2024 Embedded Seminar

A scalable vision for the future through edge AI

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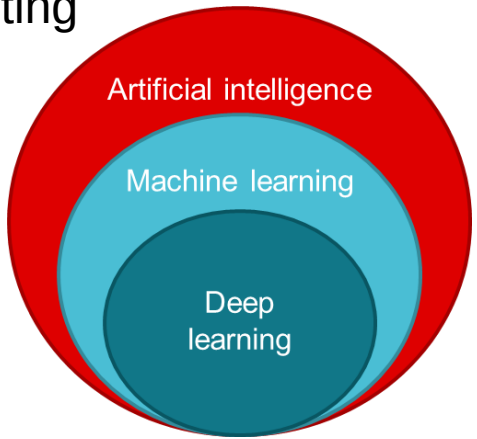
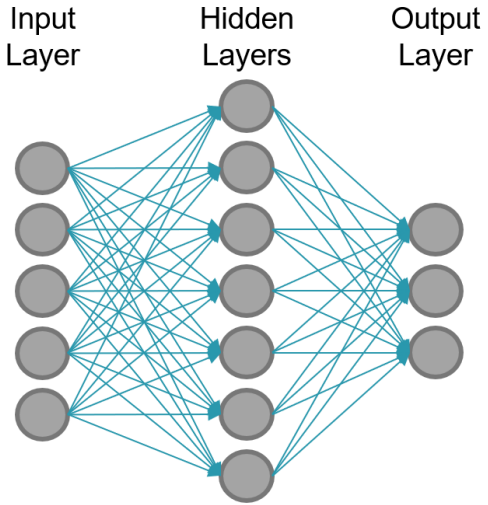
Terminology

- 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

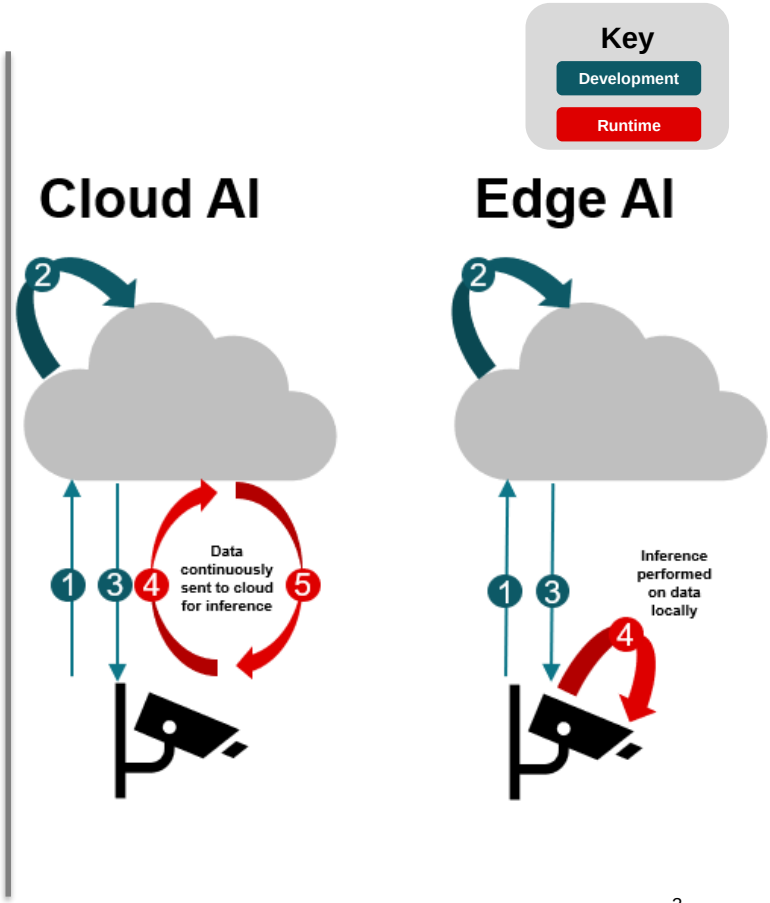




Why AI at the Edge?

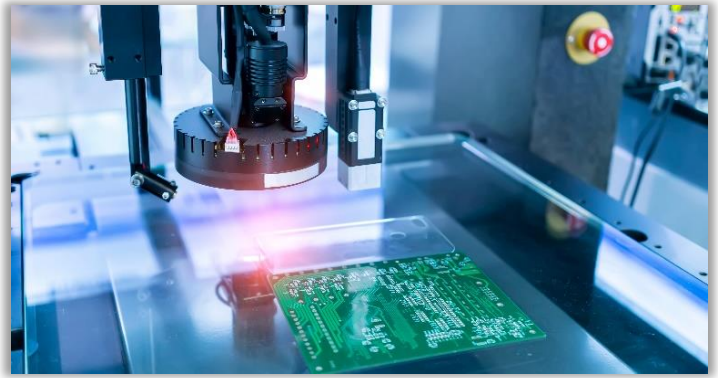
- Edge AI – running AI where data is generated
  - Algorithms run on embedded processors or microcontrollers
  - Minimizes movement of data

- Benefits
  - Reduced latency
  - Privacy
  - No Cloud compute or network costs
  - Increasing support & performance from embedded vendors

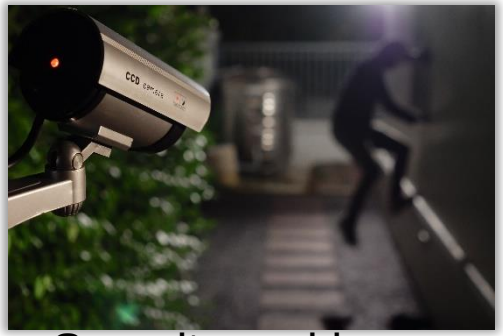


Edge AI application areas

Automotive ADAS



Machine vision & defect detection

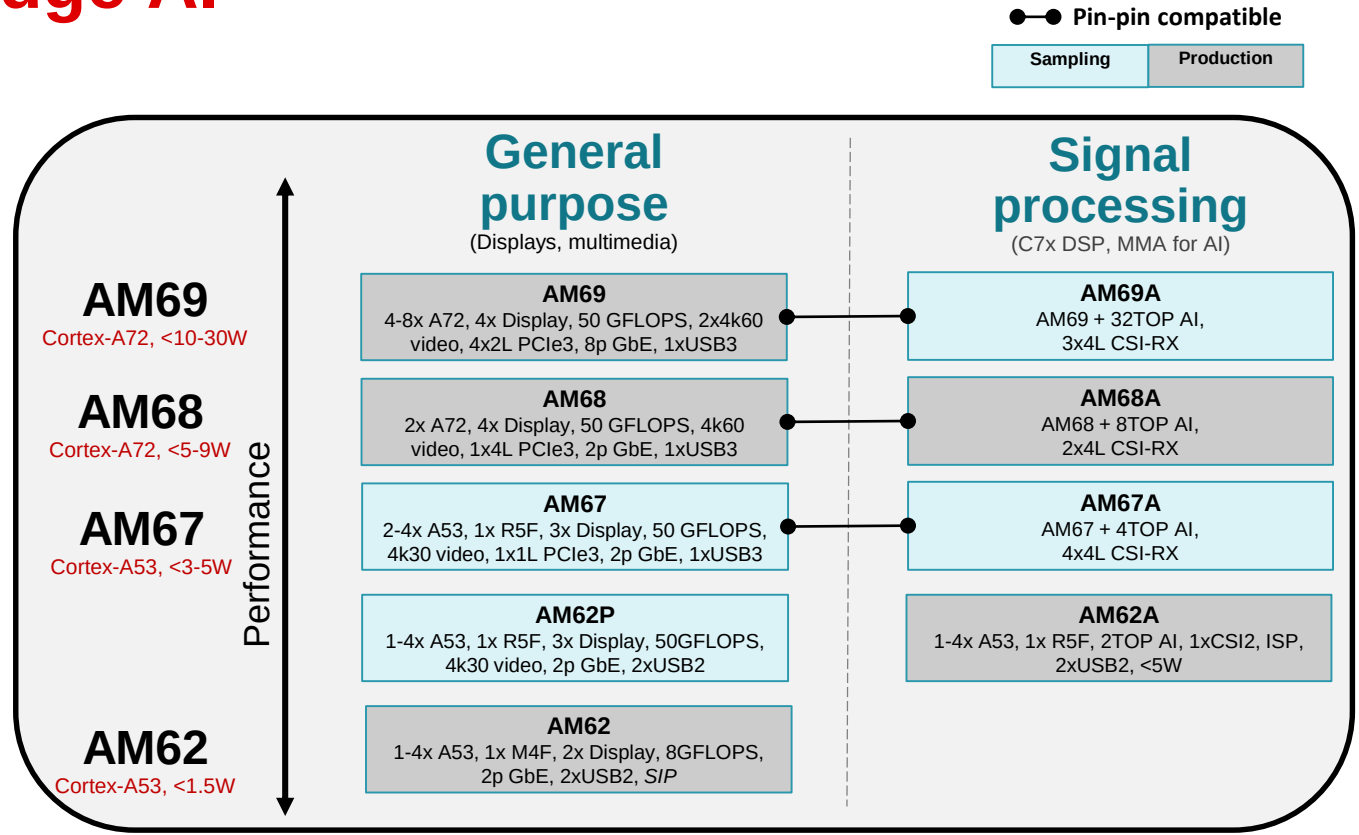


Security and home automation cameras

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

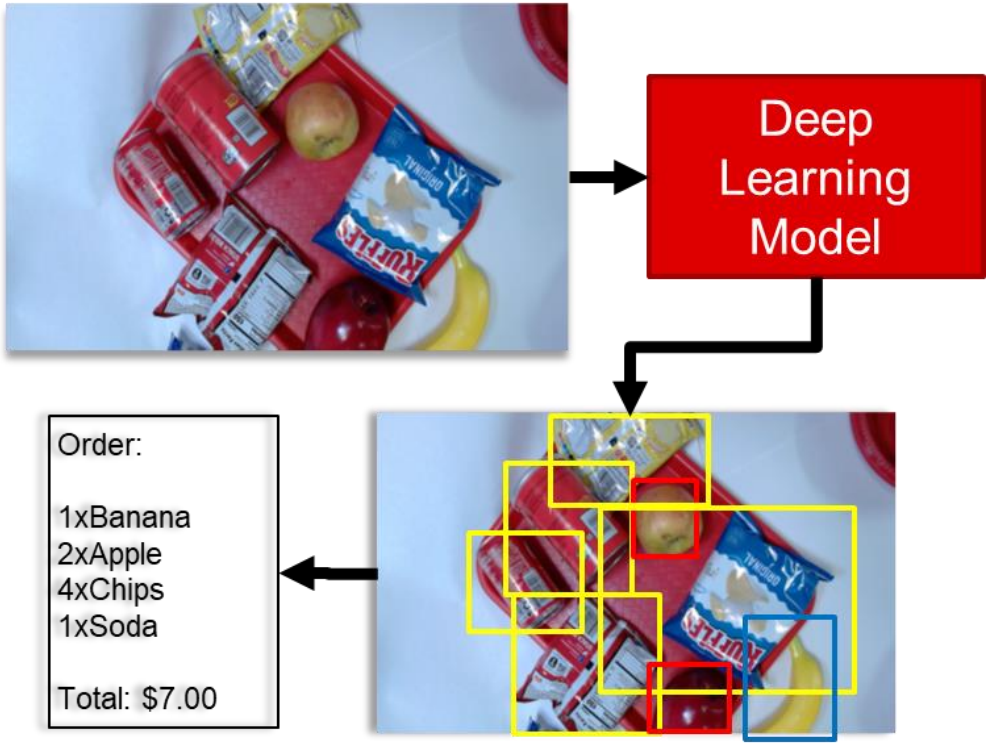
- Common deep learning accelerator (DLA) architecture
  - Each DLA contains a TI C7x DSP with a matrix multiply accelerator (MMA)
  - Scalable number of DLA's offered to ensure correct amount of AI performance
- Common software infrastructure
  - Foundational Linux SDK's
  - AI components built on top 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

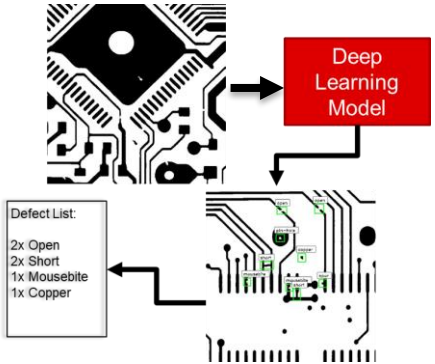


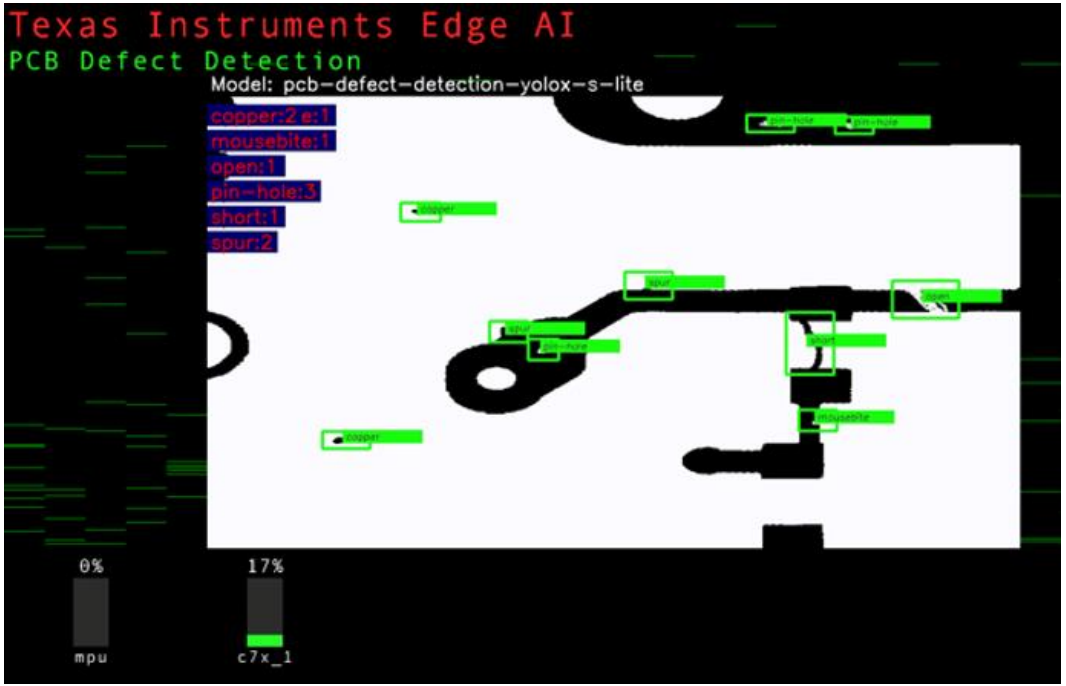
Example: PCB defect detection

- **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.

TensorFlow Lite · ONNX · gstreamer · PyTorch

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.

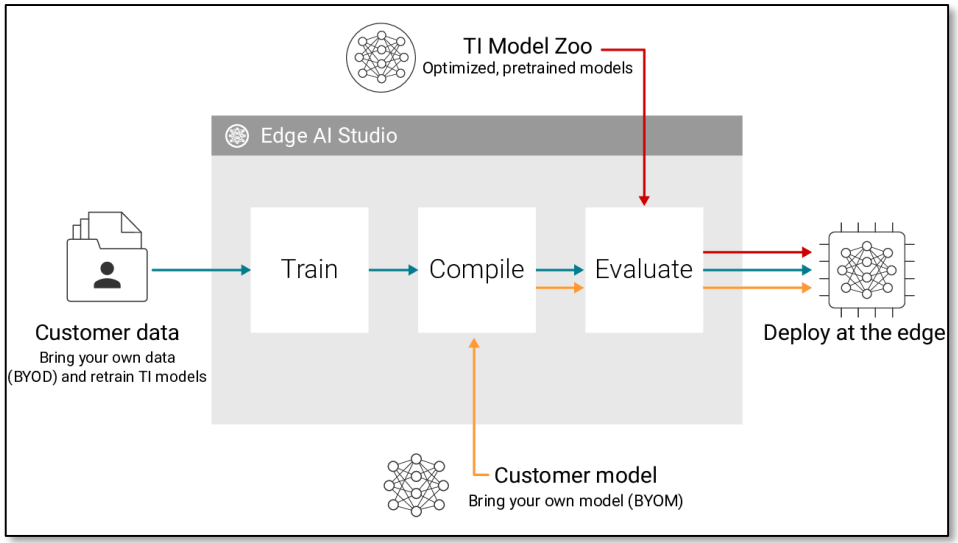
Real-time monitoring and control

Predictive maintenance, temperature and humidity monitoring, vibration monitoring.

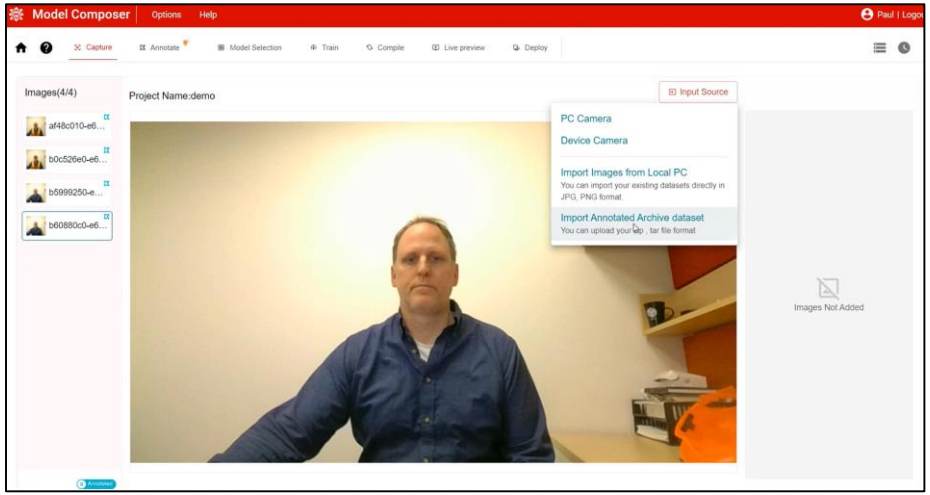
TI Edge AI Studio

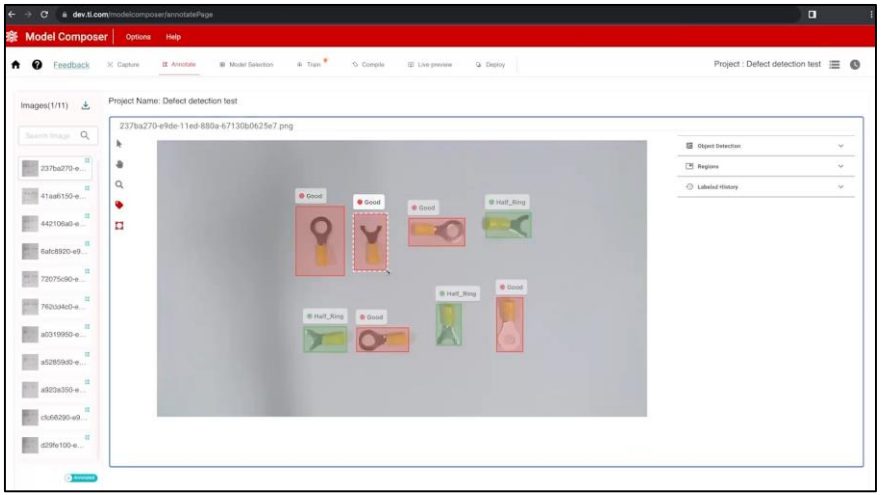
- Suite of tools for edge AI evaluation and development
  - Model Composer – No-code solution for creation and training of models
  - Model Analyzer – Evaluate model performance on remote hardware
  - Command line tools available for advanced development

- 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

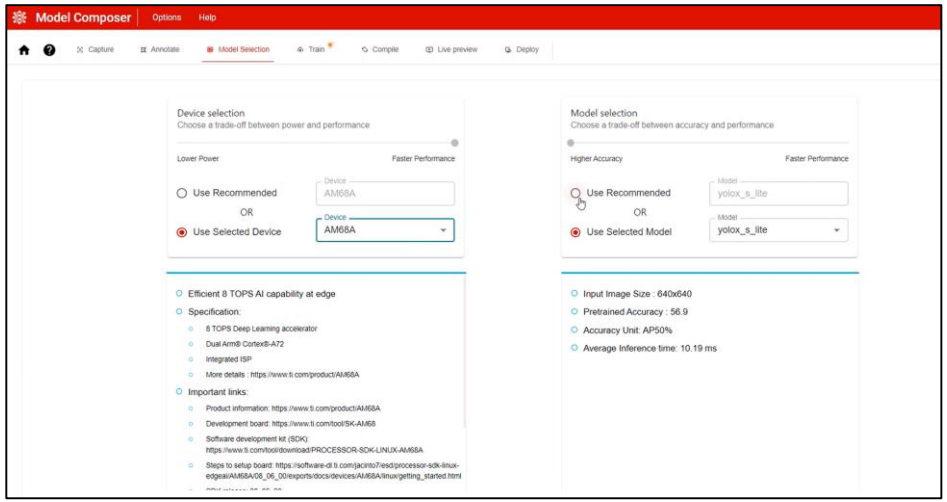


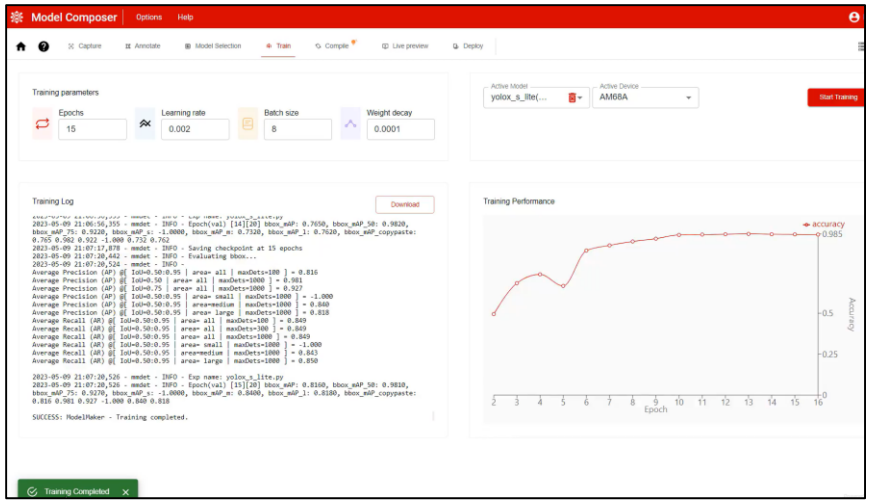


- Live capture images
- Upload pre-captured images
- Import entire datasets

- Annotate data directly
- Annotate entire images or specific objects

Edge AI Studio: Select and train model

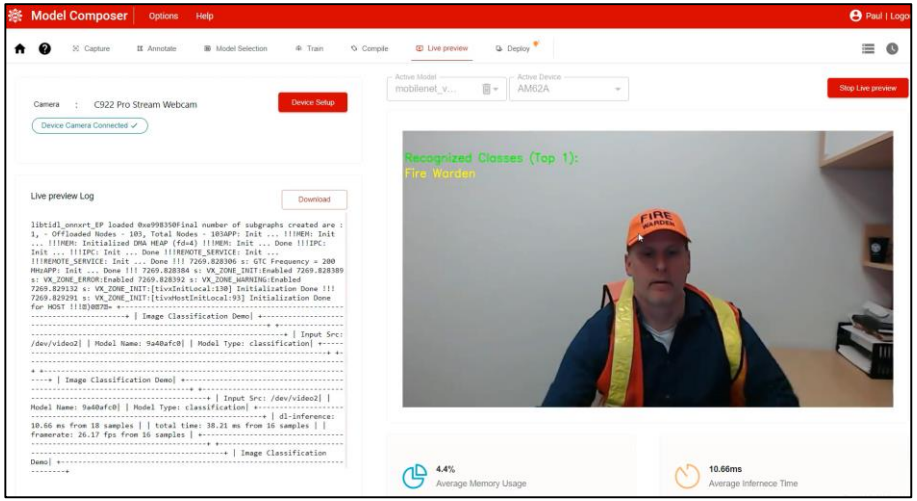


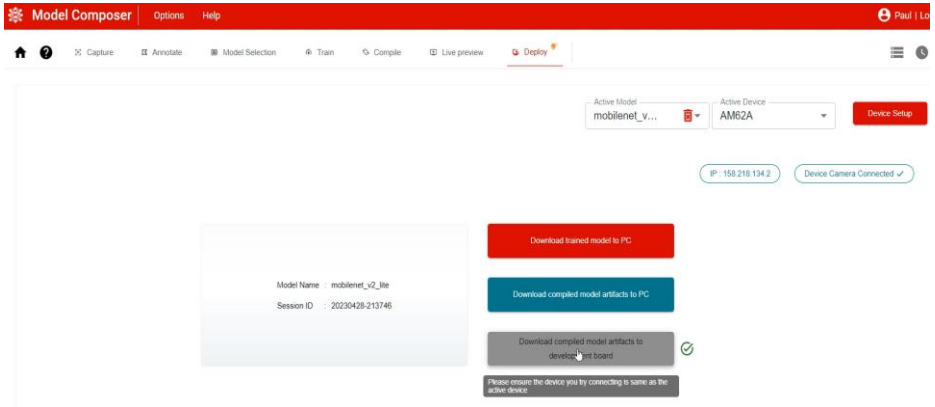


- Select device
- Select model to be used
- Determine performance tradeoffs

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

Edge AI Studio: preview and deploy





- Connect to hardware
- Live preview results from trained model
- View performance in real time

- Download model to PC
- Download artifacts directly to connected board

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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