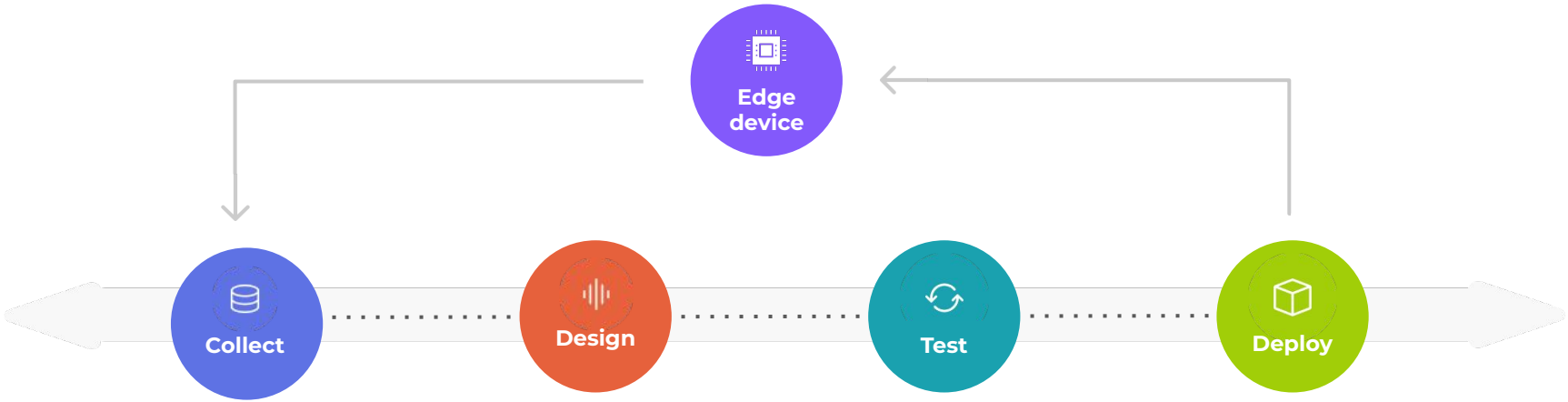
EDGE IMPULSE

Making the impossible, possible

Aurelien Lequertier, VP Solutions

Develop edge ML applications with Edge Impulse

The infrastructure and integrations your data science and ML teams need.



Rapidly build custom datasets

Develop models & algorithms

Accurately test model performance

Easily deploy on any edge target

Empower all enterprises and developers with ML

40,000+
Developers

75,000+
Projects

1,000+
Enterprises

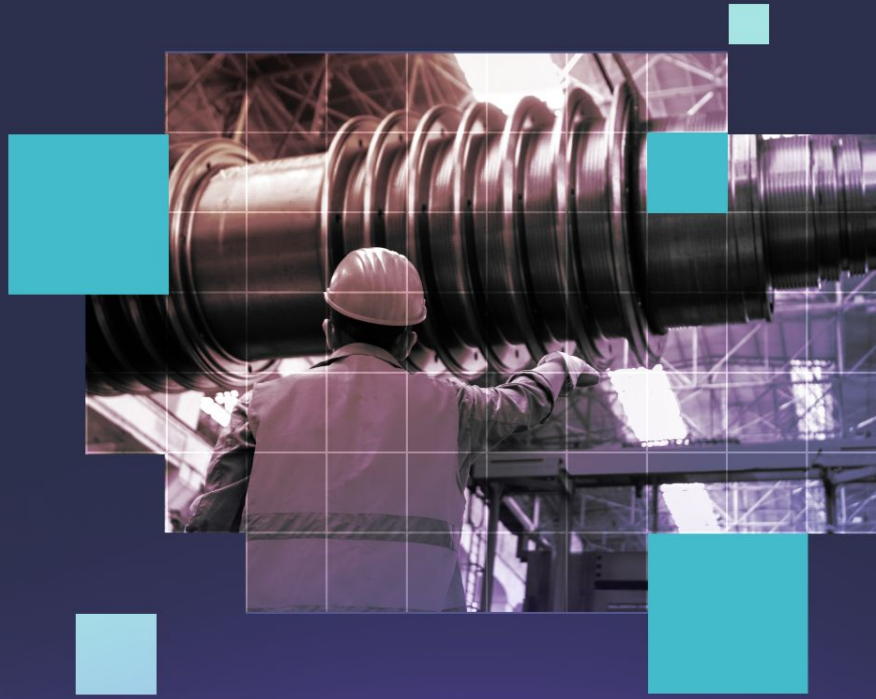
TRUSTED BY LEADING ENTERPRISES

Any sensor, any data, any use case

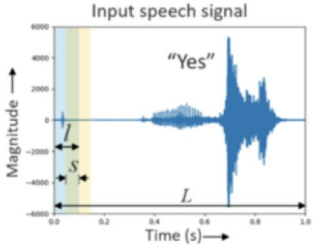
	Ultra low power	Low-end MCU	High-end MCU	NPU	MPU	GPU
Memory	Anomaly detection 10kB	Sensor fusion classification 18kB	Audio classification 50kB	Image classification 256kB	Object detection complex voice processing 1MB	Video classification 1GB+
Sensor	✓	✓	✓	✓	✓	✓
Audio	✓	✓	✓	✓	✓	✓
Image			✓	✓	✓	✓
Video					✓	✓

EDGE IMPULSE

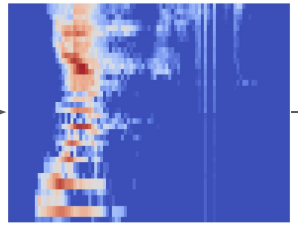
Few-Shot Keyword Spotting



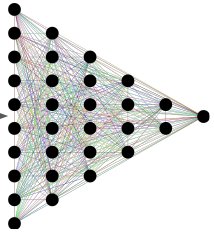
How Keyword Spotting works?



Collecting data



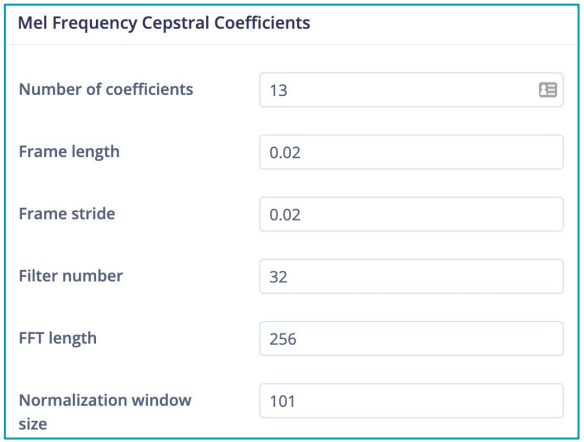
Features extraction (MFCC)



Neural Network

Some typical Keyword Spotting model

- Extracted features fed into NN
- 1D or 2D Convolutional network



Few-Shot Keyword Spotting

Problem

Keyword spotting requires giant, diverse datasets which are difficult to source

Few-Shot Keyword Spotting

~560 samples,
class balanced

Last training performance (validation set)

ACCURACY
75.2%

LOSS
1.11

Confusion matrix (validation set)

	NO	NOISE	UNKNOWN	YES
NO	68.2%	0%	18.2%	13.6%
NOISE	3.7%	85.2%	11.1%	0%
UNKNOWN	15.6%	9.4%	56.3%	18.8%
YES	3.1%	6.3%	0%	90.6%
F1 SCORE	0.68	0.84	0.63	0.83

Few-Shot Keyword Spotting

~10.8k samples,
class balanced

19x the data for 12% better accuracy

Last training performance (validation set)

ACCURACY
87.3%

LOSS
0.41

Confusion matrix (validation set)

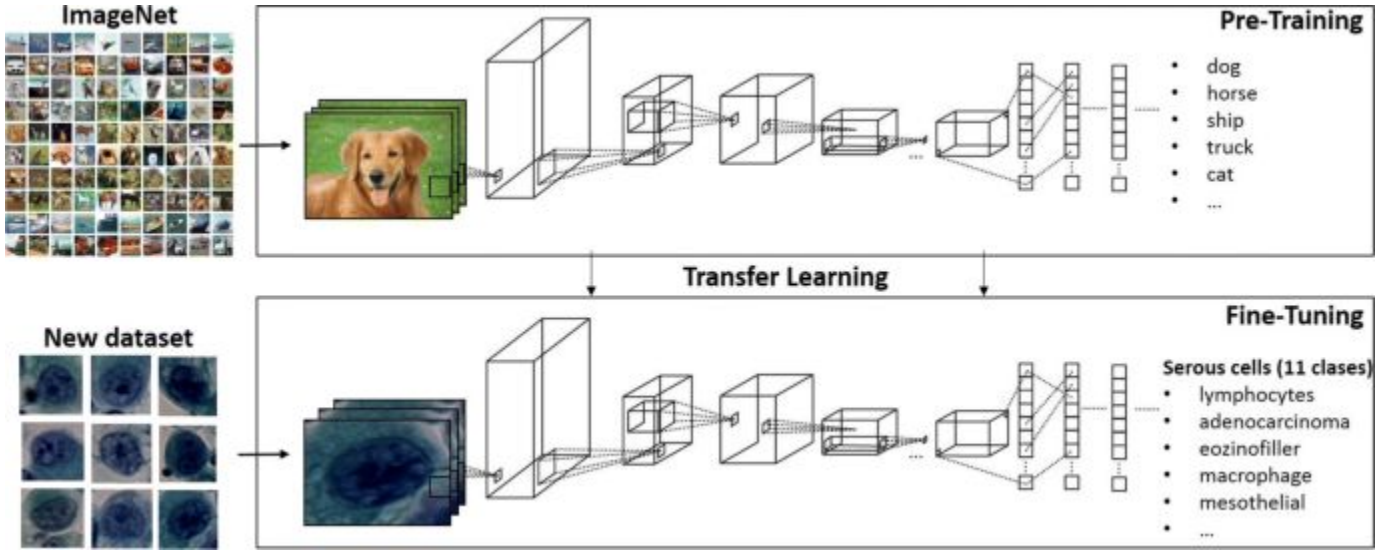
	NOISE	OFF	ON	UNKNOWN
NOISE	95.4%	0.2%	0.4%	4%
OFF	2.0%	87.1%	5.6%	5.4%
ON	4.2%	6.1%	86.4%	3.3%
UNKNOWN	10.3%	4.9%	4.5%	80.3%
F1 SCORE	0.90	0.88	0.88	0.83

Few-Shot Keyword Spotting

Solution

Transfer learning, just like we do with images, but for keyword spotting

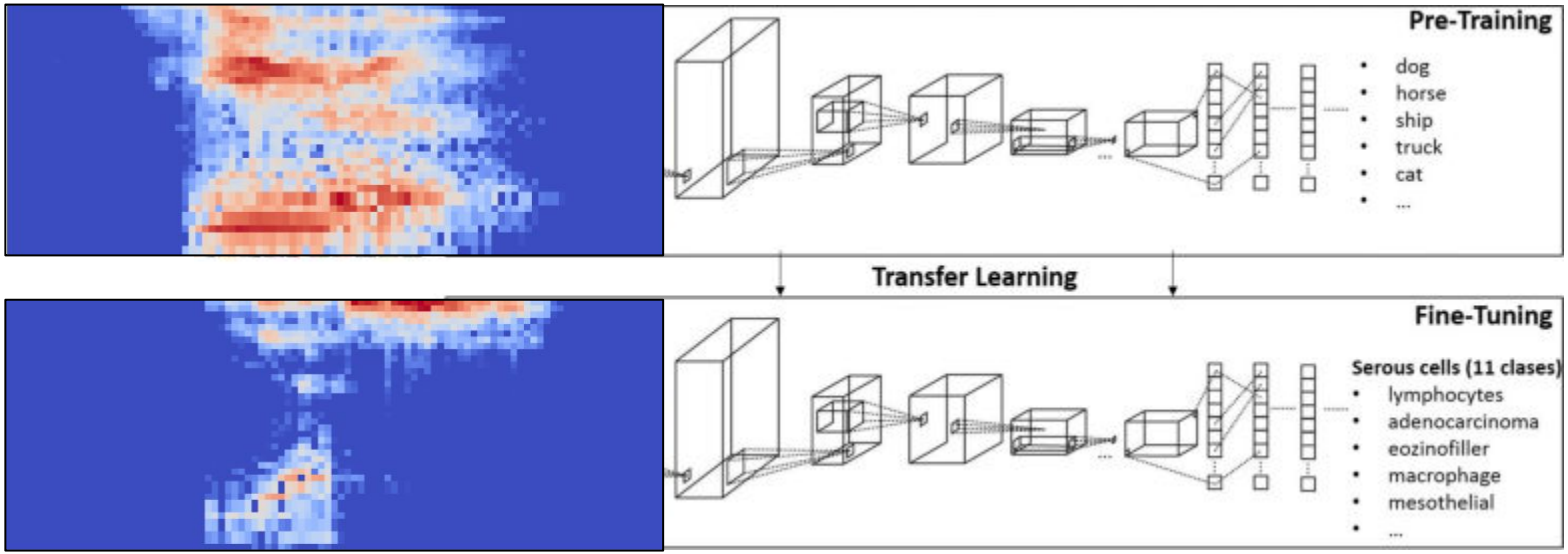
Few-Shot Keyword Spotting



Few-Shot Keyword Spotting

Millions of utterances in many languages

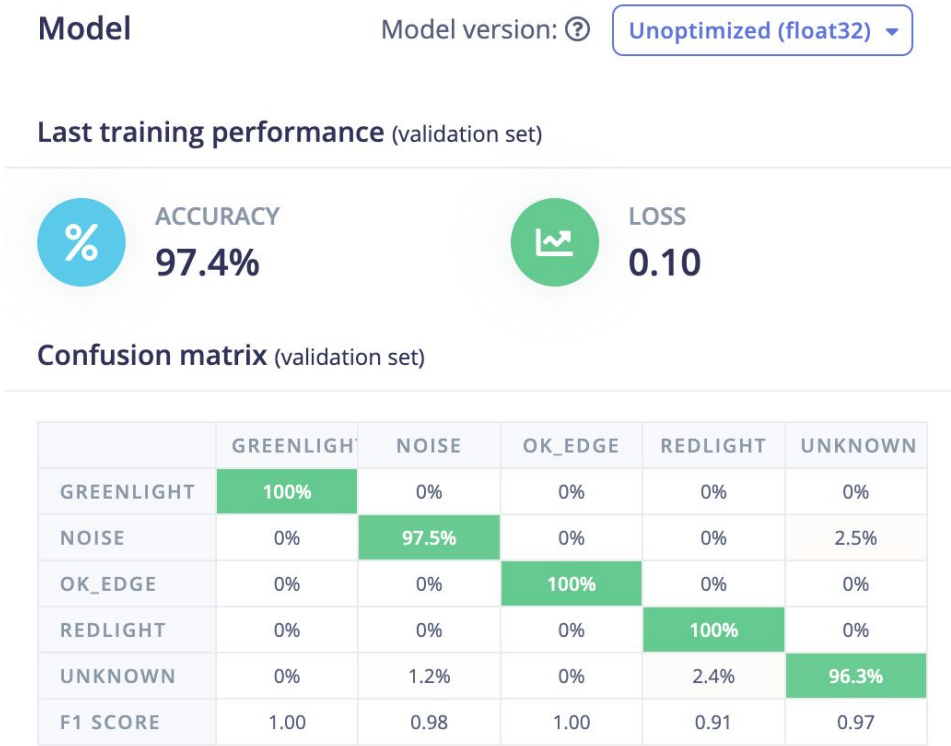
https://www.seas.harvard.edu/news/2021/12/voice-technology-rest-world



A few examples of specific utterances

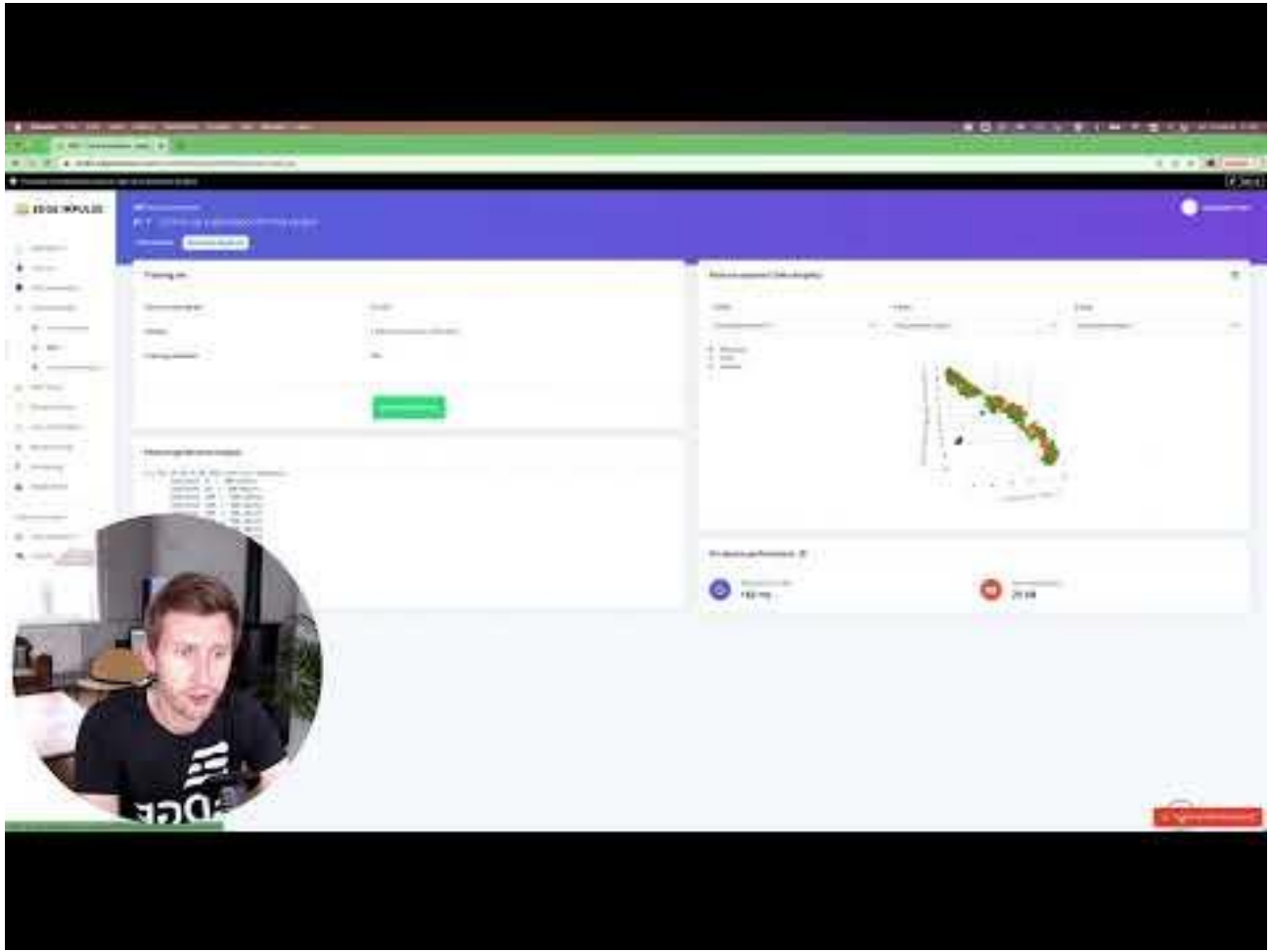
Few-Shot Keyword Spotting

Model trained with ~20 occurrences for each keyword



	GREENLIGH	NOISE	OK_EDGE	REDLIGHT	UNKNOWN
GREENLIGHT	100%	0%	0%	0%	0%
NOISE	0%	97.5%	0%	0%	2.5%
OK_EDGE	0%	0%	100%	0%	0%
REDLIGHT	0%	0%	0%	100%	0%
UNKNOWN	0%	1.2%	0%	2.4%	96.3%
F1 SCORE	1.00	0.98	1.00	0.91	0.97

Demo



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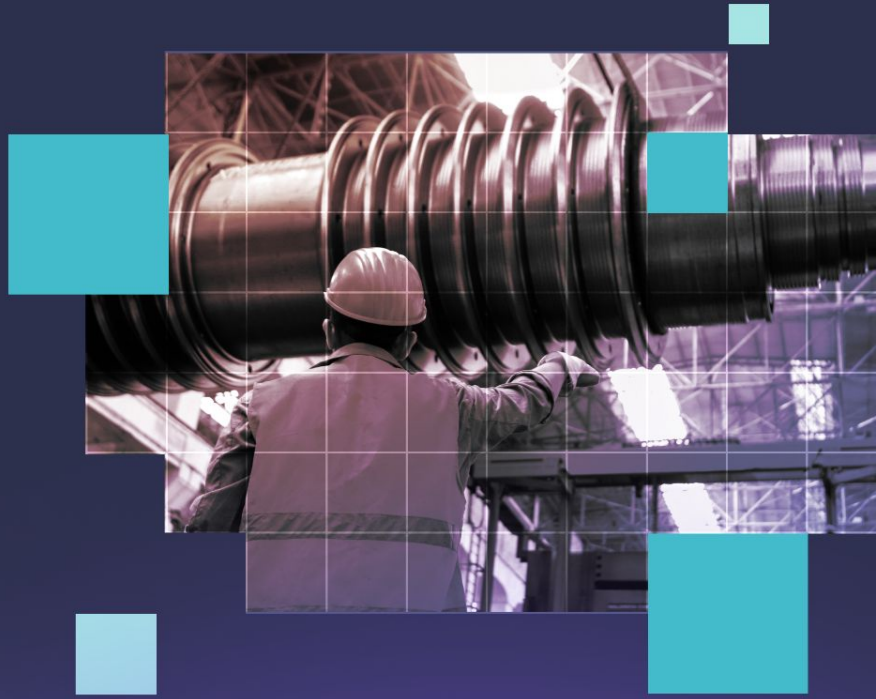
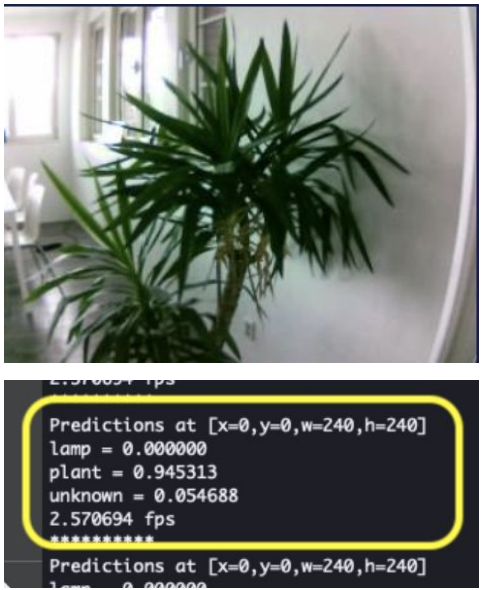
FOMO (Faster Objects, More Objects)



What is Computer Vision?

Image classification



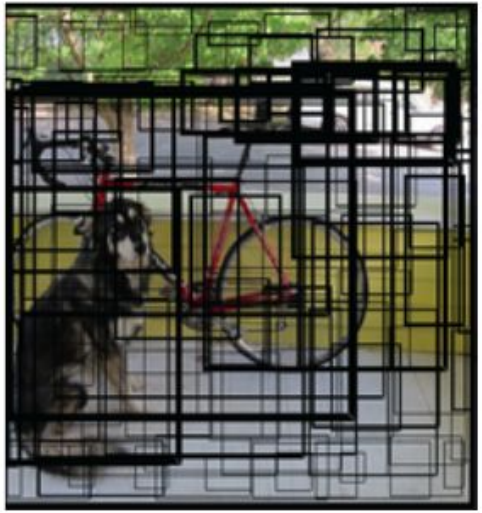
Object detection

Object Detection

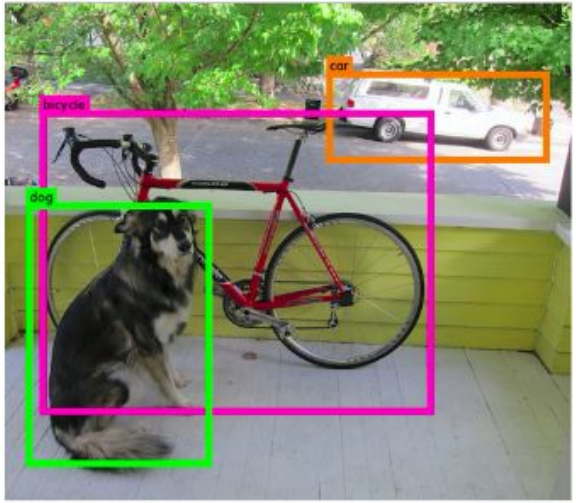
Problem

Traditional object detection models are poorly suited to MCUs

Object Detection



Multiple Bounding Boxes



Final Bounding Boxes

Source: https://pjreddie.com/darknet/yolov1/

Object Detection

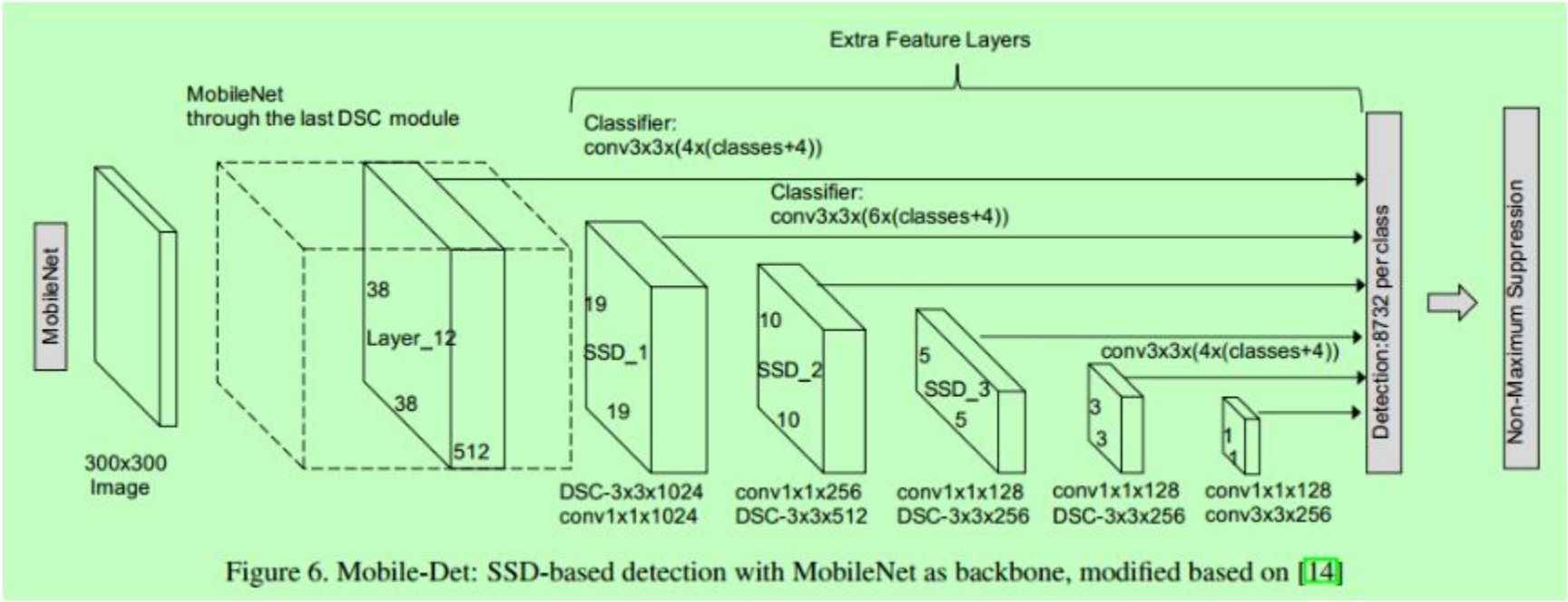


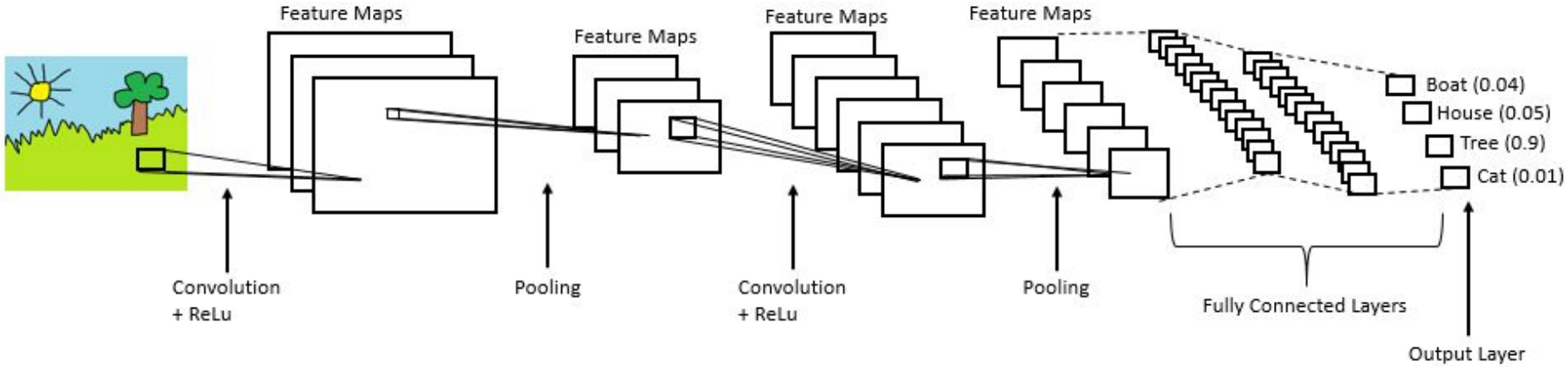
Figure 6. Mobile-Det: SSD-based detection with MobileNet as backbone, modified based on [14]

Object Detection

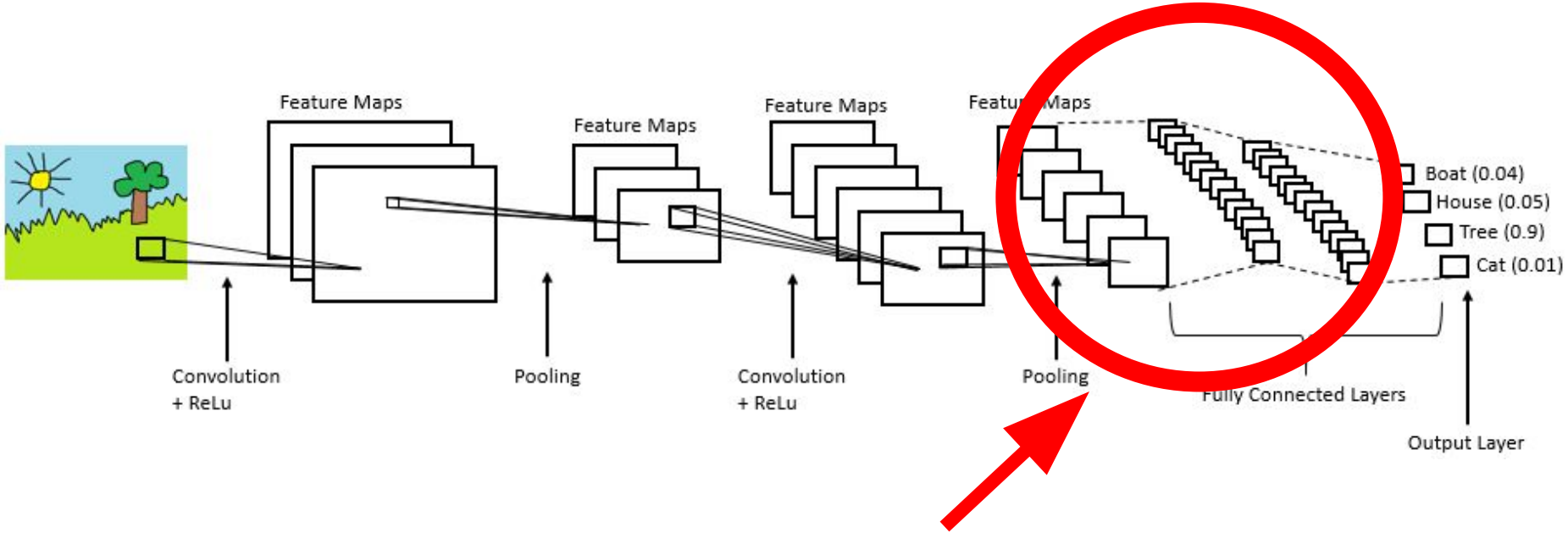
Solution

Simplify the model so that it is smaller and better suited to the problems in scope

Object Detection



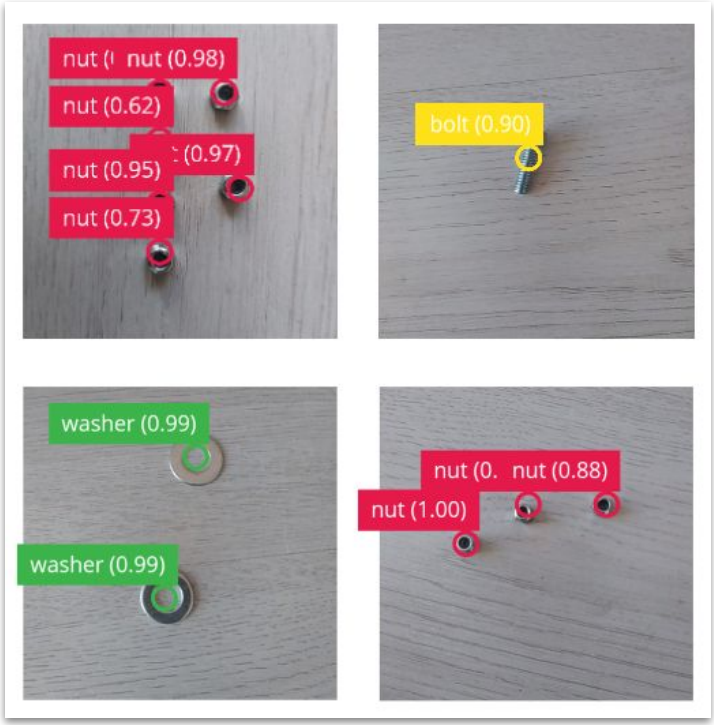
Object Detection



Replace with single per-region class probability map

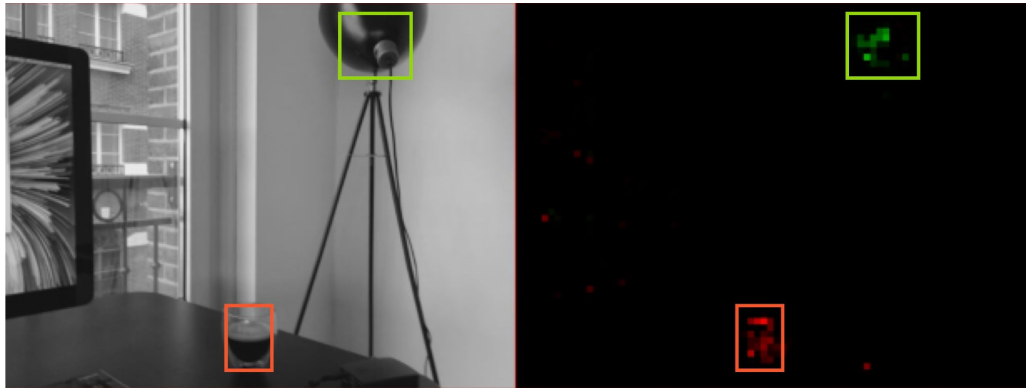
Introducing FOMO: Faster objects, more objects

- Object detection on MCUs
- Based on MobileNet architecture
- Ultra fast: 60 fps on RPi class, 30 fps on Cortex M7 (Arduino Nicla Vision), 10 fps on Cortex M4F
- Better at detecting smaller and more numerous objects
- Capable of segmentation and counting objects

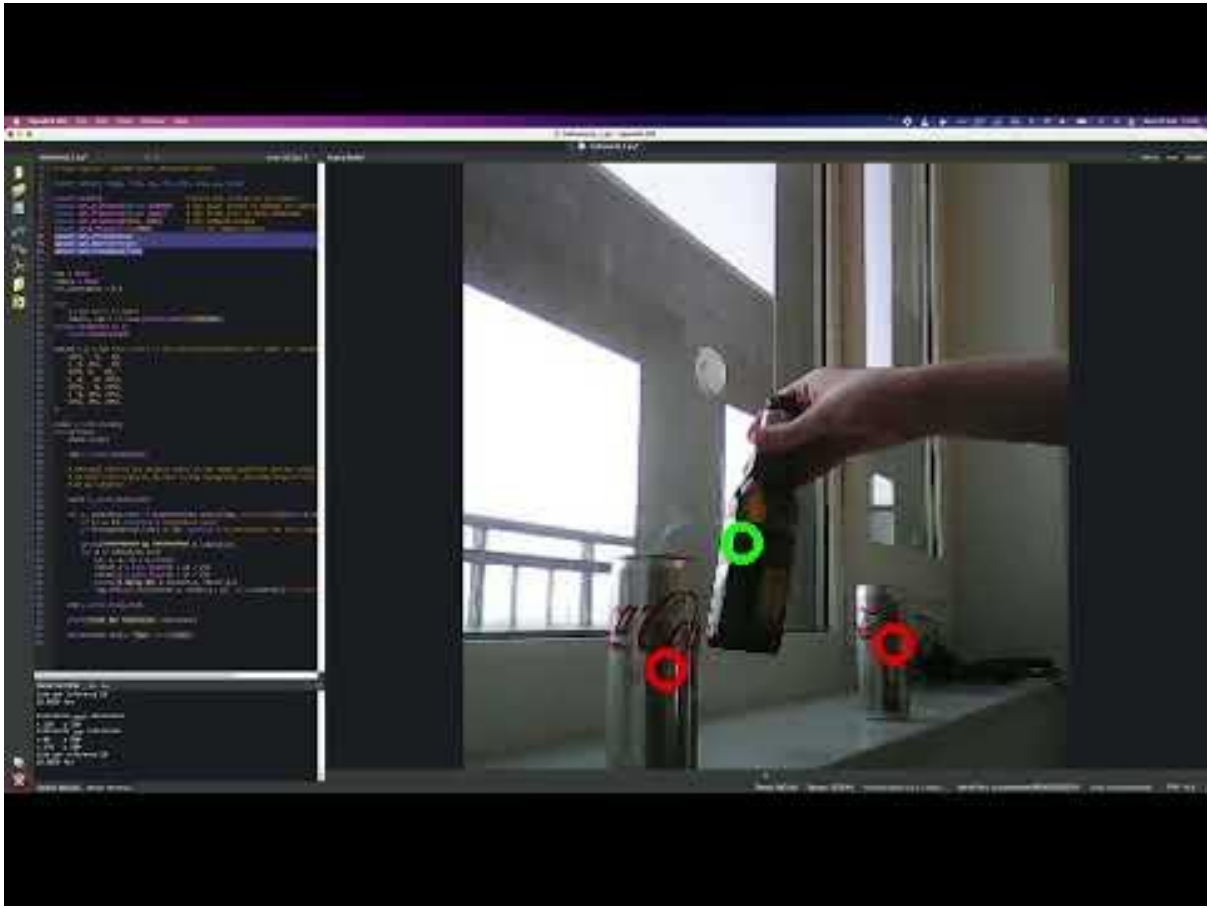


Introducing FOMO: Faster objects, more objects

- Heatmap of objects location
- Training on centroids



Demo



To go further

Create your free account on edgeimpulse.com

Build your first keyword spotting model in 5 minutes: studio.edgeimpulse.com/evaluate

FOMO: edgeimpulse.com/fomo

Documentation: docs.edgeimpulse.com

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Thank you!

@aureleq