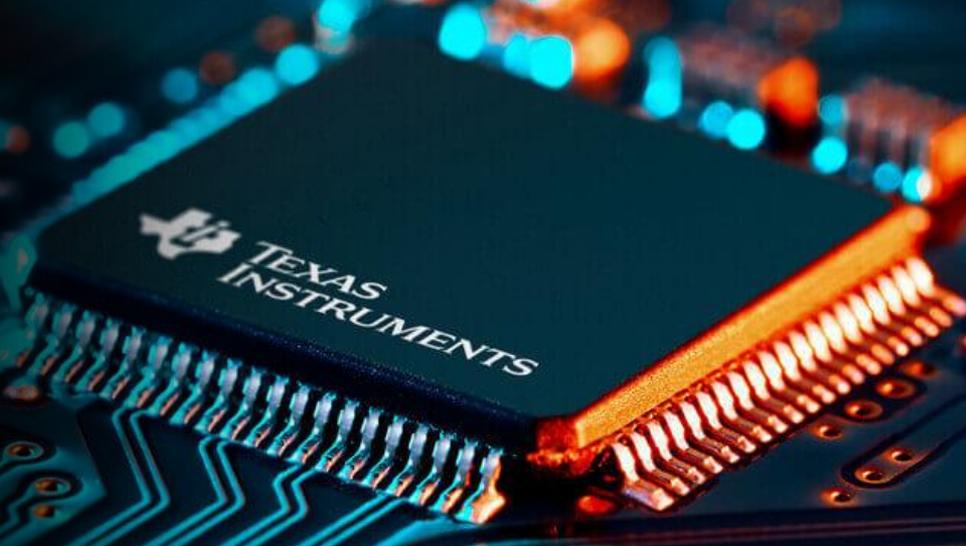


2024 Embedded Seminar

A scalable vision for the future
through edge AI

Alec May

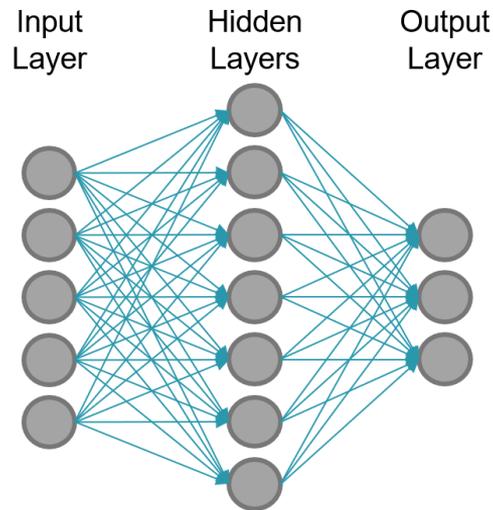
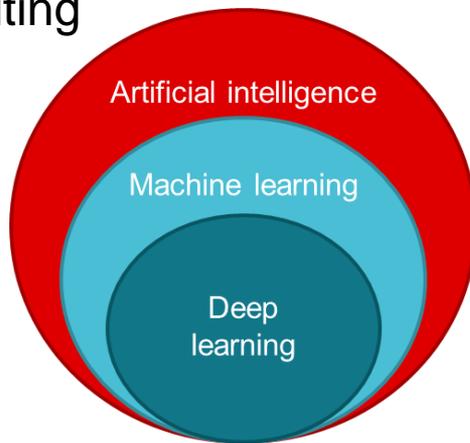
Platform Marketing Manager



ti TEXAS
INSTRUMENTS

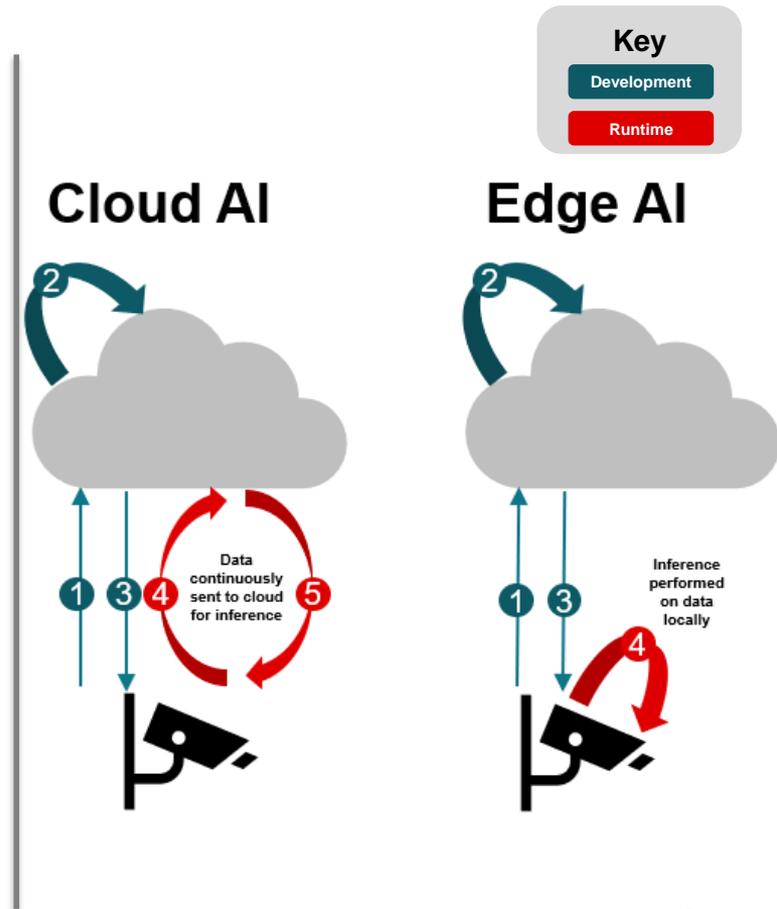
Terminology

- Artificial intelligence (AI) – computers using human-like intelligence to solve tasks
 - Machine learning (ML) – algorithm uses data to find or “learn” patterns
 - Deep learning (DL) – very large algorithm using raw data input (Usually needs lots of data!)
-
- Machine learning provides significant advantages over classical computing
 - Scalability
 - Reduced development effort
 - Higher accuracy

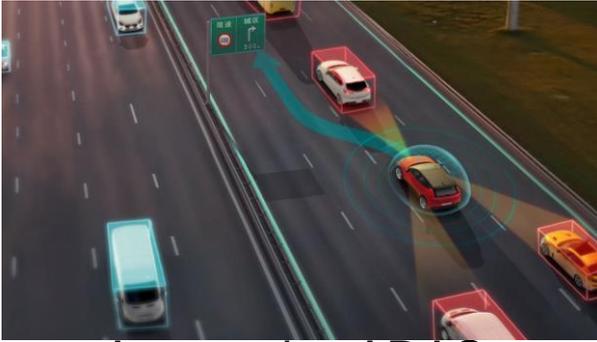


Why AI at the Edge?

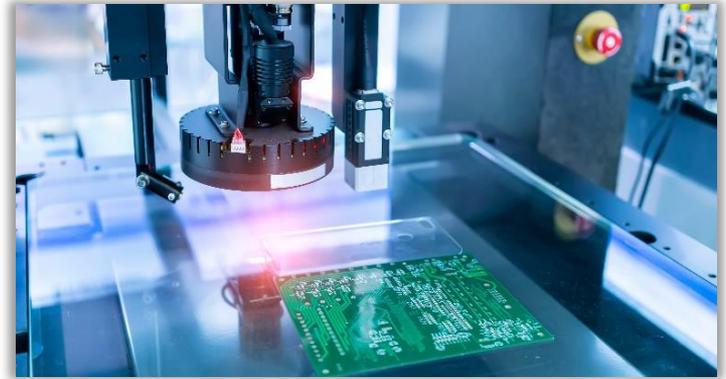
- Edge AI – running AI where data is generated
 - Algorithms run on embedded processors or microcontrollers
 - Minimizes movement of data
- Benefits
 - Reduced latency
 - Privacy
 - No Cloud compute or network costs
 - Increasing support & performance from embedded vendors



Edge AI application areas



Automotive ADAS



Machine vision & defect detection



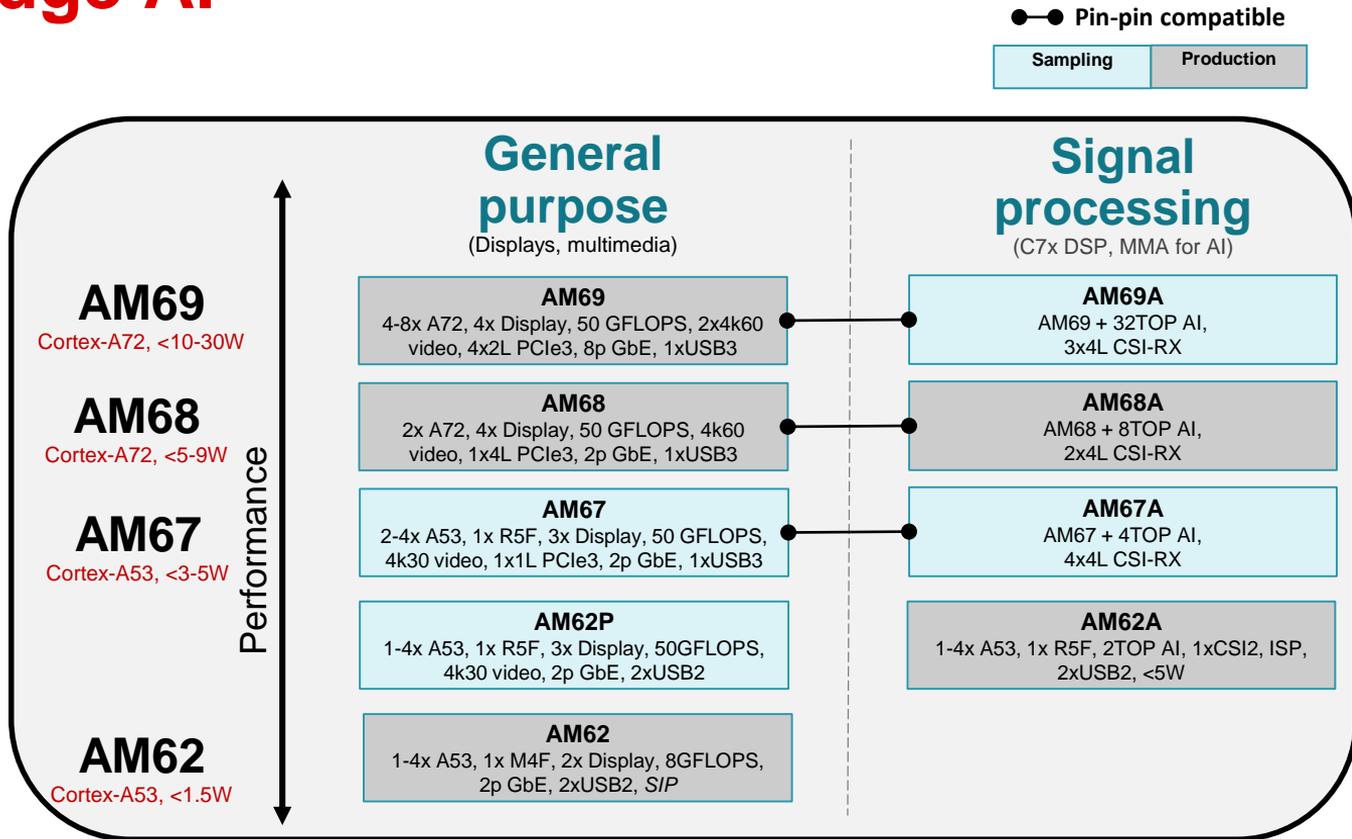
Security and home automation cameras



Robotics

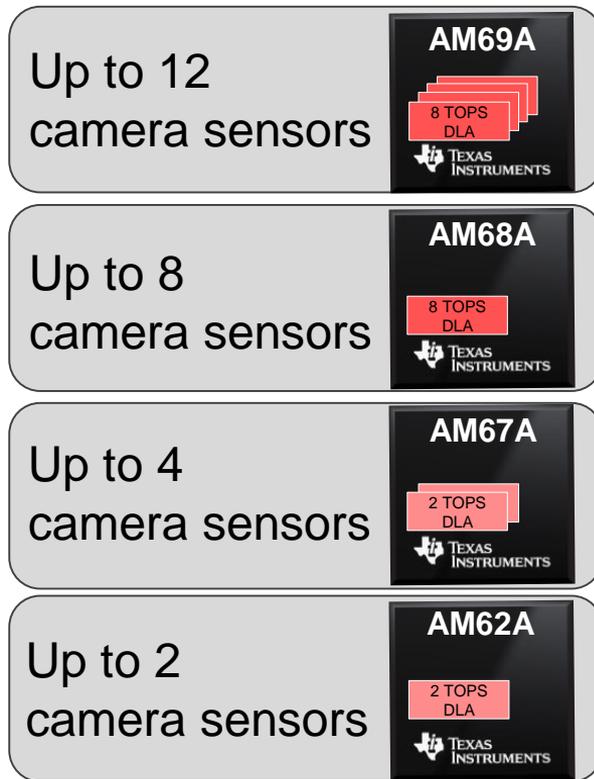
History of TI edge AI

- Linux processors for vision, displays, multimedia
- CSI lanes and ISP for vision pipeline
- Addition of dedicated AI hardware acceleration to bring intelligence to vision processing
- Targeted for applications such as ADAS, in-cabin sensing, robotics, and more



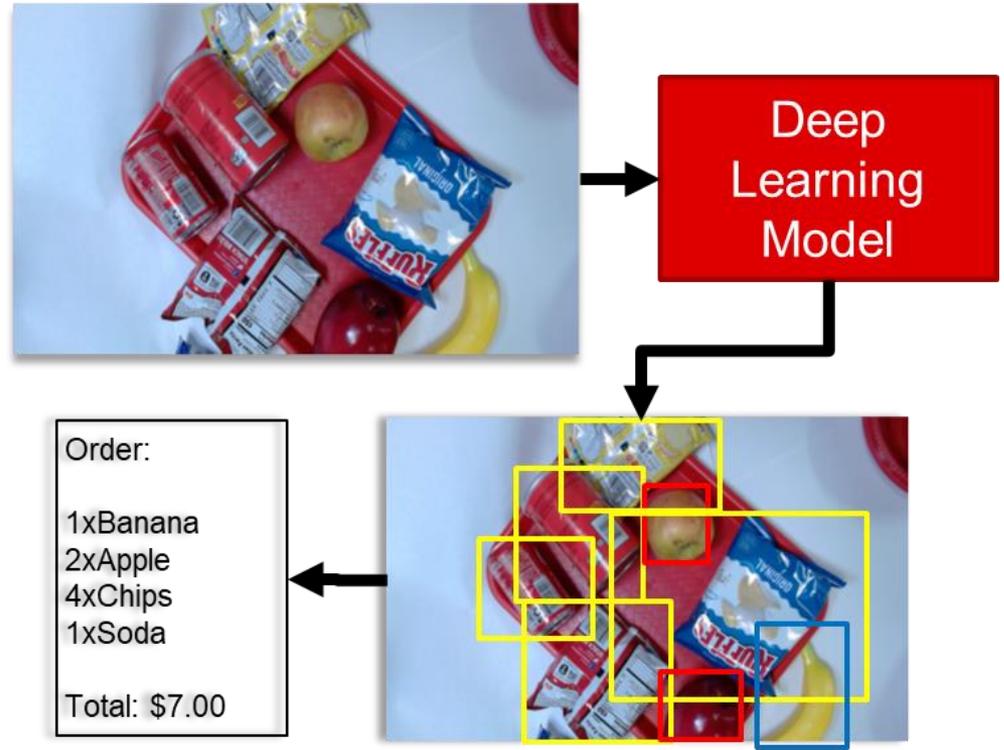
Scalability of edge AI

- Common deep learning accelerator (DLA) architecture
 - Each DLA contains a TI C7x DSP with a matrix multiply accelerator (MMA)
 - Scalable number of DLA's offered to ensure correct amount of AI performance
- Common software infrastructure
 - Foundational Linux SDK's
 - AI components built on top of industry standard frameworks
 - Simplified migration between AI devices to get desired performance
 - Edge AI studio serves as common toolset for evaluation
- Wide range of partners who can help overcome project hurdles



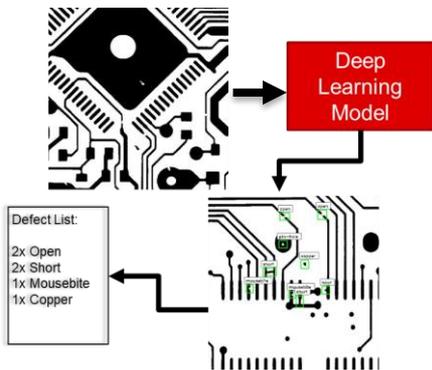
Example: smart retail

- **Task** – Detect and classify items on retail checkout tray
- **Why use deep learning here?**
 - Easier to implement
 - More accurate and robust
 - More scalable
- **Impacts**
 - Completely automates checkout process
 - Faster checkout, lower delays
 - Improved accuracy
 - Less risk of theft than self-checkout

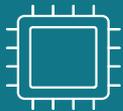


Example: PCB defect detection

- **Task** – Detect and classify PCB defects
- **Why use deep learning here?**
 - Easier to implement
 - More accurate and robust
- **Impacts**
 - Faster analysis of PCB defects
 - Less missed defects



Direction of edge AI



AI acceleration

Expand range of AI performance by offering versions of products with AI accelerators on-chip.

Sensing modalities

Support new types of sensing to democratize other forms of digital signal processing



Easy to use tools

Use Edge AI studio as a starting point for any AI project on a TI device



Industry standard frameworks

Leverage open-source frameworks and tools that engineers are already familiar with.



Technologies for edge AI

Perception

ADAS applications, object detection and classification, depth and motion estimation.



Audio

Wake word detection, command recognition, speaker recognition and verification.



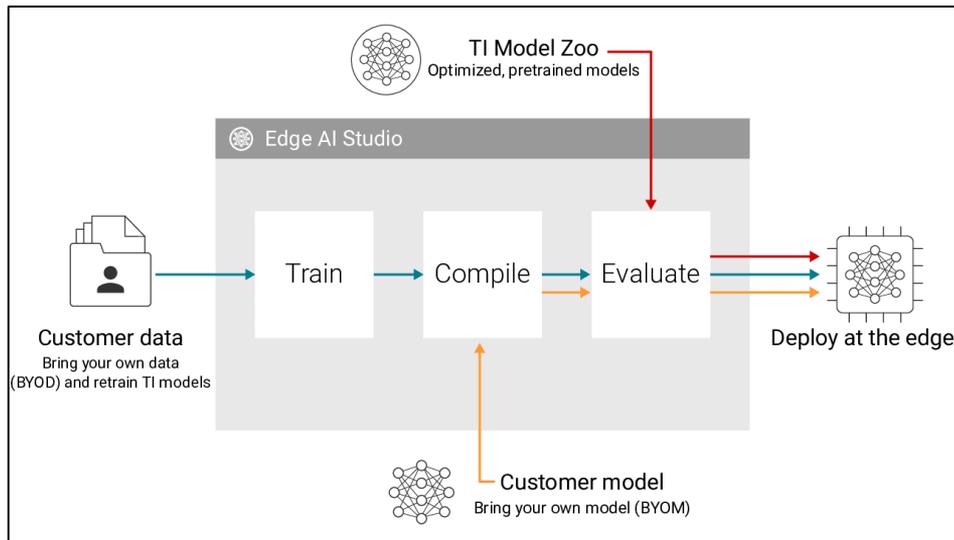
Real-time monitoring and control

Predictive maintenance, temperature and humidity monitoring, vibration monitoring.

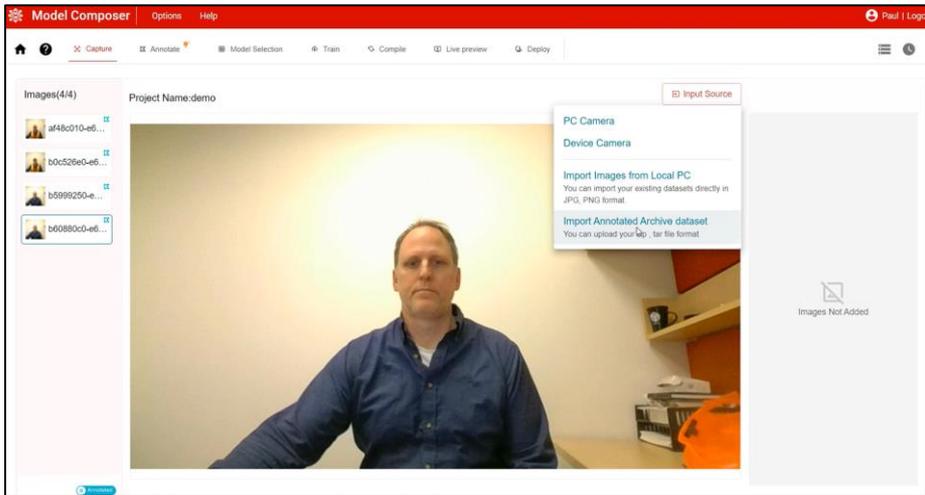


TI Edge AI Studio

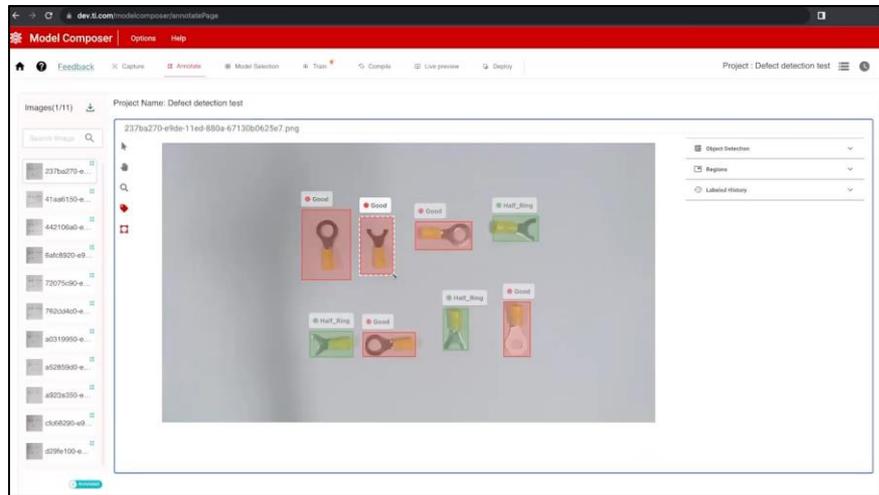
- Suite of tools for edge AI evaluation and development
 - Model Composer – No-code solution for creation and training of models
 - Model Analyzer – Evaluate model performance on remote hardware
 - Command line tools available for advanced development
- Users can start by
 - Evaluating pretrained models
 - Retraining TI models with custom data
 - Compiling a custom model for a TI device



Edge AI Studio: Data capture and annotation



- Live capture images
- Upload pre-captured images
- Import entire datasets



- Annotate data directly
- Annotate entire images or specific objects

Edge AI Studio: Select and train model

Device selection
Choose a trade-off between power and performance

Lower Power Faster Performance

Use Recommended OR Use Selected Device

Model selection
Choose a trade-off between accuracy and performance

Higher Accuracy Faster Performance

Use Recommended OR Use Selected Model

Specifications:

- Efficient 8 TOPS AI capability at edge
- 6 TOPS Deep Learning accelerator
- Dual Armv8 Cortex-A72
- Integrated ISP
- More details: <https://www.ti.com/product/AM55A>

Important links:

- Product information: <https://www.ti.com/product/AM55A>
- Development board: <https://www.ti.com/tool/SK-AM55>
- Software development kit (SDK): <https://www.ti.com/tool/download/PROCESSOR-SDK-LINUX-AM55A>
- Steps to setup board: https://software-dl.ti.com/jacinto/esd/processor-sdk-linux-cggs/AM55A09_06_00/exports/docs/devices/AM55A/#/getting_started.html

- Select device
- Select model to be used
- Determine performance tradeoffs

Training parameters

Epochs: 15 Learning rate: 0.002 Batch size: 8 Weight decay: 0.0001

Active Model: yolox_s_lite Active Device: AM55A Start Training

Training Log Download

```
2023-05-09 21:06:59.955 - mmet - INFO - Epoch[val] [14]/10 | bbox_mAP: 0.9850, bbox_mAP_50: 0.9820,
bbox_mAP_75: 0.9220, bbox_mAP_s: 1.0000, bbox_mAP_m: 0.7120, bbox_mAP_l: 0.7520, bbox_mAP_copypaste:
0.7050, 0.7620, 0.9220, 1.0000, 0.7120, 0.7520
2023-05-09 21:07:17.878 - mmet - INFO - Saving checkpoint at 15 epochs
2023-05-09 21:07:20.462 - mmet - INFO - Evaluating blob...
2023-05-09 21:07:20.526 - mmet - INFO -
Average Precision (AP) @ IoU=0.50:0.95 | area= all | mAPDet=1000 | = 0.816
Average Precision (AP) @ IoU=0.50 | area= all | mAPDet=1000 | = 0.983
Average Precision (AP) @ IoU=0.75 | area= all | mAPDet=1000 | = 0.927
Average Precision (AP) @ IoU=0.50:0.95 | area= small | mAPDet=1000 | = 1.000
Average Precision (AP) @ IoU=0.50:0.95 | area= medium | mAPDet=1000 | = 0.860
Average Precision (AP) @ IoU=0.50:0.95 | area= large | mAPDet=1000 | = 0.838
Average Recall (AR) @ IoU=0.50:0.95 | area= all | mAPDet=1000 | = 0.840
Average Recall (AR) @ IoU=0.50:0.95 | area= all | mAPDet=100 | = 0.860
Average Recall (AR) @ IoU=0.50:0.95 | area= small | mAPDet=1000 | = 1.000
Average Recall (AR) @ IoU=0.50:0.95 | area= medium | mAPDet=1000 | = 0.843
Average Recall (AR) @ IoU=0.50:0.95 | area= large | mAPDet=1000 | = 0.830
2023-05-09 21:07:20.526 - mmet - INFO - Exp name: yolox_s_lite.py
2023-05-09 21:07:20.526 - mmet - INFO - Epoch[val] [15]/10 | bbox_mAP: 0.8300, bbox_mAP_50: 0.9820,
bbox_mAP_75: 0.9270, bbox_mAP_s: 1.0000, bbox_mAP_m: 0.8600, bbox_mAP_l: 0.8300, bbox_mAP_copypaste:
0.8160, 0.9830, 0.9270, 1.0000, 0.8400, 0.8380
SUCCESS: ModelMaker - Training completed.
```

Training Performance

Graph showing Accuracy vs Epoch. Accuracy starts at ~0.75 at epoch 2 and reaches ~0.985 by epoch 15.

Training Completed

- Set training parameters
- Execute training
- View performance results
- Compare to other models or devices

Questions and next steps

- Learn more about TI edge AI - ti.com/edgeai
- Get started with Edge AI Studio - dev.ti.com/edgeaistudio/
- See TI demos of edge AI - dev.ti.com/tirex/global?id=edge-ai-demos
- Browse TI analytics processors – ti.com/processors



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