# SMART RETAIL VERIFICATION

*Tanisha Bhatia (DESE), Shubham Lanjewar (DESE) and Pandarasamy Arjunan*

Edge AI 2025

## Background and Motivation

- Traditional retail relies heavily on manual item identification and checkout processes
- Growing demand for seamless, automated retail experiences
- Overcome manual item identification
- Human error in billing and stock verification
- Improve customer experience
- Lower operational costs
- Enable loss prevention by ensuring that scanned items match items taken by the customer.

## Objectives

- Collection of dataset for training & Validation.
- Identifying model for Edge AI deployment.
- Model Compression
- Deployment & Testing
- Verification on Python GUI

## Dataset / Data collection

- 7 classes of food items
- Total samples: 4050
- Pre-processing:
  - Resizing to 96 x96
  - Grayscale Conversion
  - Normalizing
- Augmentation:
  - Flip, Rotation
  - Brightness, Exposure
  - Shear , Blur

## Edge AI Model

- FOMO : Small Size, accurate and faster
- Model compression: INT8 Quantization
- Model characteristics
  - Peak RAM usage :
  - 363.2 KB ( Before Compression)
  - 119 KB ( After Compression)
- Performance : F1 Score 91.3% (INT8)
- Latency: 60ms (INT8)

## Hardware and Software specs.

- Nicla Vision : Dual ARM Cortex M7, 480MHz, 2MP Color Camera, 1MB RAM, 2MB Flash
- Software: Edge Impulse, Roboflow

## Prototype & demonstration

- Camera is mounted on a stand to capture an image from the top
- Demonstration done with multiple objects

Github Link : https://github.com/shubhamlanjewar97/SmartRetailVerification_EdgeAI_CP_330
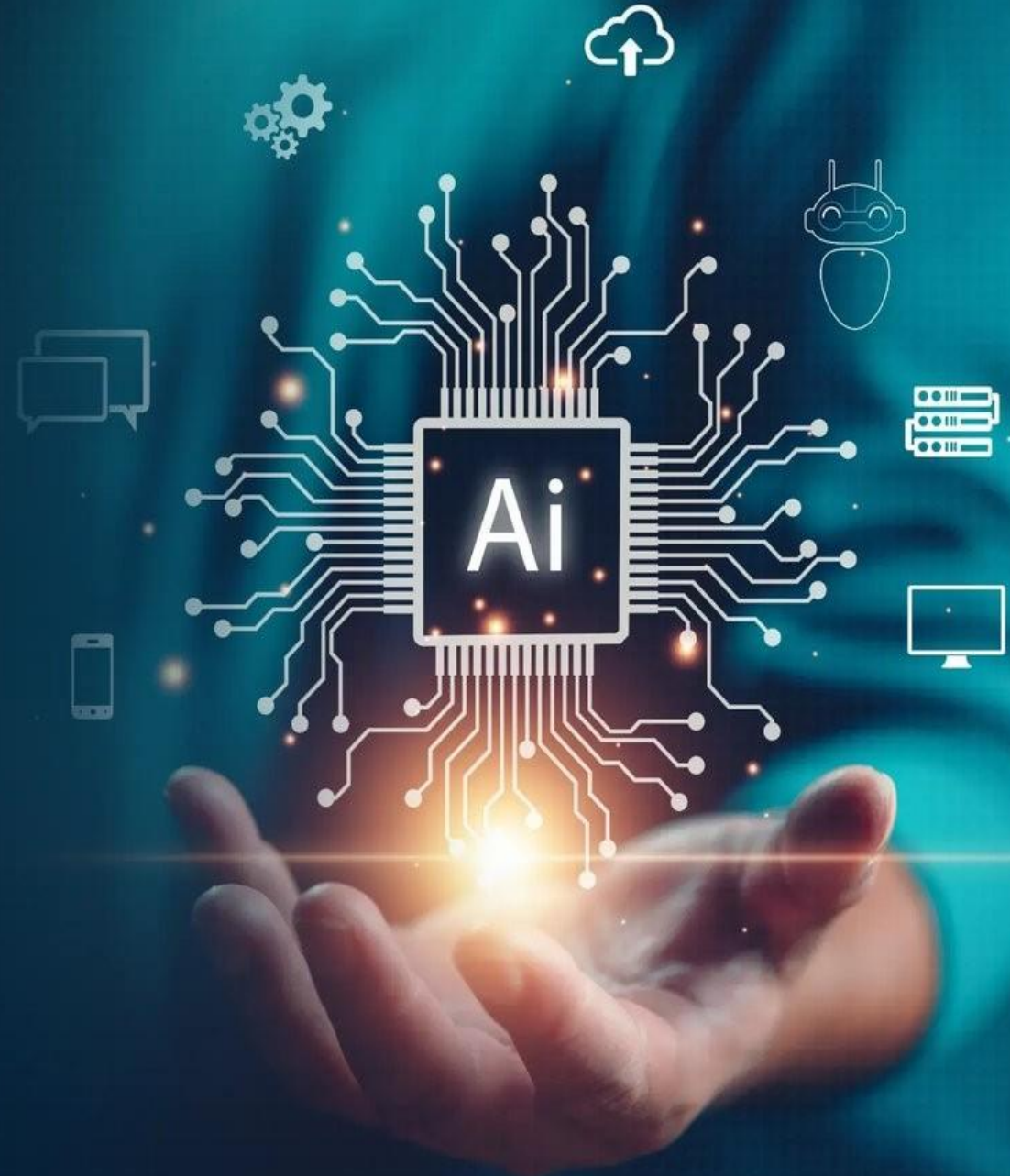
Demo Video: https://youtu.be/7rlVvd7OBcQ

# CP 330: Edge AI
# Smart Retail Verification

*Tanisha Bhatia, DESE, tanishab@iisc.ac.in*
*Shubham Lanjewar, DESE, shubhaml@iisc.ac.in*
*Pandarasamy Arjunan*, RBCCPS, samy@iisc.ac.in
*Indian Institute of Science, Bangalore*

Image source: https://leverx.com

# Introduction

- Smart retail verification using object detection on Nicla Vision

- Nicla Vision captures the image and does inference

- Sends object detection data to the Windows application

- Windows application provides a user interface for billing and verification

# Motivation

- Traditional retail relies heavily on manual item identification and checkout processes

- Growing demand for seamless, automated retail experiences

- Manual processes lead to human errors in billing and stock verification

- Need to reduce checkout time and improve customer experience

- Enable loss prevention through verification of scanned vs. taken items

# Methodology

## Edge Device – Nicla Vision

- Nicla Vision captures images through the onboard camera

- Runs FOMO object detection model

- Process detections to merge nearby objects of the same class

- Sends data to PC over UART communication with costom-desined protocol

# Methodology

## PC Application

- Provides a GUI for the user

- Maintains product catalog with prices

- Receives detection data from the Nicla Vision

- Allows manual item entry for billing

- Performs verification between billed and detected items

# Data Collection and Preprocessing

## Dataset

- 4 classes [KitKat, Goodday, HiddenSeek, Unibic]
- Total Samples: 4050 (After Aggregation)
- Samples: 1350 (Before Augmentation)
- Augmentation on Roboflow
- Resizing to 96*96 and convert to grayscale

# Model Development

## Model Selection FOMO

- FOMO (faster objects, more objects)
- Small size, Faster inference
- Suitability for edge devices

## Model Compression

- INT8 quantization
- Original peak ram usage: 363.2KB
- Compressed Size: 119.4 KB

# Model

Model version: ⑦ [ Unoptimized (float32) ▾ ]

## Last training performance (validation set)

**%**  F1 SCORE ⑦
**92.0%**

## Confusion matrix (validation set)

|  | BACKGROUND | HIDENSEEK | KITKAT | UNIBIC | GOODDAY |
|---|---|---|---|---|---|
| BACKGROUND | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| HIDENSEEK | 4.3% | 95.7% | 0% | 0% | 0% |
| KITKAT | 0% | 0% | 100% | 0% | 0% |
| UNIBIC | 11.1% | 0% | 0% | 88.9% | 0% |
| GOODDAY | 4.2% | 0% | 0% | 0% | 95.8% |
| F1 SCORE | 1.00 | 0.95 | 0.92 | 0.90 | 0.90 |

## Metrics (validation set)

| METRIC | VALUE |
|---|---|
| Precision (non-background) ⑦ | 0.89 |
| Recall (non-background) ⑦ | 0.95 |
| F1 Score (non-background) ⑦ | 0.92 |

## On-device performance ⑦          Engine: ⑦ [ EON™ Compiler (RAM optimized) ▾ ]

🕐 INFERENCING TIME
**115 ms.**

▭ PEAK RAM USAGE
**363.2K**

▭ FLASH USAGE
**113.8K**

# Model Summary (float32)

# Model

Model version: ⑦ [ Quantized (int8) ▾ ]

**Last training performance** (validation set)

**%** F1 SCORE ⑦
**91.3%**

**Confusion matrix** (validation set)

| | BACKGROUND | HIDENSEEK | KITKAT | UNIBIC | GOODDAY |
|---|---|---|---|---|---|
| BACKGROUND | 100.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| HIDENSEEK | 4.4% | 95.6% | 0% | 0% | 0% |
| KITKAT | 0% | 0% | 100% | 0% | 0% |
| UNIBIC | 10.8% | 0% | 0% | 89.2% | 0% |
| GOODDAY | 8.3% | 0% | 0% | 0% | 91.7% |
| F1 SCORE | 1.00 | 0.92 | 0.90 | 0.92 | 0.90 |

**Metrics** (validation set)

| METRIC | VALUE |
|---|---|
| Precision (non-background) ⑦ | 0.89 |
| Recall (non-background) ⑦ | 0.94 |
| F1 Score (non-background) ⑦ | 0.91 |

**On-device performance** ⑦          Engine: ⑦ [ EON™ Compiler (RAM optimized) ▾ ]

🕐 INFERENCING TIME
**60 ms.**

▭ PEAK RAM USAGE
**119.4K**

▯ FLASH USAGE
**91.0K**

# Model Summary (int8)

# Conclusion

## Project outcomes

- Successful implementation of an Edge AI-based retail verification system

-  Effective model compression for embedded deployment

- Creation of a user-friendly interface for retail verification

- Real-time detection and verification capabilities

# Setup

**CP 330: Edge AI**

# Object Detection

**CP 330: Edge AI**

# User Interface (success case)

# User Interface (fail case)

# Thank you