TeraSoft
Accelerating your Research & Development

強化AI專題實作力：MATLAB GPU Coder 助力模型高效部署至 Python平台

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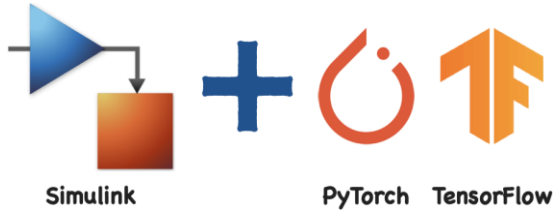
Authorized Reseller

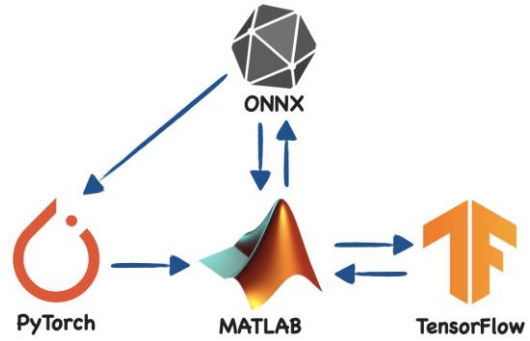
Common use case: combine MATLAB with python for AI

Techniques:

Co-execute

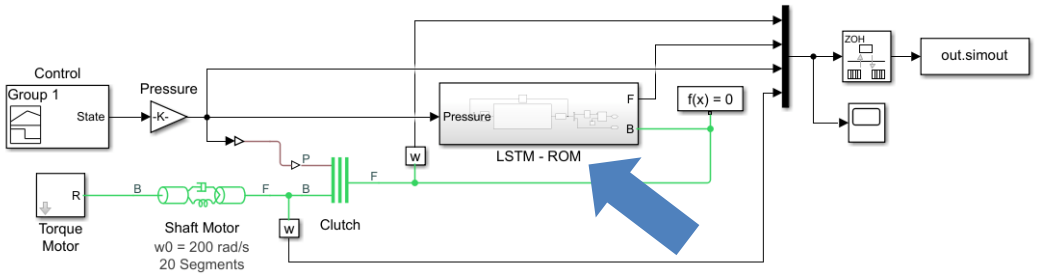


Exchange Models

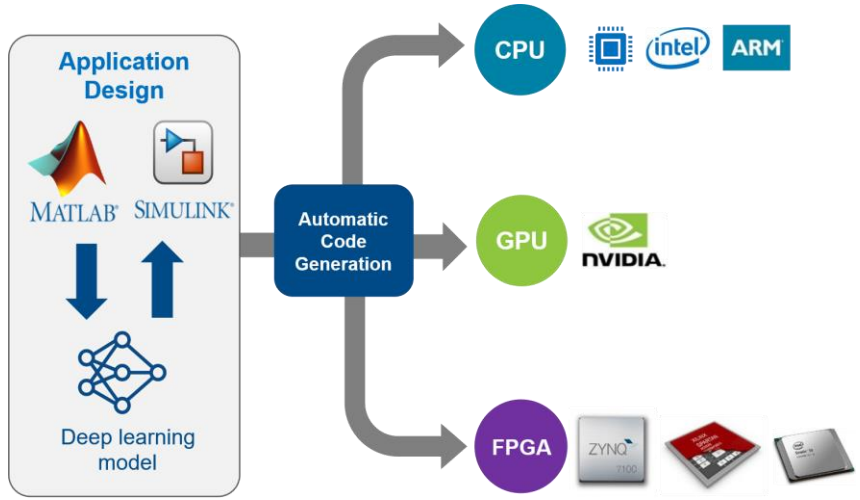


Applications:

Engineering + AI



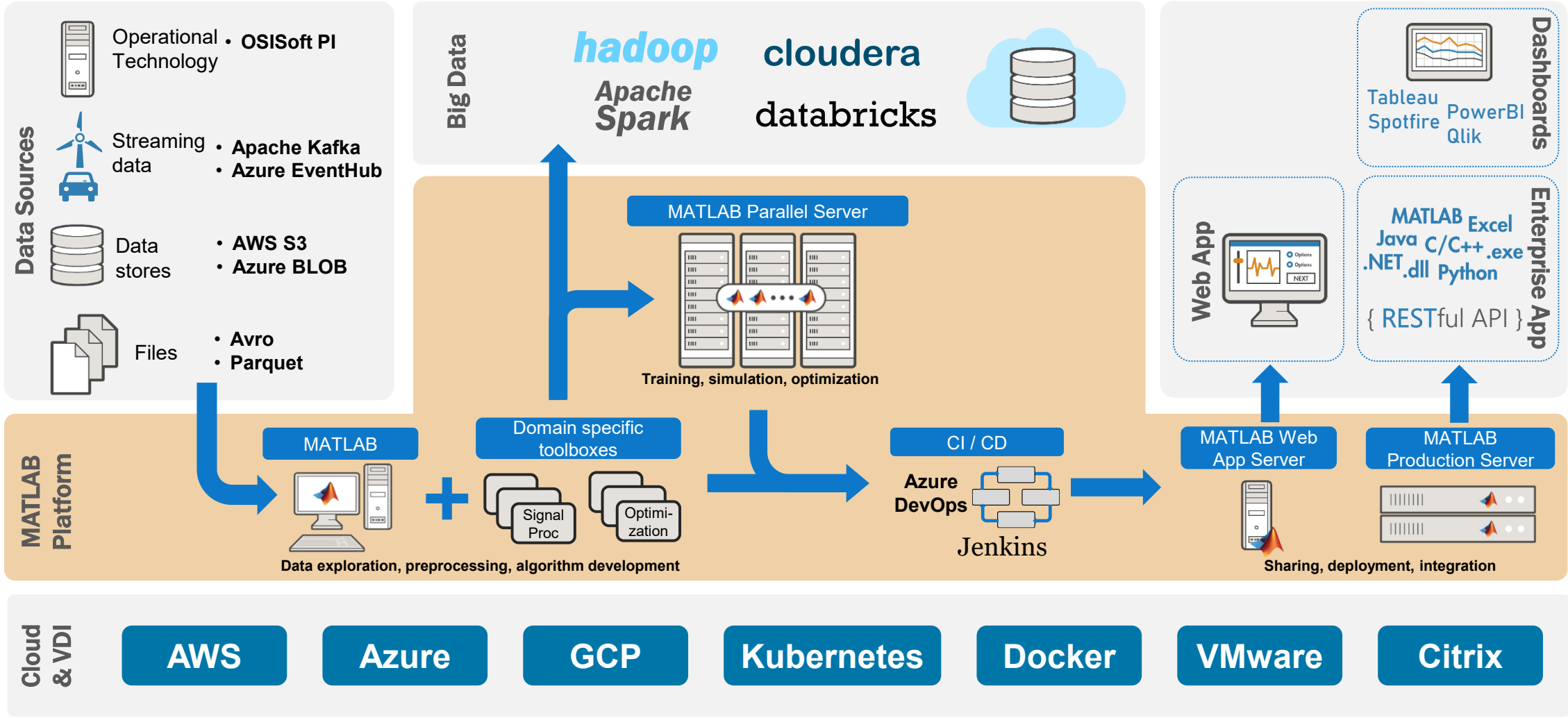
Deploy to Embedded Processors



Requires Deep Learning Toolbox

Comprehensive end-to-end solutions for complex IT environments

Access and Explore Data → Preprocess Data → Analyze Data → Develop Algorithms & Models → Operationalize



Cloud & VDI: AWS | Azure | GCP | Kubernetes | Docker | VMware | Citrix

MATLAB®校園授權-Campus Wide License

你擁有的不只是一個軟體!

校園授權享有的資源，比你想像多更多

各領域線上課程

程式基礎/人工智慧技巧課程，上完領證書

MATLAB雲端硬碟

5G 儲存空間，資料存取無障礙

線上版MATLAB

在網頁瀏覽器上使用

手機板MATLAB

在手機/平板上用MATLAB，支援ios/Andoid

叢集 & 分散式運算

提升平行運算速度

支援低成本硬體

Arduino /Raspberry Pi/ Begal /LEGO

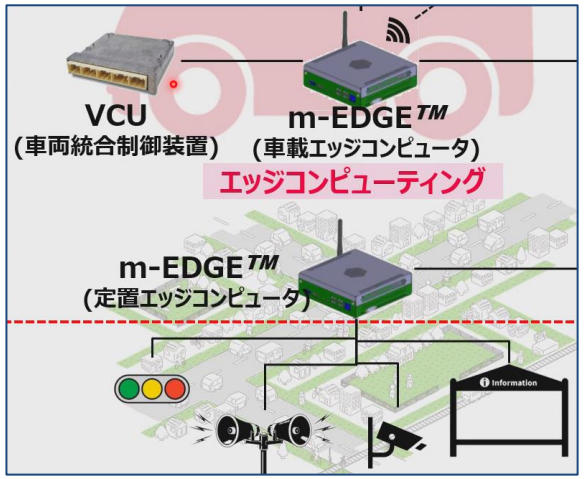
MATLAB線上作業評分系統

作業自動評分系統

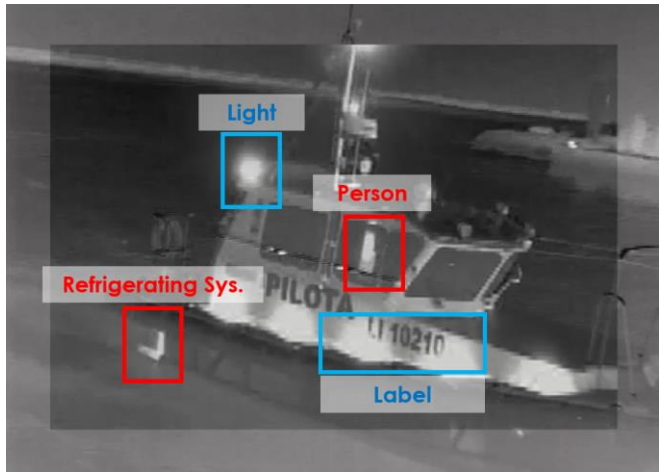
軟體下載安裝

不限下載電腦台數/維護期內更新

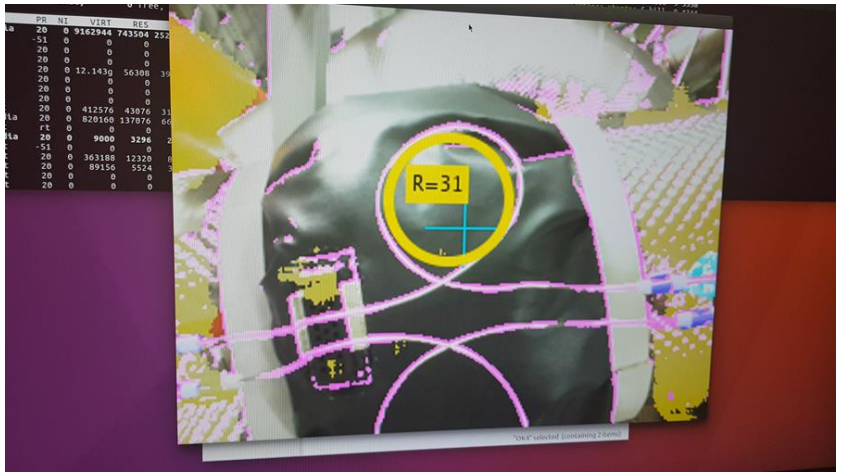
Wide Range of Applications with GPU Coder



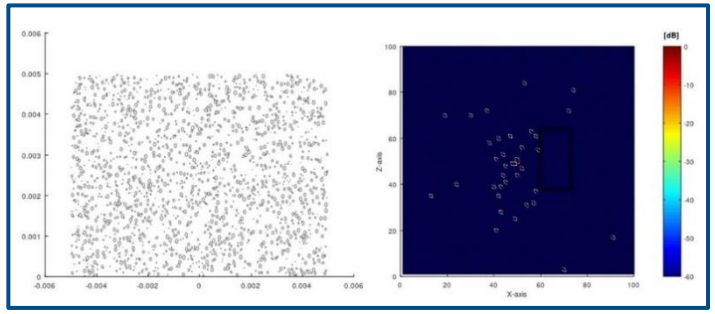
DENSO Ten
Vehicle detection and traffic flow analysis



Drass
Maritime object tracking on NVIDIA GPU

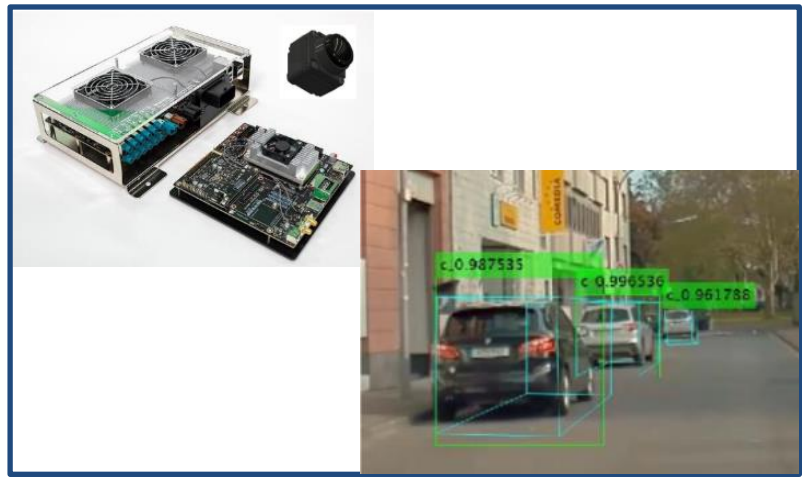


Airbus
Aircraft inspection on Jetson



M&R Technology
Medical Ray-Tracing Algorithms

JINGCE Electronics
Display measurement instrument on Jetson



Continental
Computer Vision Stack for AD

Drass Develops Deep Learning System for Real-Time Object Detection in Maritime Environments

Challenge

Help ship operators monitor sea environments and detect objects, obstacles, and other ships

Solution

Create an object-detection deep learning model that can be deployed on ships and run in real time

Results

- Data labeling automated
- Development time reduced
- Flexible and reproducible framework established

First day of object detection tests with optronic system prototype.

"From data annotation to choosing, training, testing, and fine-tuning our deep learning model, MATLAB had all the tools we needed—and GPU Coder enabled us to rapidly deploy to our NVIDIA GPUs even though we had limited GPU experience."

- Valerio Imbriolo, Drass Group

Link to user story

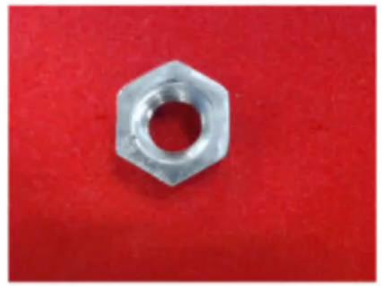
Automated Optical Inspection Example

tb_myNDNet_Jetson.mlx | myNDNet_Preprocess.m | myNDNet_Postprocess.m | targetFunction.m

CNN and post-processing

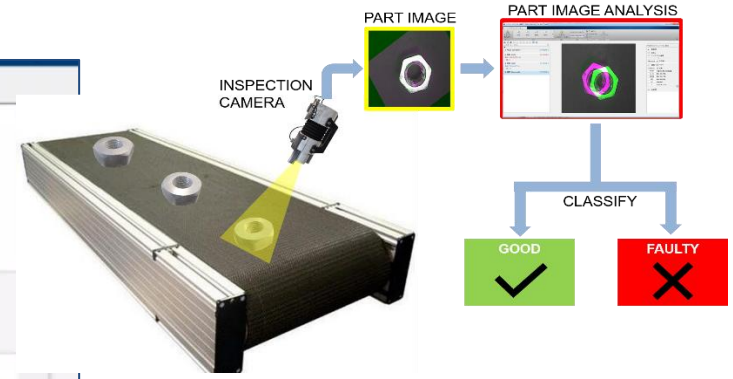
Read new image captured by webCam. The images used to train network were pre-processed image to fit it in input image size of network. Original image captured by webCam is like this;

```
50  img = imread('testImg.png');
51  figure, imshow(img)
```



```
52  % So, we need to extract where the nuts are as an ROI before passing image
53  % to the network.
```

Pre-processing for captured image from webcam



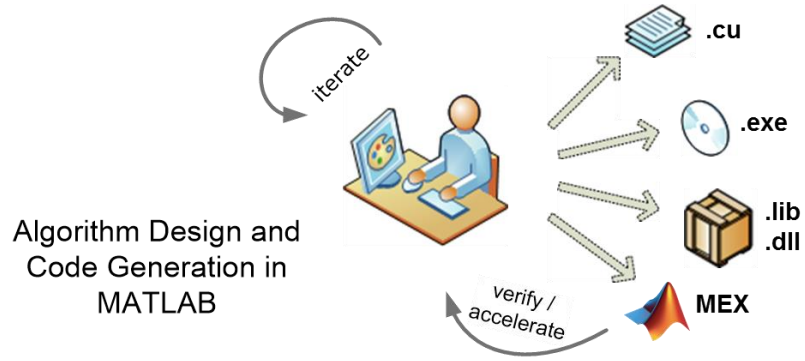
Why Use CUDA code generation ?

Pains: Hand code

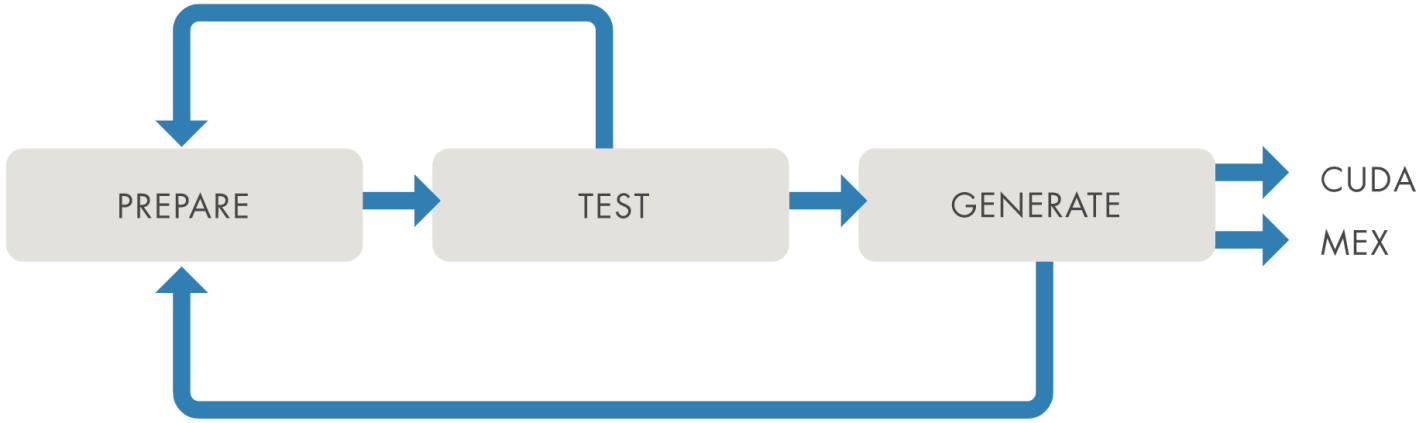
- **Cannot code in CUDA**
- Time consuming
- Manual Coding Errors
- Multiple implementations
- Expensive

Solution: GPU Coder

- Automatically convert to CUDA
- Get to optimized CUDA faster
- Eliminate manual coding errors
- Maintain Single “Truth”
- Stay within MATLAB/Simulink at a higher level



Working with GPU Coder: Three-Step Workflow



Prepare your MATLAB algorithm for code generation

- Make implementation choices
- Use supported language features

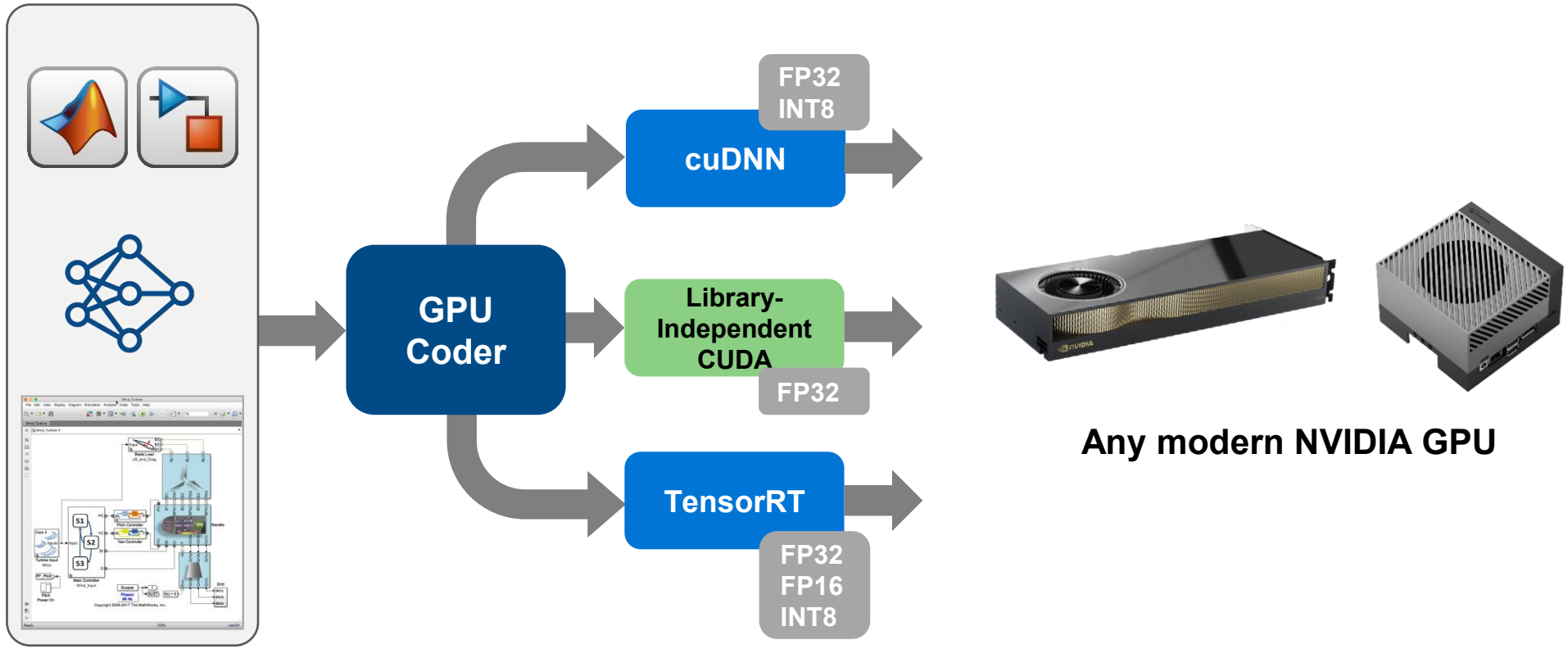
Test if your MATLAB code is ready for code generation

- Validate that MATLAB program generates code
- Accelerate execution of user-written algorithm

Generate source code or MEX for final use

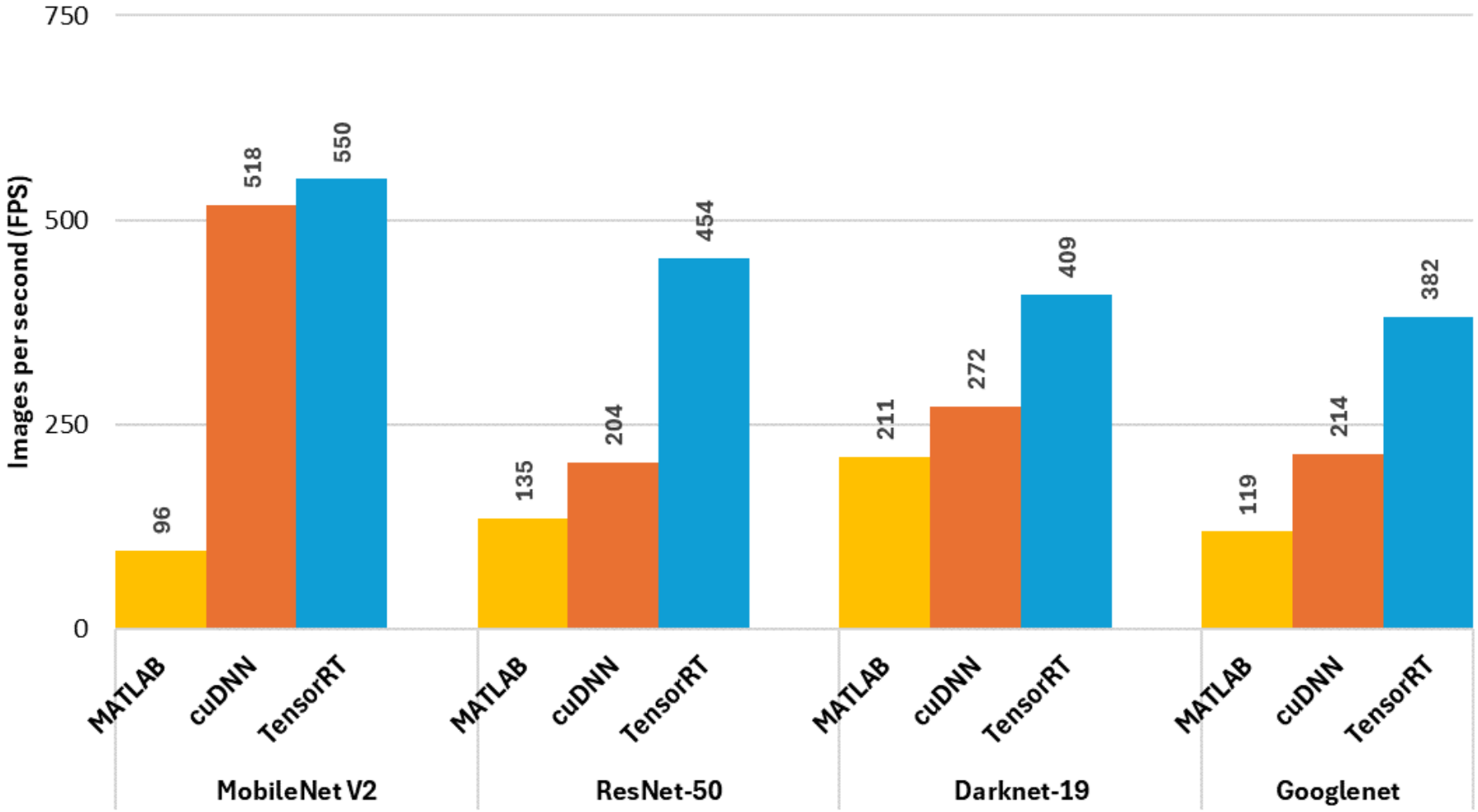
- Iterate your MATLAB code and use profiling tools to help optimize further
- Implement as source, executable, or library

Deep Learning Code Generation



Performance of Generated Code from GPU Coder

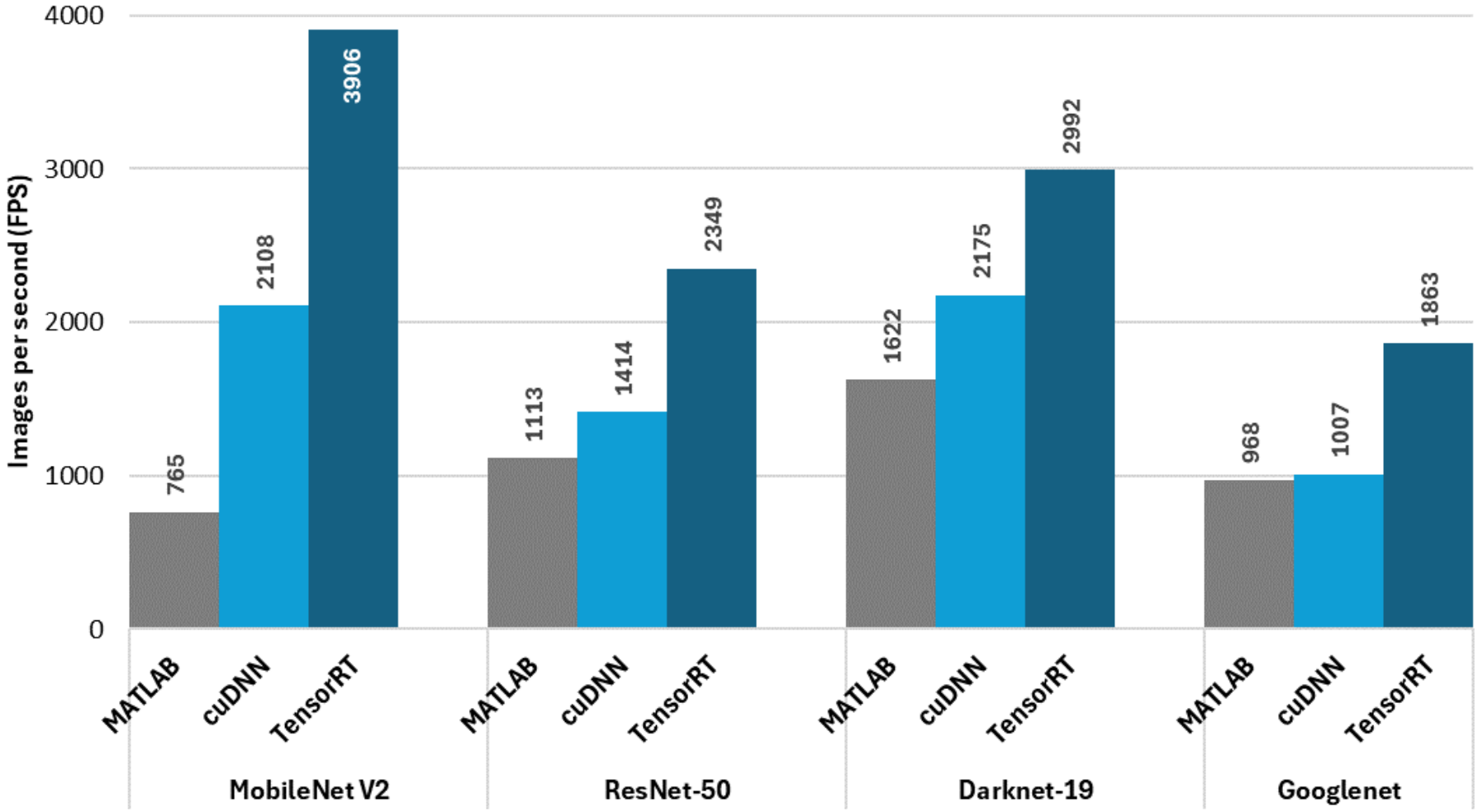
Batch Size 1



AMD® EPYC 7262 CPU 3.2 GHz | NVIDIA® RTX A5000 GPU | NVIDIA libraries: CUDA12.2 - cuDNN 8.9 – TensorRT 8.6.1

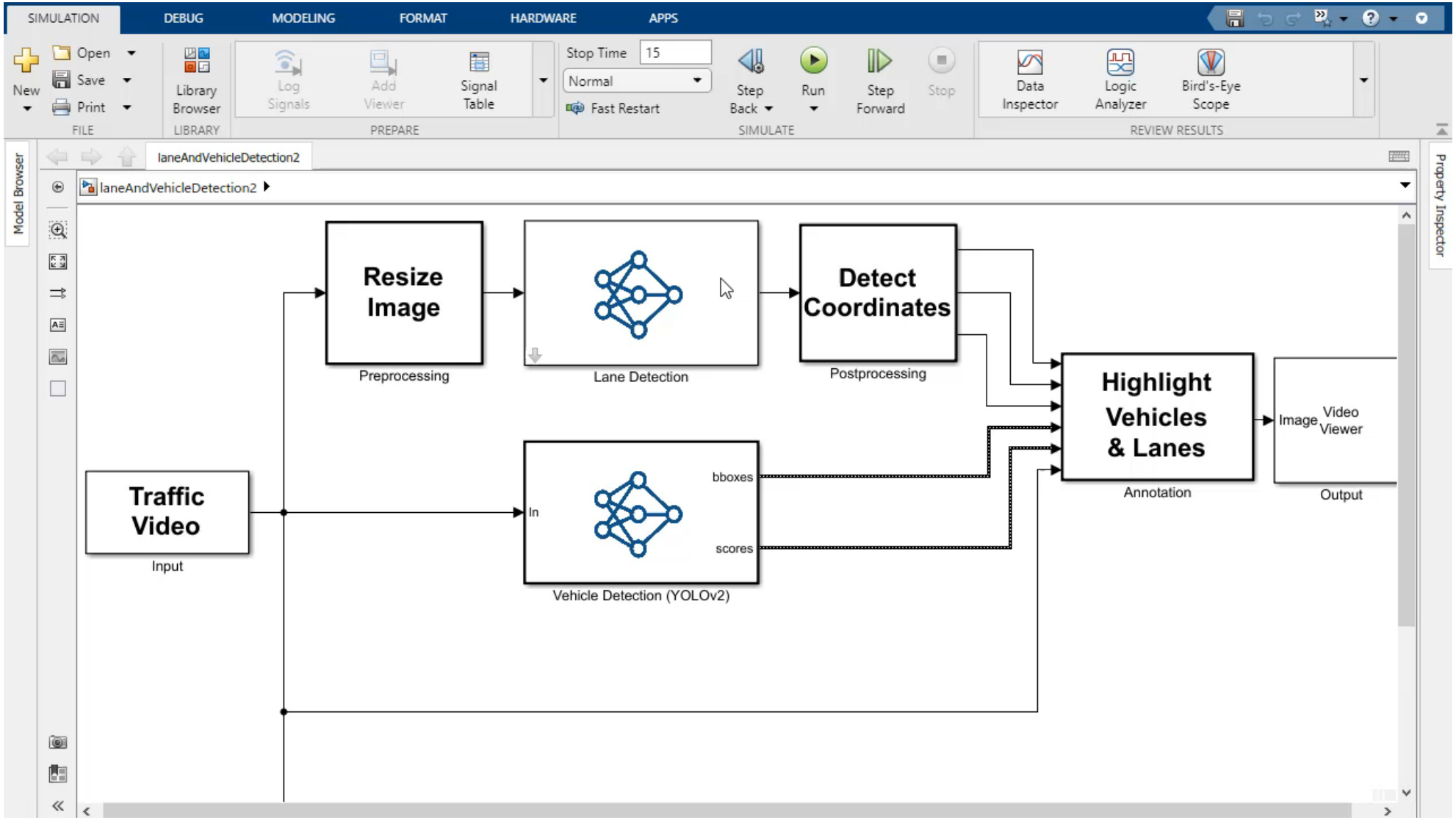
Performance of Generated Code from GPU Coder

Batch Size 8



AMD® EPYC 7262 CPU 3.2 GHz | NVIDIA® RTX A5000 GPU | NVIDIA libraries: CUDA12.2 - cuDNN 8.9 – TensorRT 8.6.1

Run Simulation on Desktop GPU



Example: Image Classification by ResNet-50

```
function out = resnet_predict(in) %#codegen
% Copyright 2020-2024 The MathWorks, Inc.

persistent dlnet;

dlIn = dlarray(in, 'SSC');
if isempty(dlnet)
    % Call the function resnet50 that returns a dlnetwork object
    % for ResNet-50 model.
    dlnet = imagePretrainedNetwork('resnet50');
end

dlOut = predict(dlnet, dlIn);
out = extractdata(dlOut);

end
```

ell pepper

ucumber

emon

corn squash

amper

- gpuDeviceCount % 顯示 GPU 數量
- gpuDevice(1) % 顯示第一張 GPU 的詳細資訊

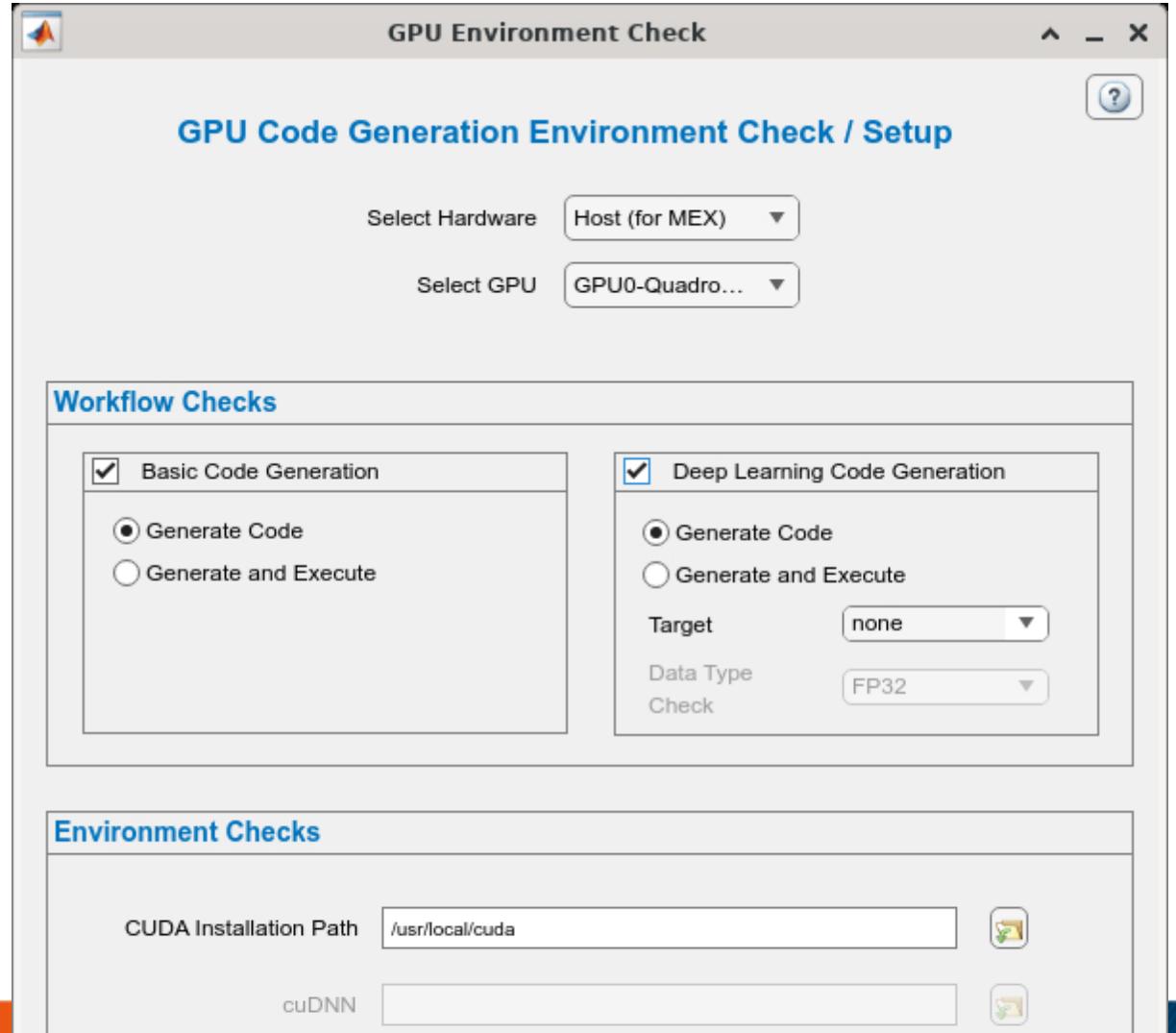
```
ans =

  CUDADevice with properties:

                      Name: 'NVIDIA RTX A500 Laptop GPU'
                     Index: 1 (of 1)
       ComputeCapability: '8.6'
             DriverModel: 'WDDM'
             TotalMemory: 4294508544 (4.29 GB)
       AvailableMemory: 3464757248 (3.46 GB)
       DeviceAvailable: true
        DeviceSelected: true

  Show all properties.
```

Verify GPU code generation environment

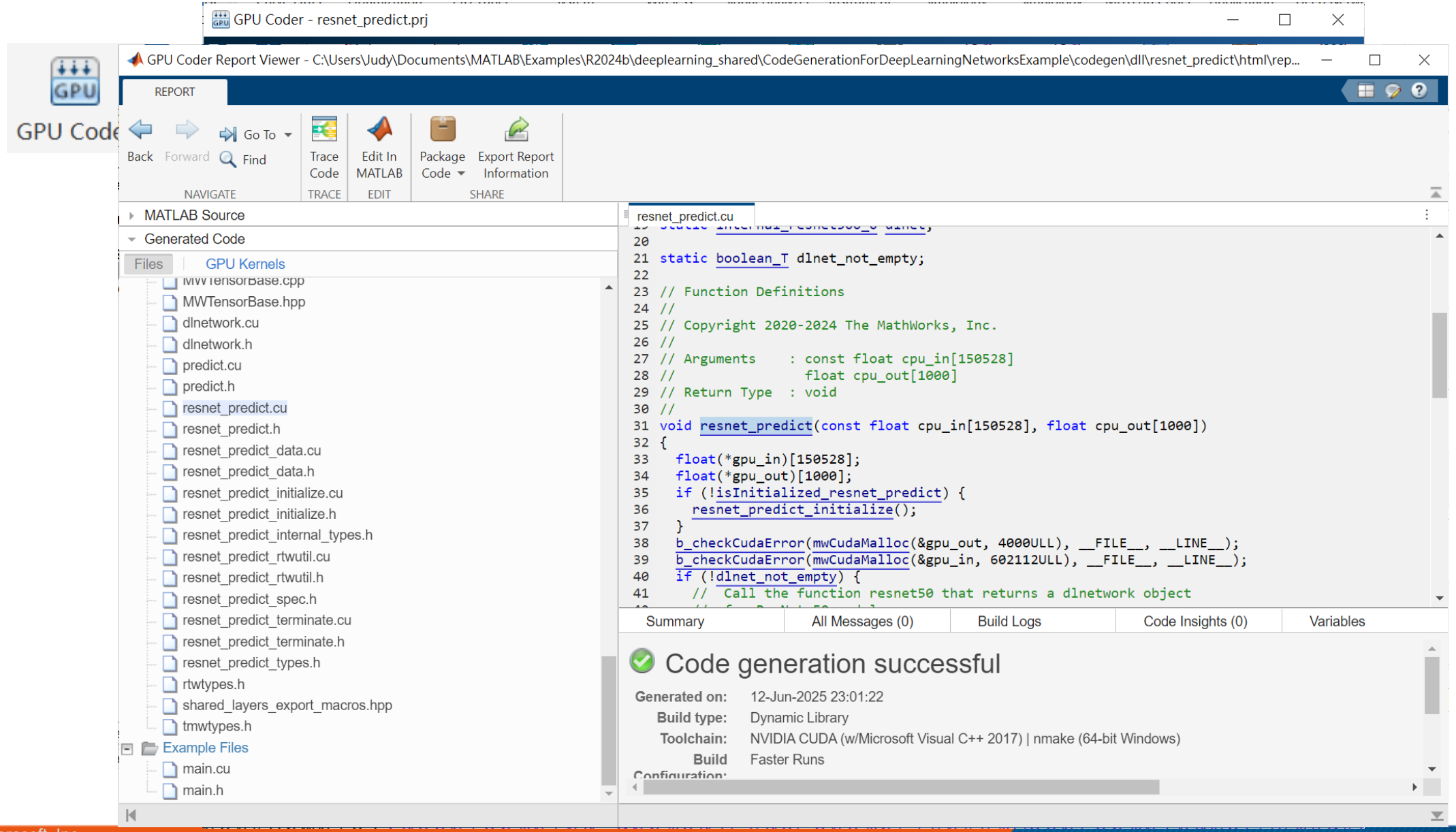
- coder.checkGpuInstall

```
Compatible GPU                  : PASSED
CUDA Environment                : PASSED
    Runtime     : PASSED
    cuFFT       : PASSED
    cuSOLVER    : PASSED
    cuBLAS      : PASSED
Host Compiler                   : PASSED
Basic Code Generation           : PASSED
Basic Code Execution            : PASSED

results =

  struct with fields:

                gpu: 1
               cuda: 1
              cudnn: 0
            tensorrt: 0
```

- gpucoderSetup



Generate GUDA code from GPU Coder

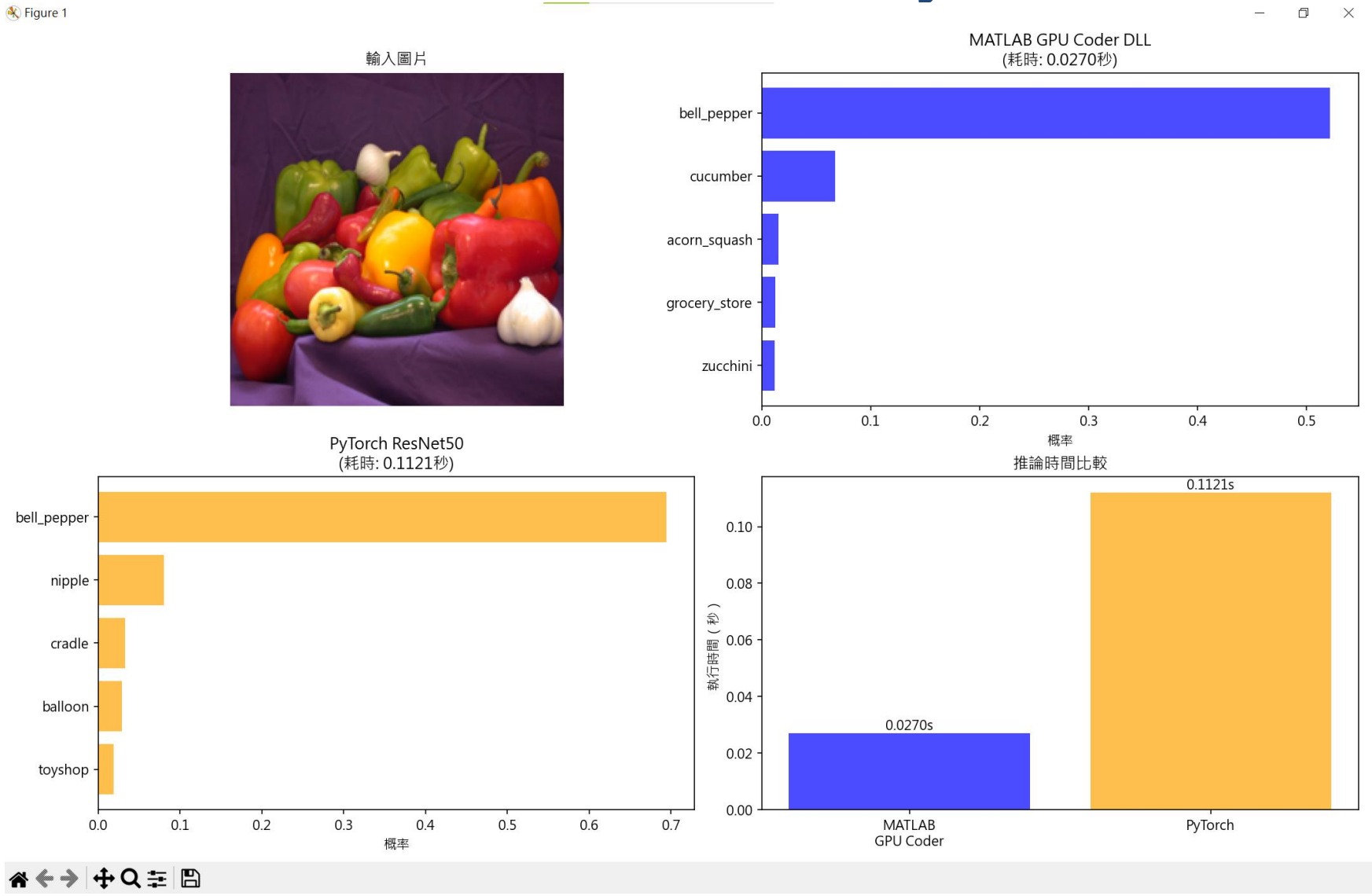


Python code

```
# === 設定CUDA環境路徑 ===
try:
    os.add_dll_directory(r"C:\Program Files\NVIDIA GPU Computing Toolkit\CUDA\v12.6\bin")
    os.add_dll_directory(r"C:\Program Files\NVIDIA GPU Computing Toolkit\CUDA\cuDNN\bin")
    os.add_dll_directory(r"D:\ProgramFiles\MATLAB\R2024b\bin\win64")  # 視你的版本而定
except:
    print("警告：無法設定CUDA路徑，DLL可能無法正常運作")
```

```
# === GPU Coder DLL 預測 ===
def setup_dll():
    dll_path = r"D:\GPU_Coder\codegen\dll\resnet_predict\resnet_predict.dll"
    if not os.path.exists(dll_path):
        print(f"[錯誤] 找不到DLL檔案: {dll_path}")
        sys.exit(1)

    dll = ctypes.CDLL(dll_path)

    # 簡化參數設定，使用基本的POINTER方式
    dll.resnet_predict.argtypes = [
        ctypes.POINTER(ctypes.c_float),  # 輸入
        ctypes.POINTER(ctypes.c_float)   # 輸出
    ]
    dll.resnet_predict.restype = None
    print("使用基本POINTER方法設定DLL參數")
```

速度比較: MATLAB GPU Coder DLL vs PyTorch: 4.15x



Key Takeaways

- MATLAB empowers rapid development of visual inspection algorithms
- GPU Coder automatically converts these algorithms into native CUDA C code
- Seamless integration with Python-based systems

- **對學校的價值**
  👉 GPU Coder 讓師生專注研究，而不是卡在 CUDA 細節
  👉 最大化 GPU cluster 投資效益，推動跨領域研究與產學合作

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