks)
- Validate performance directly on target
- Small footprint, runs on any STM32
- To address any kind of problem with ML or CNN libraries



Making Edge AI accessible to all STM32 portfolio

STM32Cube.AI & NanoEdge AI are compatible with all STM32 series



MPU

STM32MP1

4158 CoreMark
Up to 800 MHz Cortex –A7
209 MHz Cortex –M4



High Perf
MCUs

STM32F3

245 CoreMark
72 MHz Cortex-M4

STM32G4

569 CoreMark
170 MHz Cortex-M4

STM32F2

Up to 398 CoreMark
120 MHz Cortex-M3

STM32F4

Up to 608 CoreMark
180 MHz Cortex-M4

STM32F7

1082 CoreMark
216 MHz Cortex-M7

STM32H7

Up to 3224 CoreMark
Up to 550 MHz Cortex -M7
240 MHz Cortex -M4

Optimized for mixed-signal Applications



Mainstream
MCUs

STM32F0

106 CoreMark
48 MHz Cortex-M0

STM32G0

142 CoreMark
64 MHz Cortex-M0+

STM32F1

177 CoreMark
72 MHz Cortex-M3



Ultra-low Power
MCUs

STM32L0

75 CoreMark
32 MHz Cortex-M0+

STM32L1

93 CoreMark
32 MHz Cortex-M3

STM32L4

273 CoreMark
80 MHz Cortex-M4

STM32L4+

409 CoreMark
120 MHz Cortex-M4

STM32L5

443 CoreMark
110 MHz Cortex-M33

STM32U5

651 CoreMark
160 MHz Cortex-M33



Wireless
MCUs

STM32WL

162 CoreMark
48 MHz Cortex-M4
48 MHz Cortex-M0+

STM32WB

216 CoreMark
64 MHz Cortex-M4
32 MHz Cortex-M0+

Latest product generation

Integrate your ML models more easily with our application-oriented code examples

Time series-based monitoring



FP-AI-MONITOR1

- Predictive maintenance and much more sensor-monitoring apps
- Runs Libraries from NanoEdge™ AI Studio

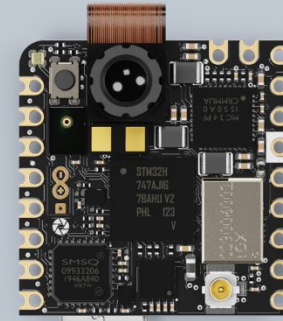
Audio and Sensing



FP-AI-SENSING1

- Human Activity Recognition
- Acoustic Scene Classification
- Data logging, labeling and result on BLE applications

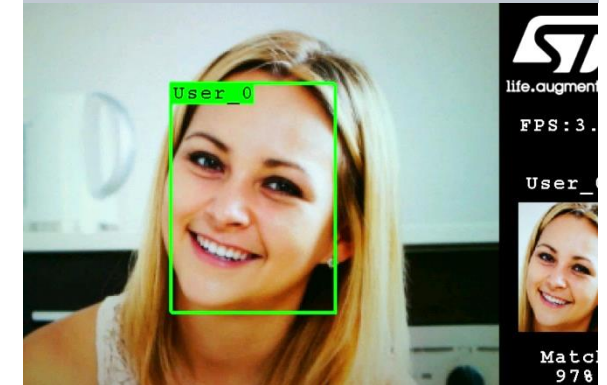
Computer Vision



FP-AI-VISION1

- Food recognition (CNN)
- Person presence detection (CNN)
- People counting (Object detection NN)
- Image processing Library

Face recognition



FP-AI-FACEREC1

- Face detection and recognition
- Fully functional without cloud connection

We provide everything to kick off your project

Design documentation



Getting started

Be guided step-by-step to learn STM32 ecosystem

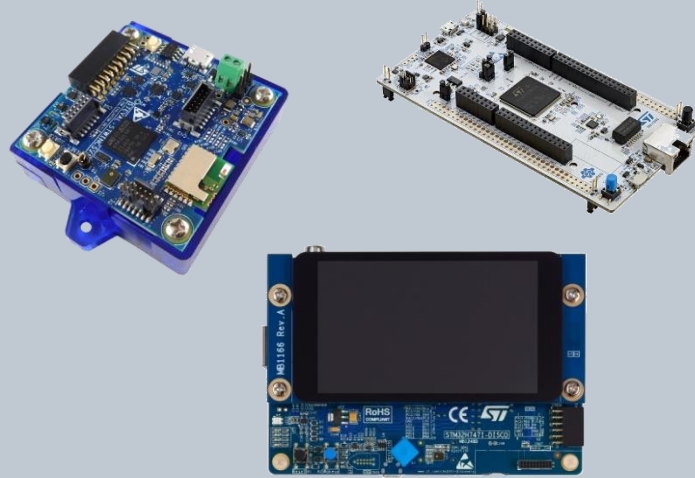


Development zone

Get started on application development and project sharing

- **Wiki by ST** is a great forum to learn and start developing AI on STM32!
- Videos of application examples
- Massive Open Online Course (MOOC)

Hardware and software tools



- Evaluation platforms for STM32 MCU/MPU
- Extra sensor boards
- Full software suite

Support & Updates



- **ST Community:** STM32 ML & AI group
- Competence center
- Distributor certified FAE
- Support center
- Newsletter

Stay focused on your expertise, we bring you everything else

AI On The Edge - Uses Cases



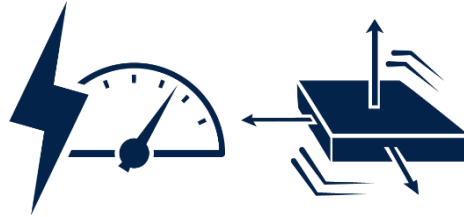
Industrial maintenance

Pump monitoring



NANOEDGE AI

STM32
Cube.AI



Problem

- Every pump has its unique signature according to pipe size, shape and mounting

Solution

- Learn the pattern of every pump in operation and detect anomalies as they occur using vibration or current sensor
- When anomaly is detected the second library is activated to recognize the default (classification)

Benefits

- Close to 100% accuracy due to local learning
- Extreme adaptability of model to wide range of pumps
- Ability to add seasonal learning phases



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Industrial maintenance

Circuit breakers predictive maintenance



Problem

- Mechanical aging of circuit breakers is virtually impossible to anticipate leading to
 - Unpredictable power outages
 - Costly production stoppage

Solution

- Circuit breaker ageing can be analyzed from vibration patterns during switching
- Vibration sensor learns normal pattern of switch and identify discrepancy to learned model



Industrial maintenance

Electrical arc detection



Problem

- Solar panels are often damaged by electric arcs caused by impurities or physical damage
- This can lead to electric fire causing damage or endanger nearby people

Solution

- Arc abnormal event can be identified by classifying arc fault features using ML or Neural Networks
- Local arc detection greatly increase reactivity to shut down the system, making panel safer and decreasing the amount of damage



Building management Leak detection



NANOEDGE AI

STM32
Cube.AI



Problem

- Flush leaks represent millions of gallons of water wasted annually in hospitality industry
 - Threshold based sensors unable to avoid false positives
 - Thousands of different set ups requiring local learning

Solution

- Vibration sensor learns normal pattern of flush and discern between leaks, ghost flushes and surrounding noises

Benefits

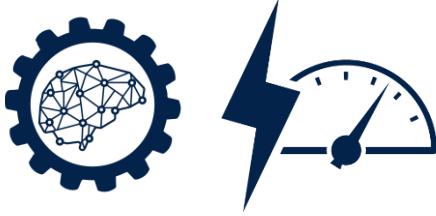
- Ability to learn any flush automatically
- Only wakes up when an anomaly is detected



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Home appliance

Air conditioner filter monitoring



Problem

- In an air conditioning system, it is very difficult to detect when a filter is clogged
- Engineers had imagined installing cameras to film the colorimetry of the filters and compare it to a pre-learned model to detect when a filter was obstructed => they failed

Solution

- Microcontroller learns the “shape” of the high-frequency directly inside the motor control card at the time of the first start-up of air conditioner
- No additional sensor is needed
- When the filter is slightly obstructed, the shape of the high frequency current is distorted and detected by the microcontroller



e-Vehicles & Power Tools

Battery management system

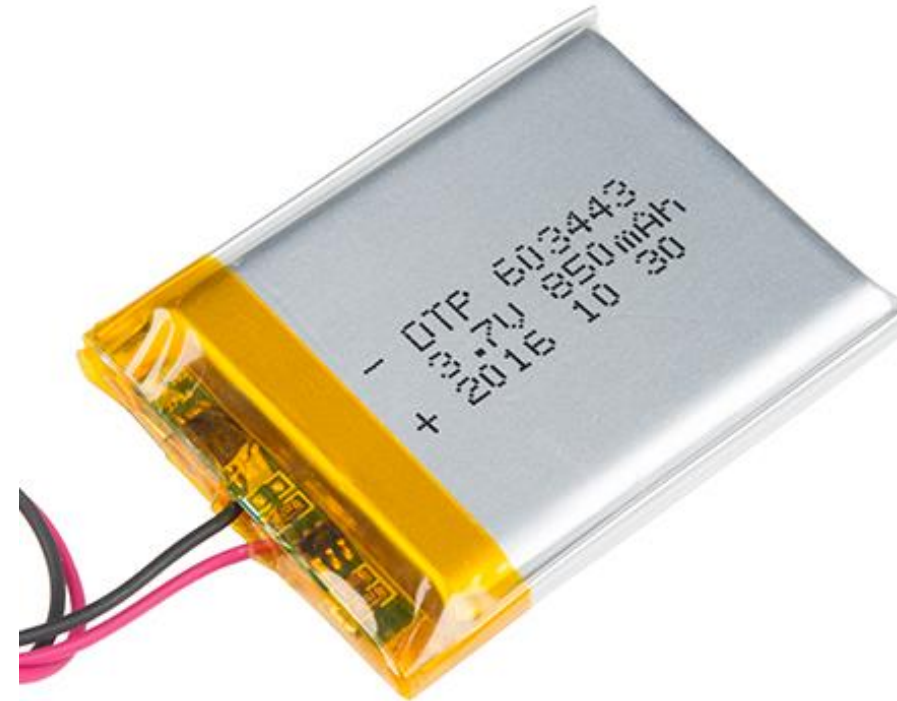


Problem

- Understanding battery state of health is mandatory for critical equipment when on-time battery replacement is needed
- State of health assessment allows as well to make an optimal battery allocation across multiple equipment based on their requirements

Solution

- Learn the charge / discharge cycles of the battery using deep learning approach
- When the state of health is below a certain level, the battery can be replaced



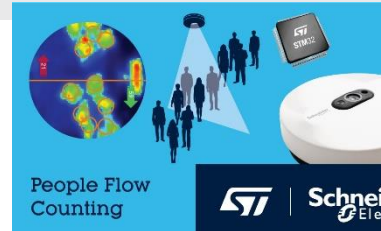
ST co-development and partnerships

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 https://www.st.com/content/st_com/en/partner/partner-program.html



Predictive maintenance of reflow oven

<https://youtu.be/FjHfnwJdMEc>

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



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