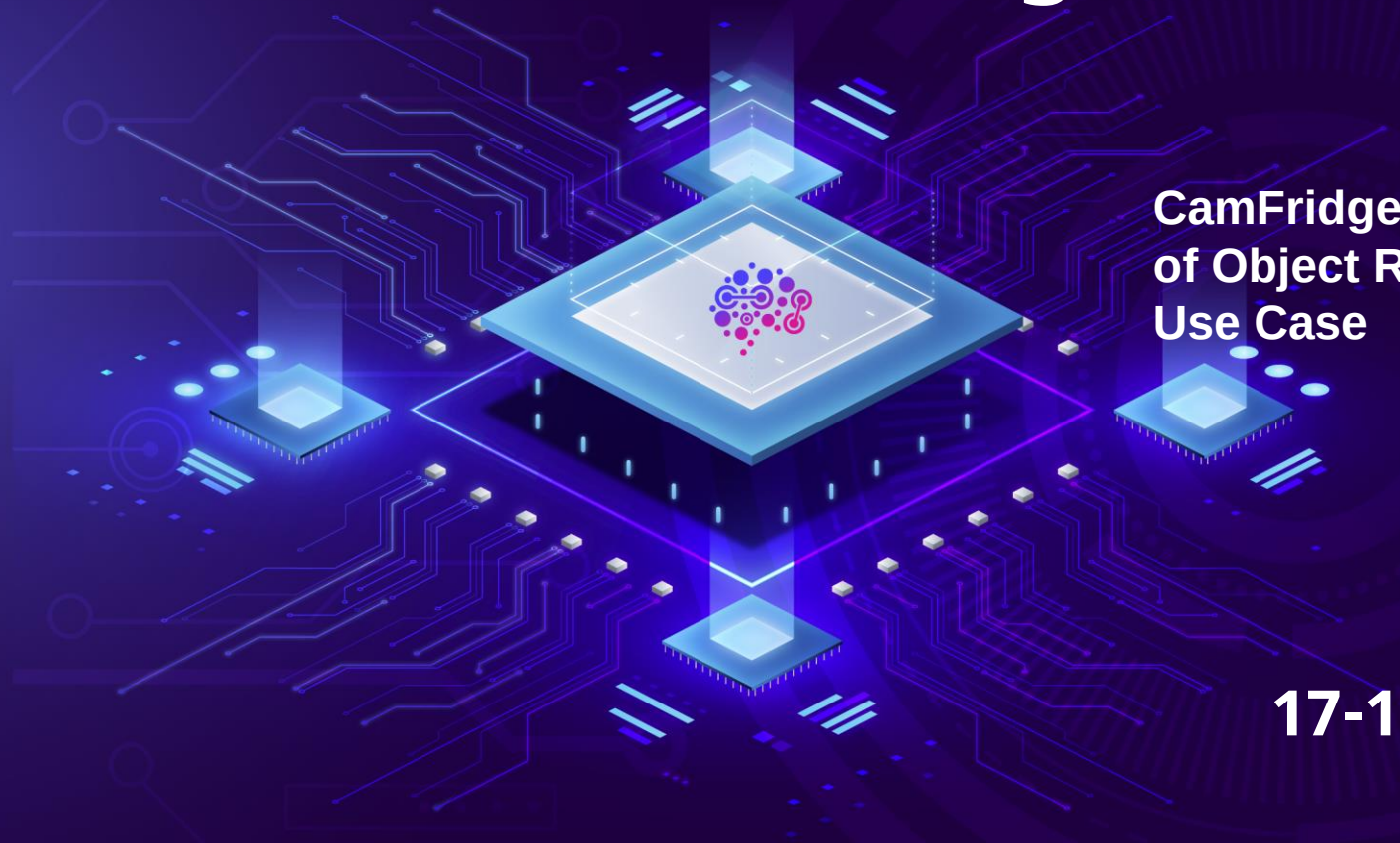
European Conference on EDGE AI Technologies and Applications - EEAI



CamFridge: Edge vs. Cloud Implementation of Object Recognition in the Fridge with Camera Use Case

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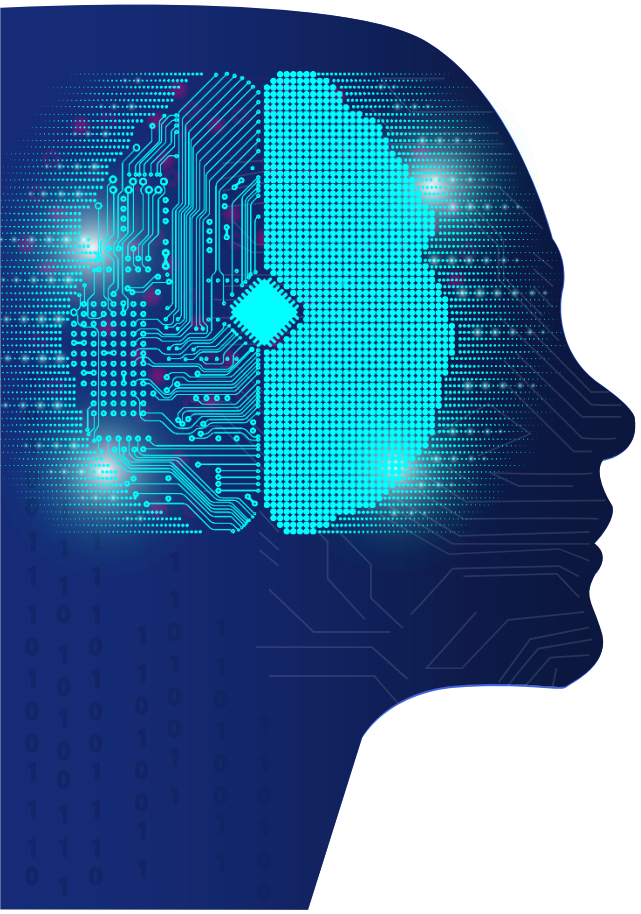
17-19 October 2023, Athens, Greece

Presentation Outline



- Introduction
- Research Goal
- Methodology
- Design and Implementation
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- Future Research
- Conclusion

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Introduction

In the modern era, object detection technologies have revolutionized various industries by enabling computer vision to *identify objects in visual data.*

These technologies find applications in sectors such as automotive, retail, security, healthcare and *home appliances*.

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Research Goal

Arçelik has a refrigerator called CamFridge, which is equipped with an embedded camera and is designed for object recognition.
Initially, we had an artificial intelligence model running in the cloud.

However we conducted a performance comparison by running the model on a custom-developed board created by our company.

Our study focuses on a critical decision:
Whether to utilize edge computing (local devices) or cloud computing for our smart refrigerator.

Sensitivity: Internal / Non-Personal Data
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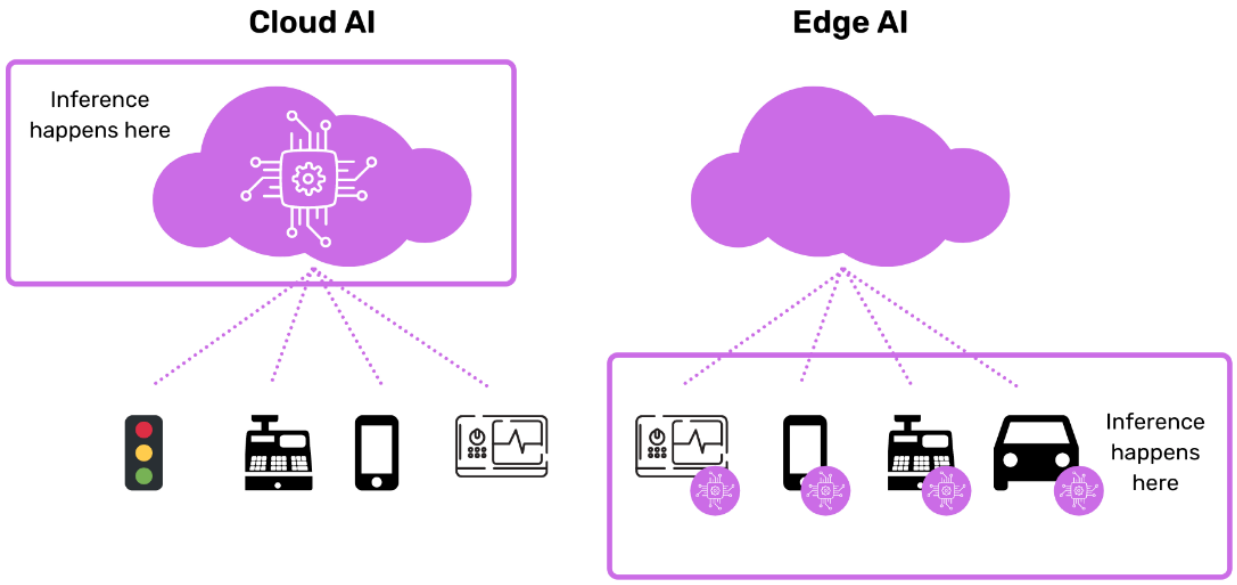
Methodology

EDGE AI

- Processes data immediately on the fridge.
- Offers low-latency, real-time decision-making.
- Suitable for our time-sensitive applications.
- Lack the required computing power for our complex models.



CLOUD AI

- Utilizes remote servers for data handling and analysis.
- Capable of managing complex models.
- Provides centralized management and scalability.
- May introduce latency due to data transfer to/from the cloud.
- Raises concerns regarding data security and privacy.

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Design and Implementation

Smart Refrigerator with Cameras:

In the Arçelik CamFridge smart refrigerator project, two cameras are strategically positioned—*one on the door and the other on the body.* This setup enables remote access for users to view refrigerator contents from their phones and explore *eco-friendly purchasing alternatives*.

Image Processing Workflow:

Upon refrigerator closure, snapshots are taken and sent to the cloud. Here, our object identification algorithm processes the images. The cloud-based algorithm then transmits the identified items along with the images to the HomeWhiz mobile application.

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Design and Implementation

Table 1: Operating Features of IMX8.

Parameter	Value
Core: Number of cores (SPEC)	1,4
Core Type	1 x Arm cortex-M7, 4 x Arm Cortex-A53
Operating Frequency [Maz] (MHz)	750,1400
L2 Cache (Max)(KB)	512
SRAM (kB)	512

As previously mentioned, we employed a custom-developed board powered by the IMX8 microprocessor, meticulously crafted by Arçelik's engineering team.

Curated the dataset by annotating images sourced from actual users' refrigerators.

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Design and Implementation

For the comparison, we chose YOLOv7 and YOLOv7-tiny because YOLOv7 is capable of being run on lightweight hardware but not at a high frame rate.

Our tests help to choose the worthiness of sacrificing detection quality over speed.

Compared to the other versions, the edge-optimized YOLOv7-tiny uses leaky ReLU as the activation function, while other models use SiLU as the activation function.

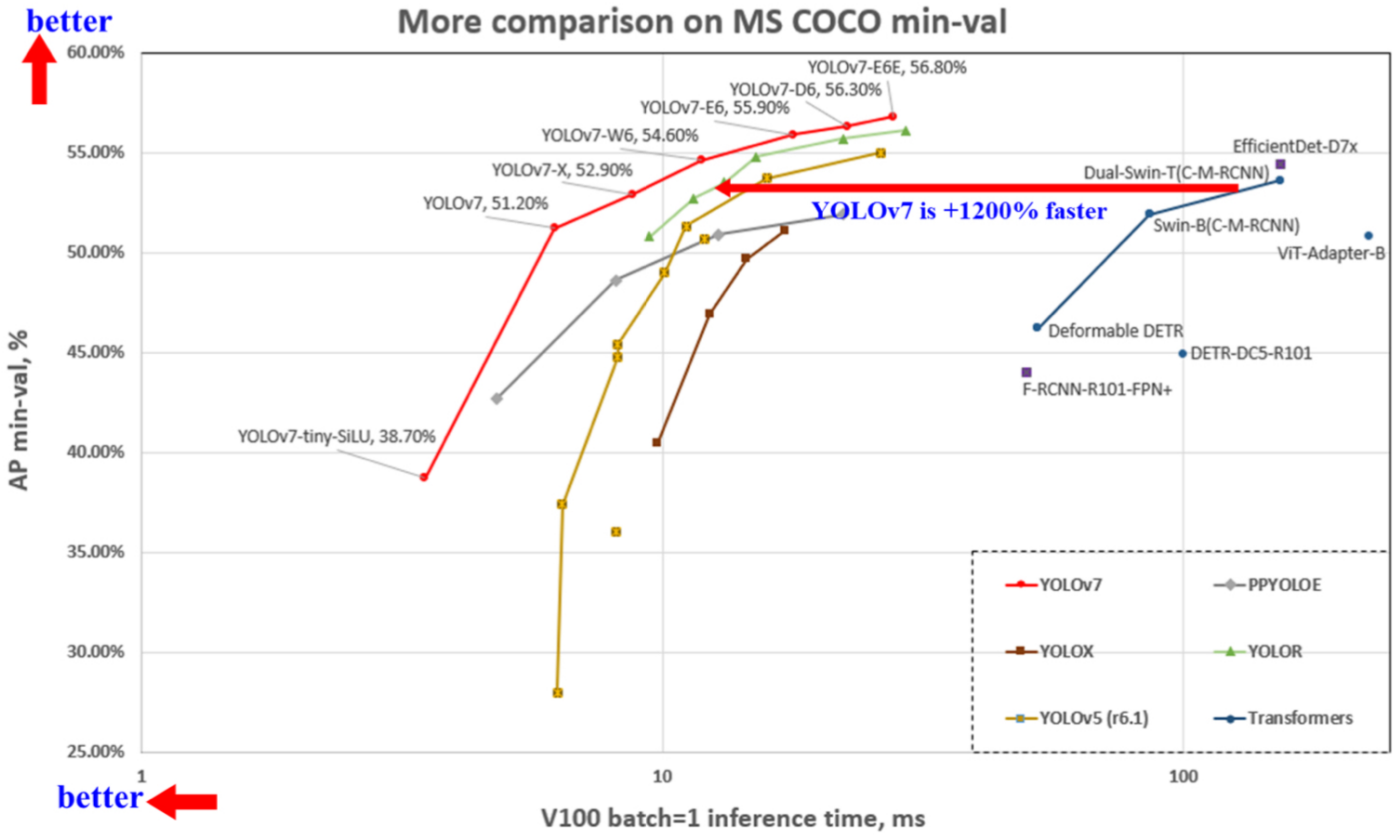

Figure 9: Comparison with other object detectors.

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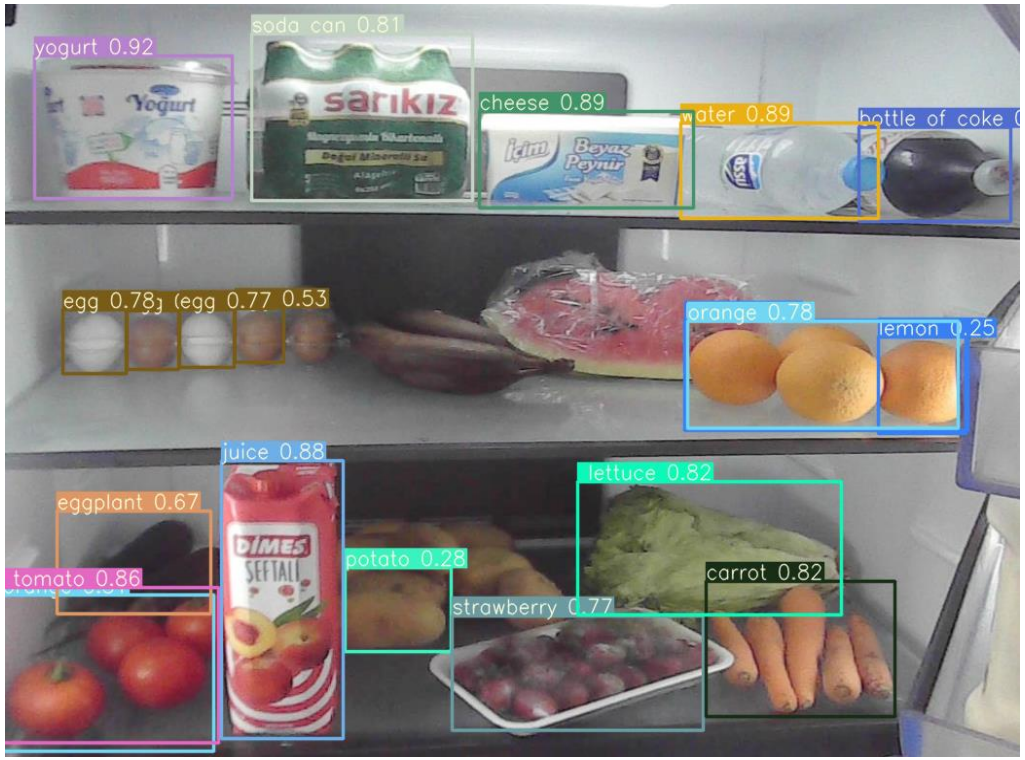
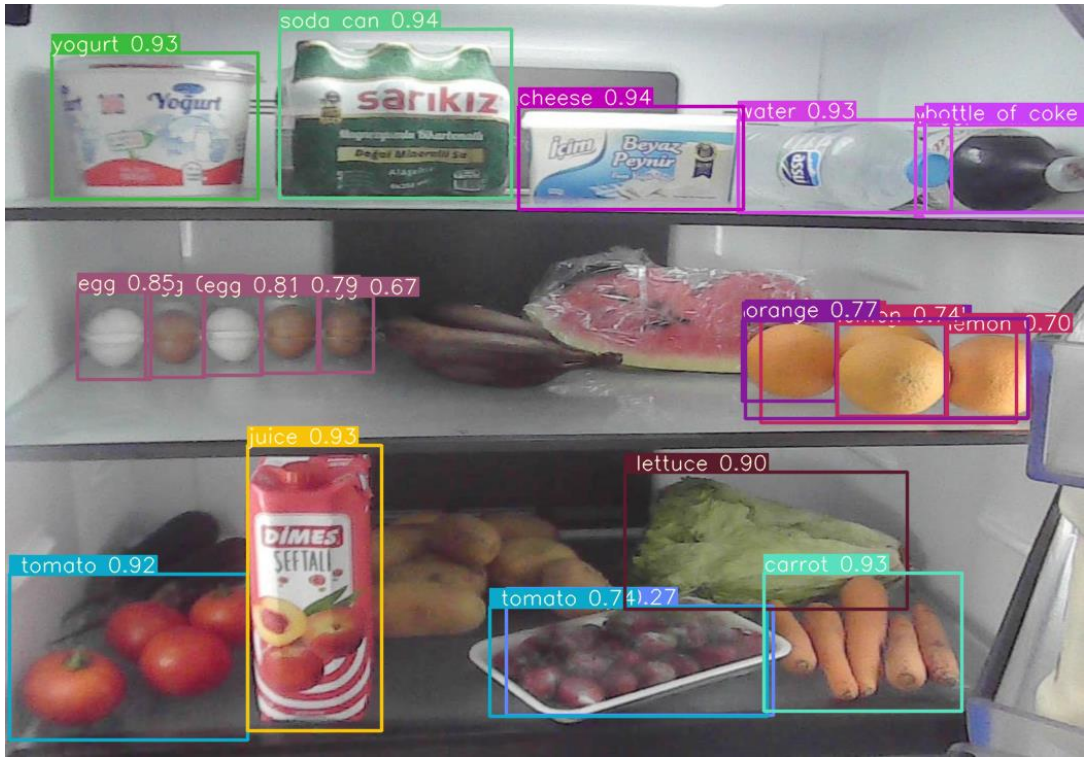
Experimental Results





1. Outcome of Our Edge-Based YOLOv7-Tiny Model.
2. Outcome of Our Cloud-Based YOLOv7 Model.

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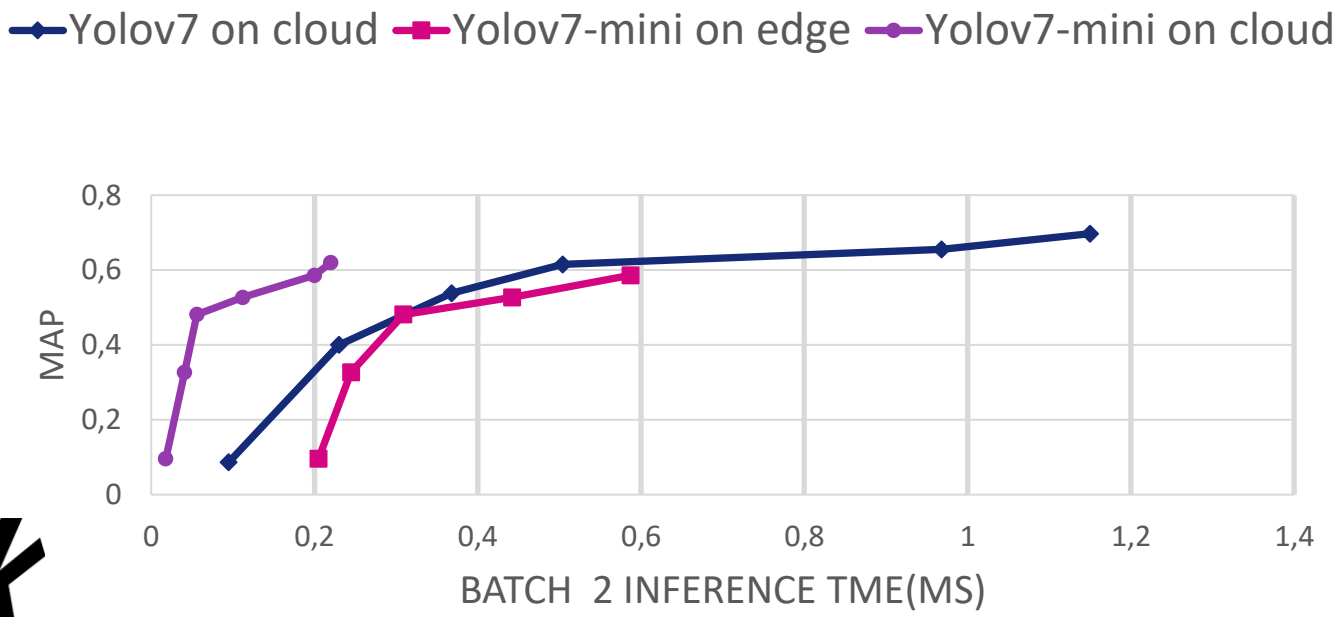
Conclusion

Table 2: Comparison of object detectors.

Model	#Param	Size	FLOPs	mAP@.5	Inference time
Yolov7	36.7M	73mb	103,7G	0,699	0,968 ms
Yolov7-tiny	6.1M	12mb	13,3G	0,621	0,597 ms



REBECCA

arçelik

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Future Research

- We aim to further improve the object recognition performance on the edge by using the Edge AI platform, which will be realized within the scope of the REBECCA project.

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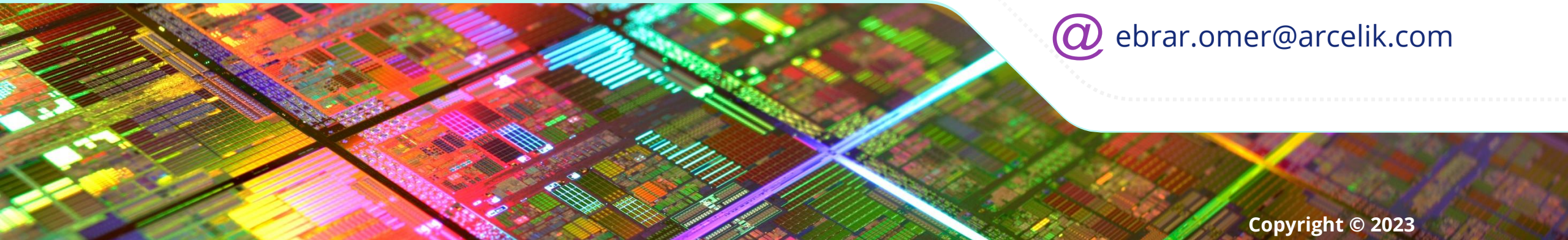
EDGE AI

Thank You

For your attention



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