MATLAB EXPO

自动光学检查与缺陷检测在工业领域的应用

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MathWorks

什么是自动光学检查?

“自动光学检查即基于图像或视频对零部件进行检查，使用摄像头扫描待测零部件的质量缺陷”

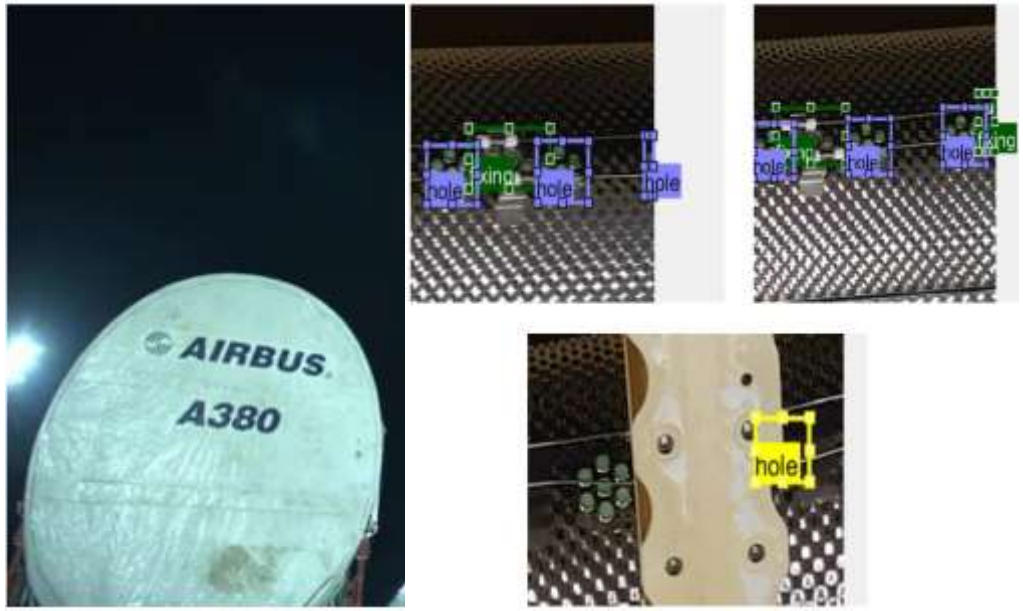
自动缺陷检测

机器视觉

视觉检测

自动检测

参考客户案例



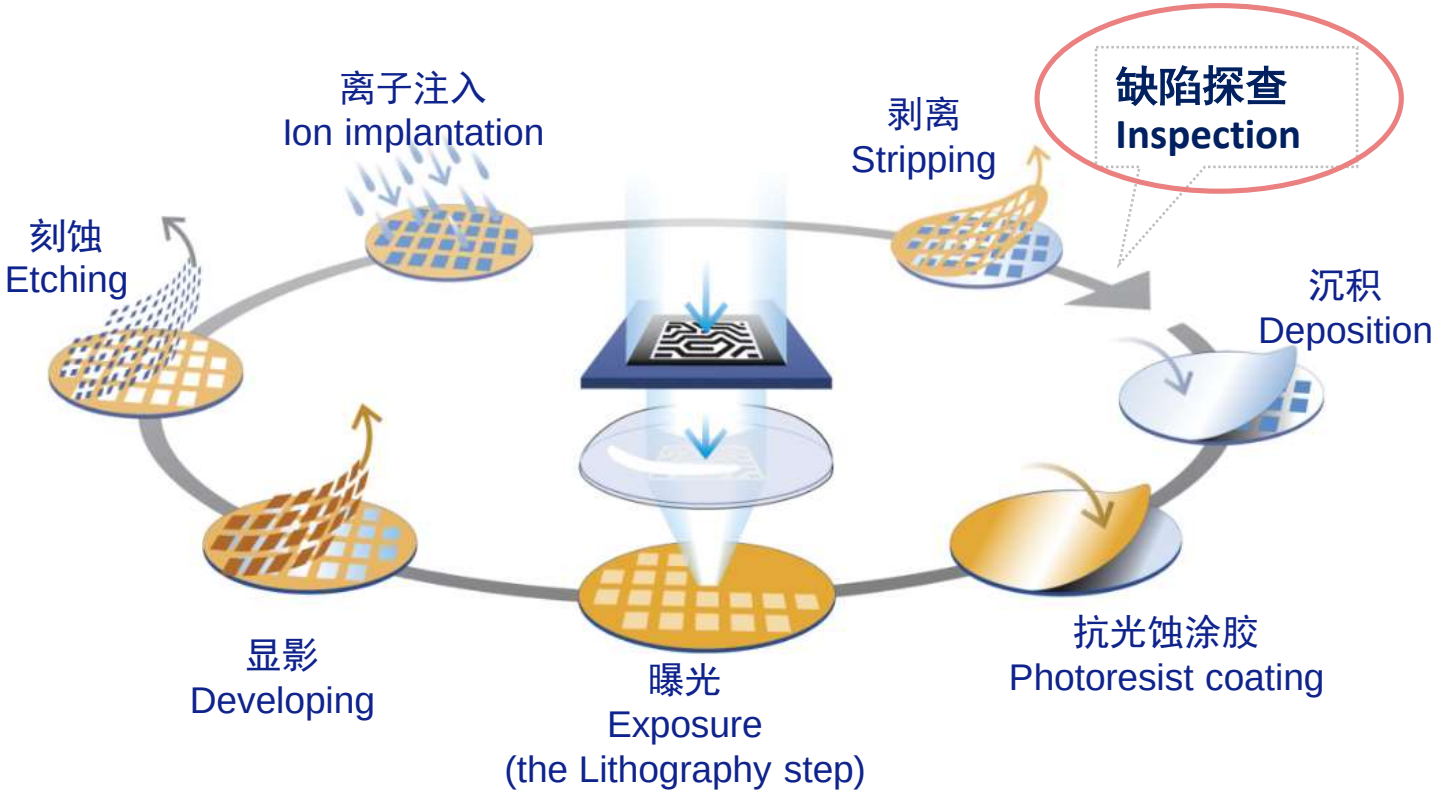
生产装配缺陷检测

铁路零部件缺损检测

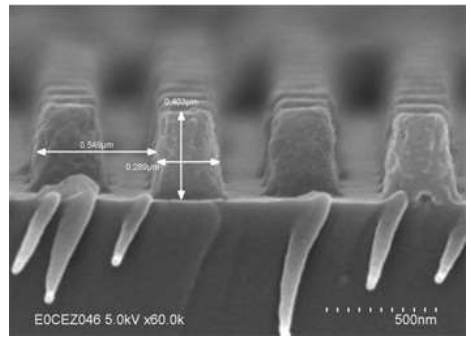
AIRBUS

KRRI

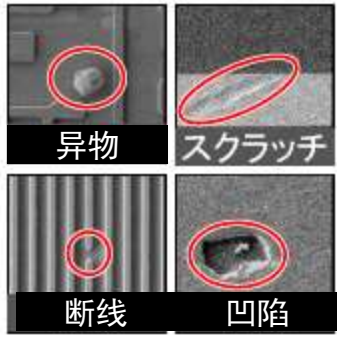
芯片制程中的缺陷检测应用



电子扫描显微镜
Scanning Electron Microscope (SEM)

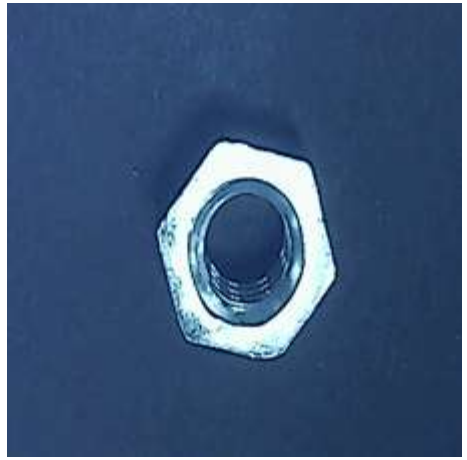


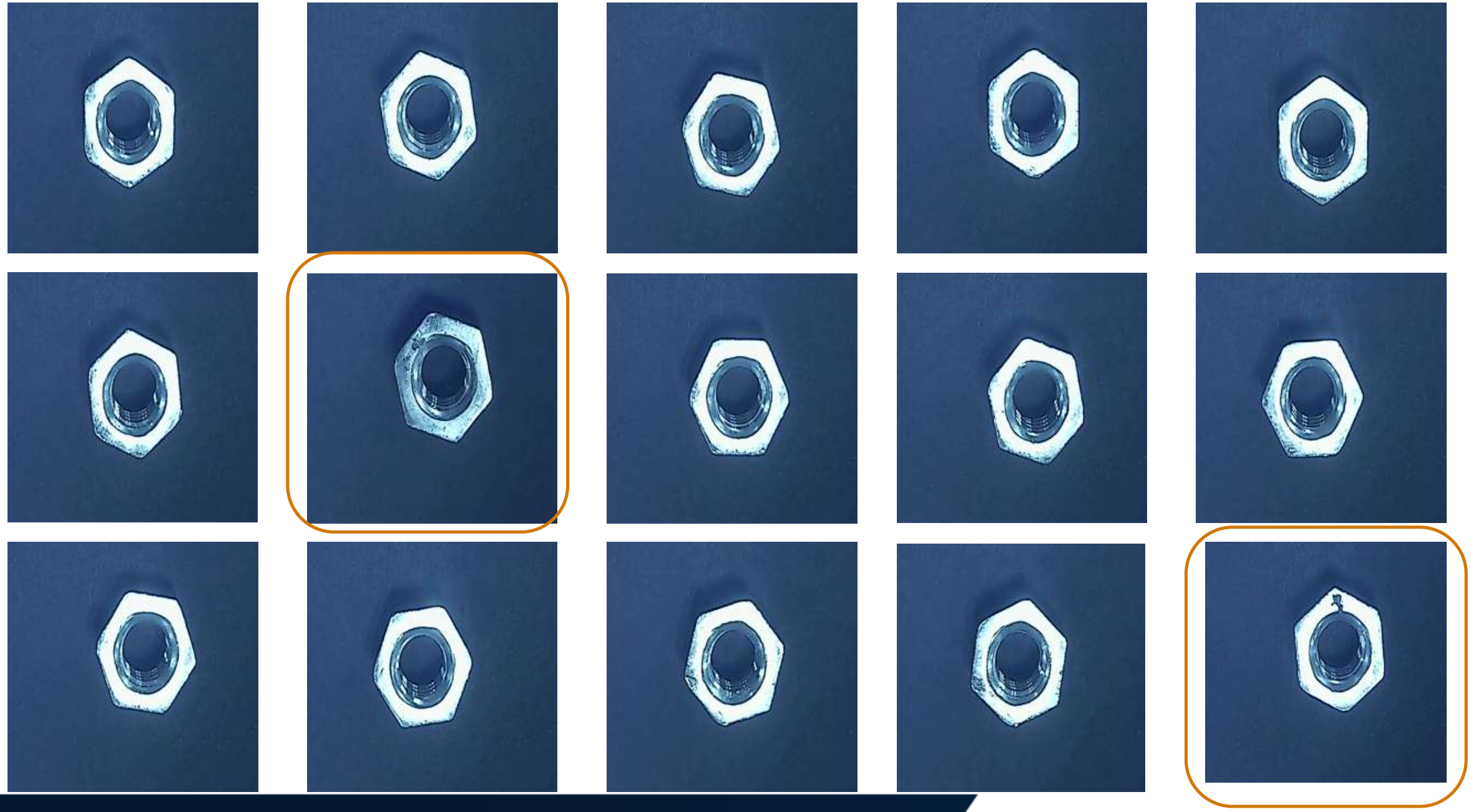
Critical Dimension SEM

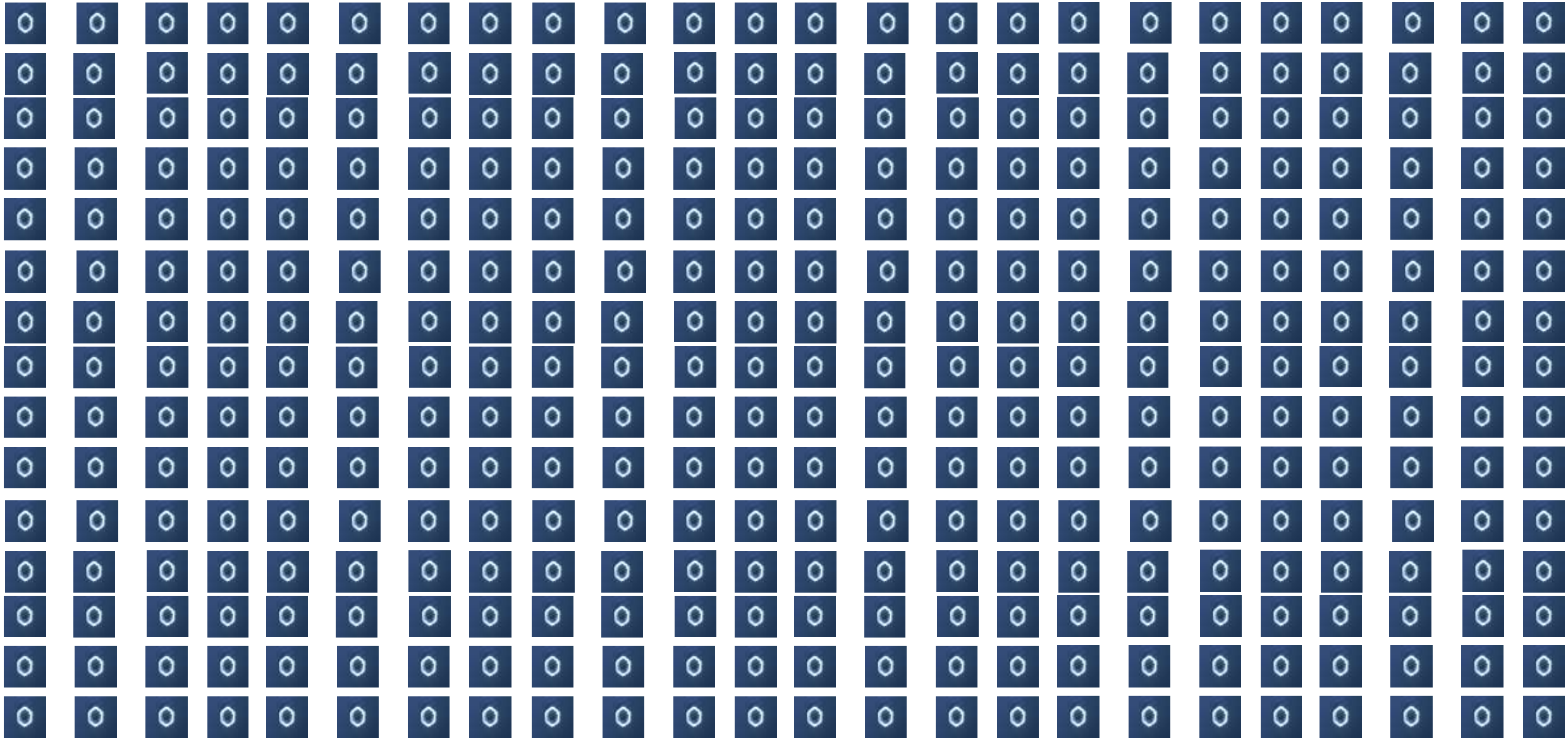


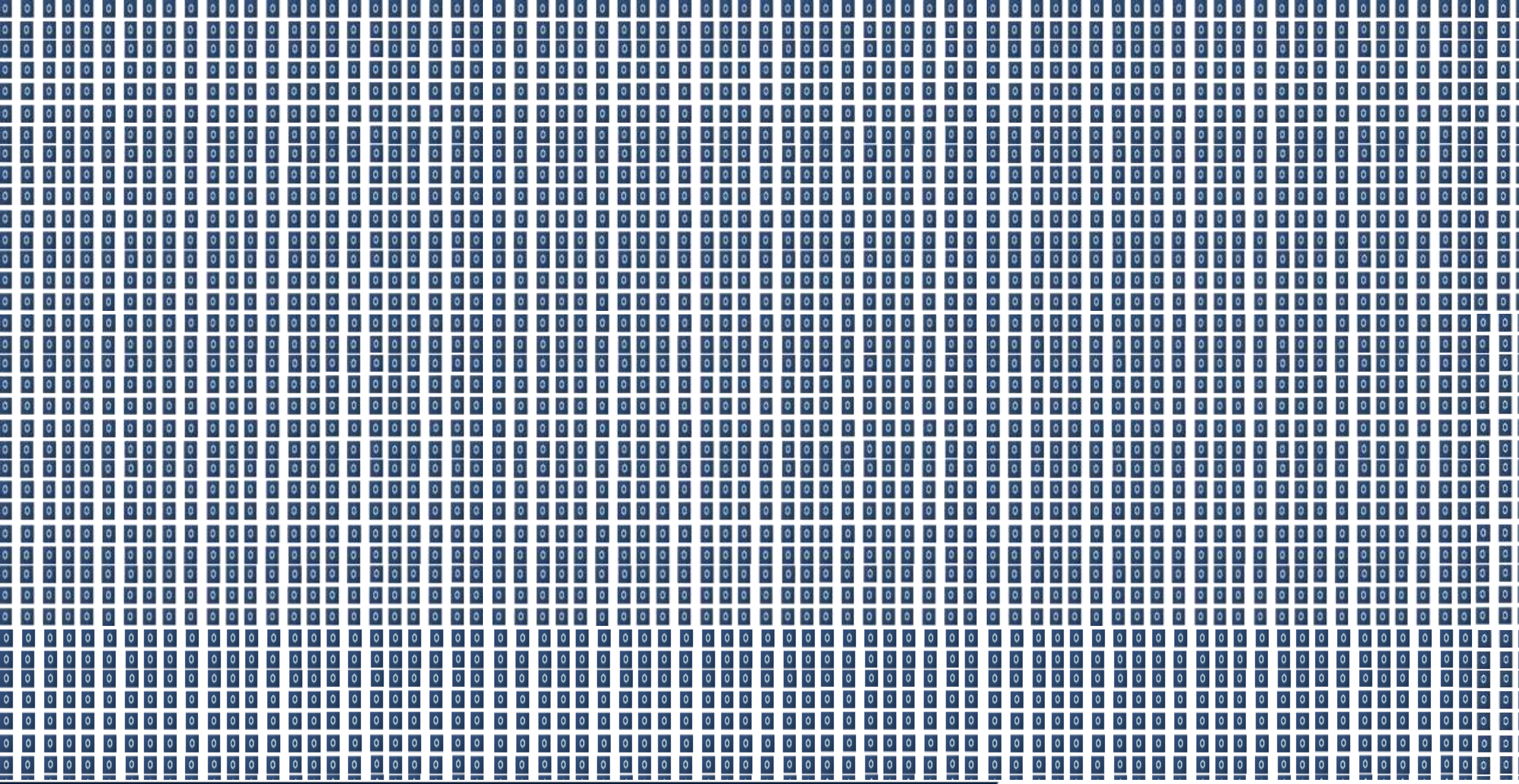
Wafer surface inspection SEM

能找到有缺陷的六边形螺母吗？



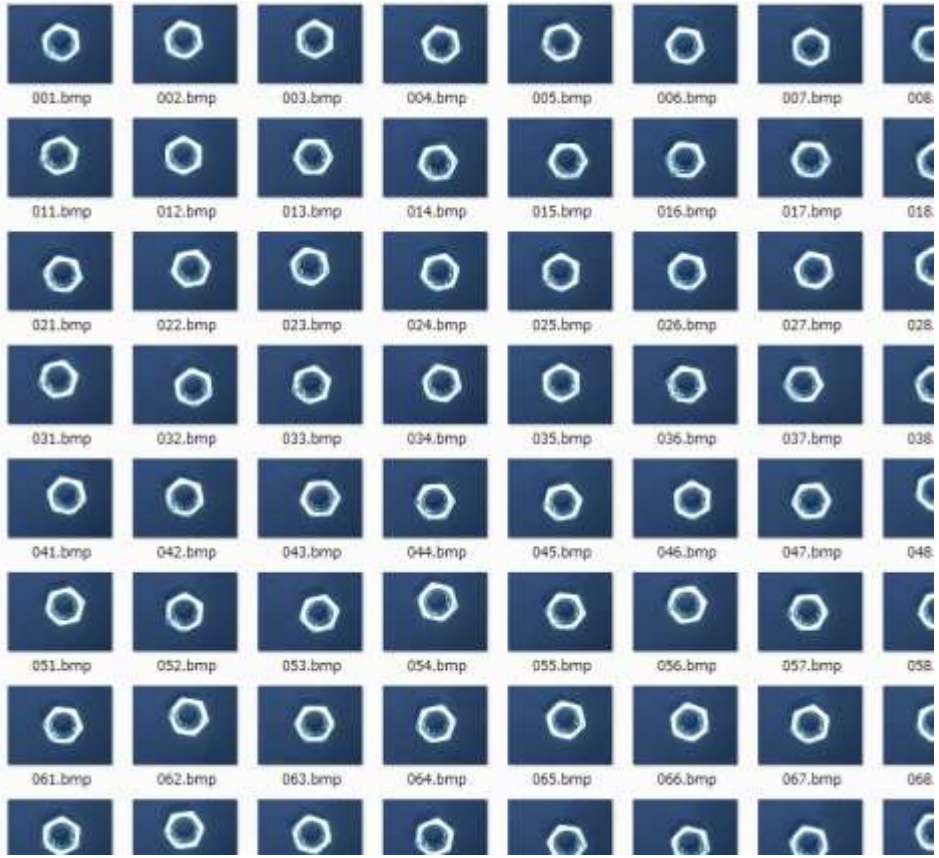




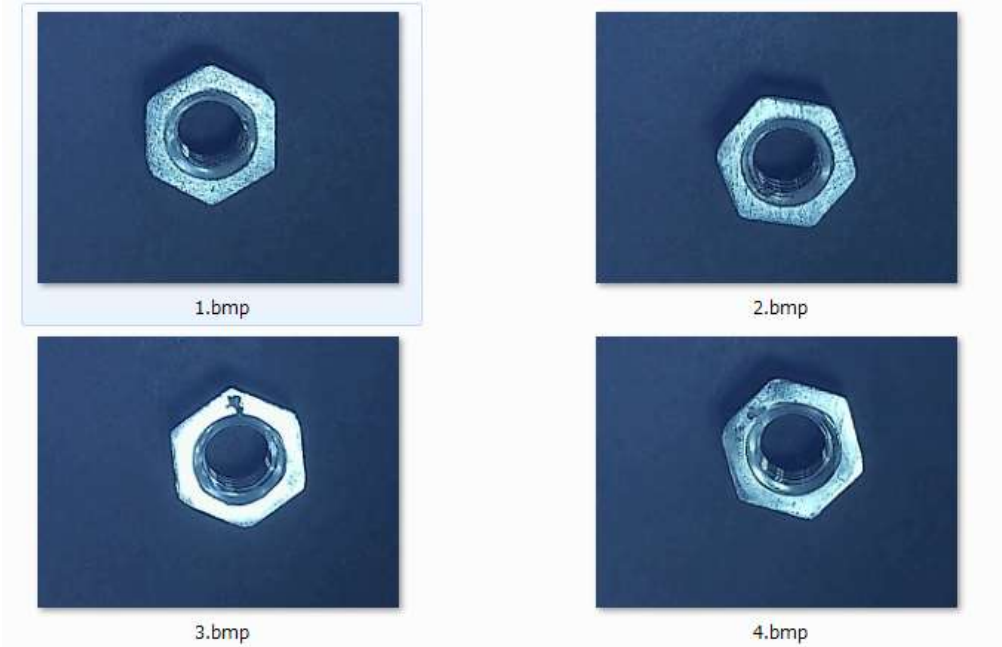


寻找缺陷六角螺母

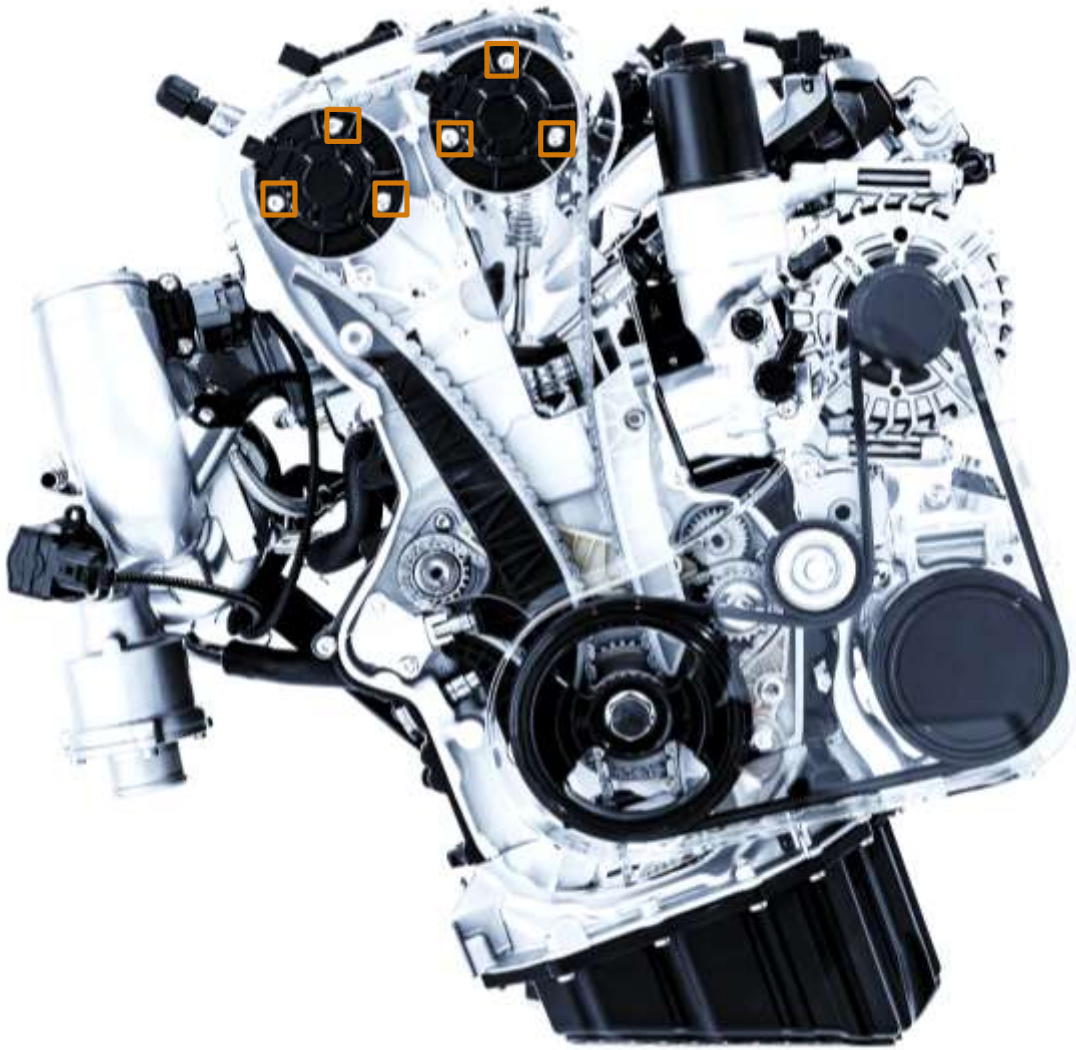
Good



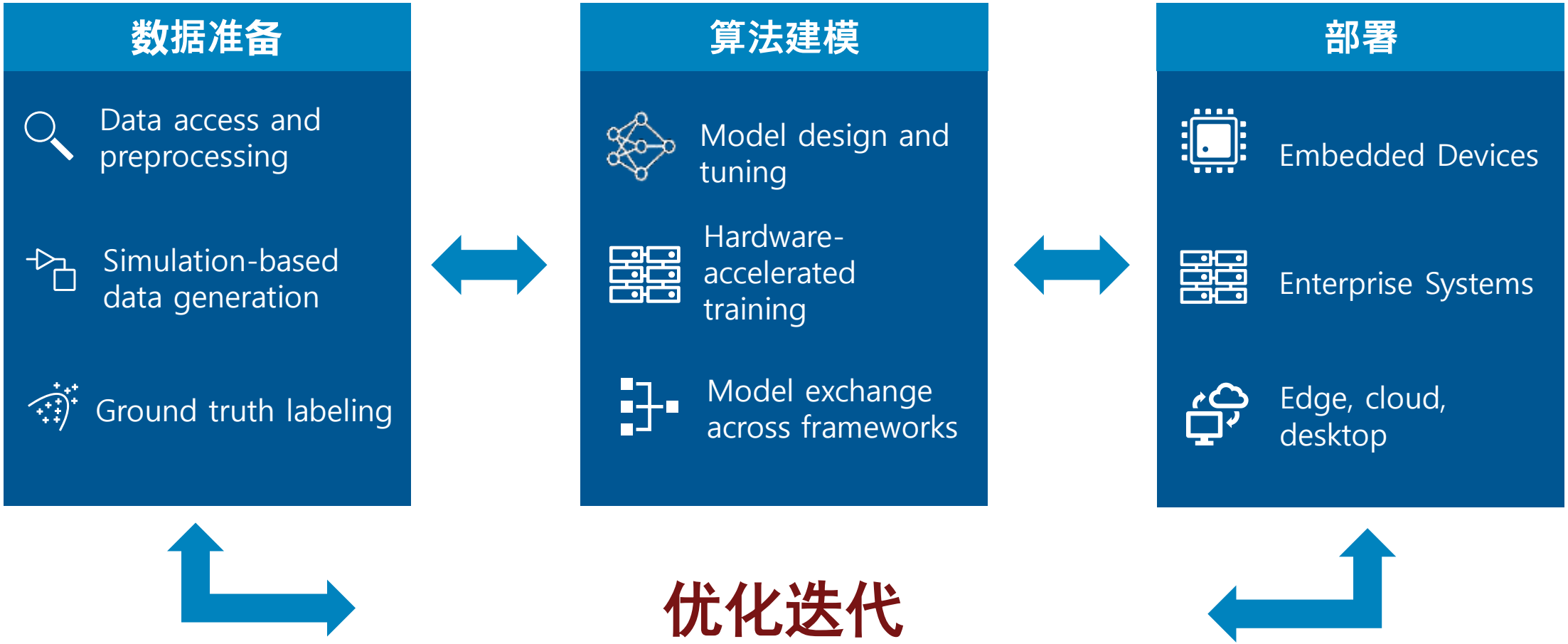
Defective



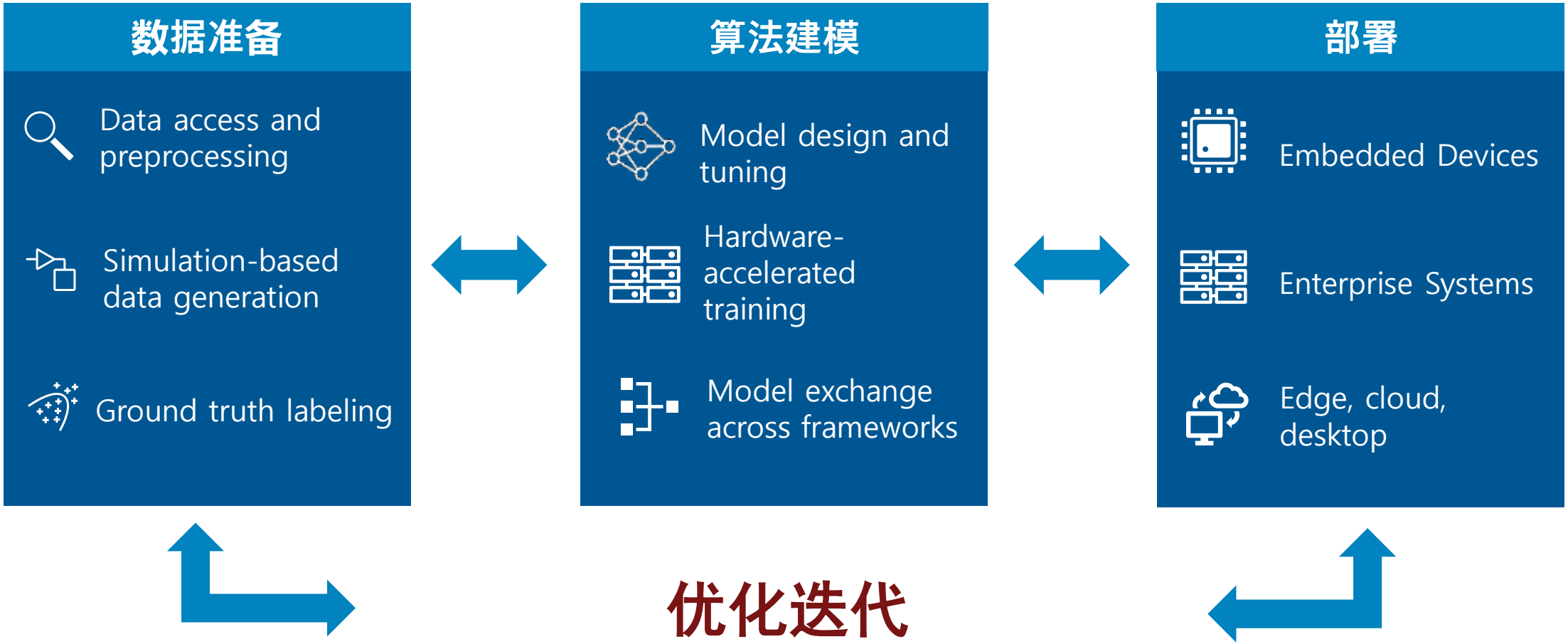
检测缺陷零部件



缺陷检测流程


数据准备
Data access and preprocessing
Simulation-based data generation
Ground truth labeling
算法建模
Model design and tuning
Hardware-accelerated training
Model exchange across frameworks
部署
Embedded Devices
Enterprise Systems
Edge, cloud, desktop
优化迭代

缺陷检测流程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数据访问和预处理 – 共同挑战

- 如何访问无法放入内存的大数据?
- 如何预处理数据，并找到恰当特征?
- 如何快速标注数据?
- 数据集不均衡或数据量不足，怎么办?

数据访问和预处理– 共同挑战

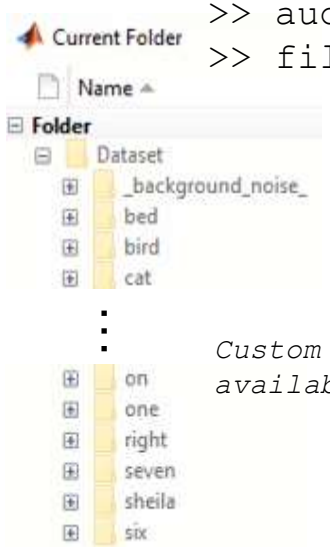
如何访问无法放入内存的大型数据集?

该如何加载和访问海量数据?

Datastores

Loads image/signal data into memory as and when needed

```
>> imageDatastore
>> audioDatastore
>> fileDatastore
```

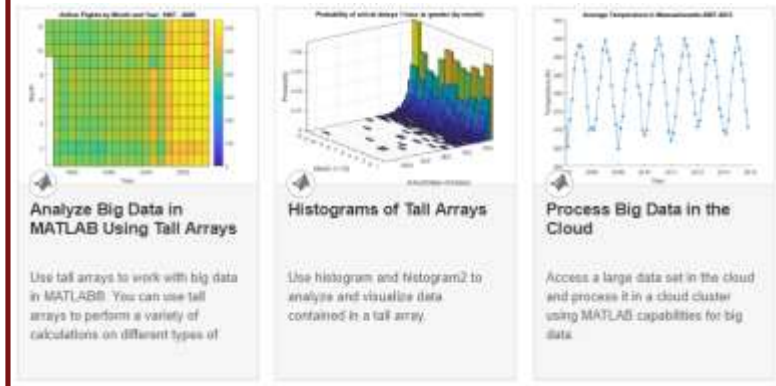


Custom Datastores also available

Tall Arrays

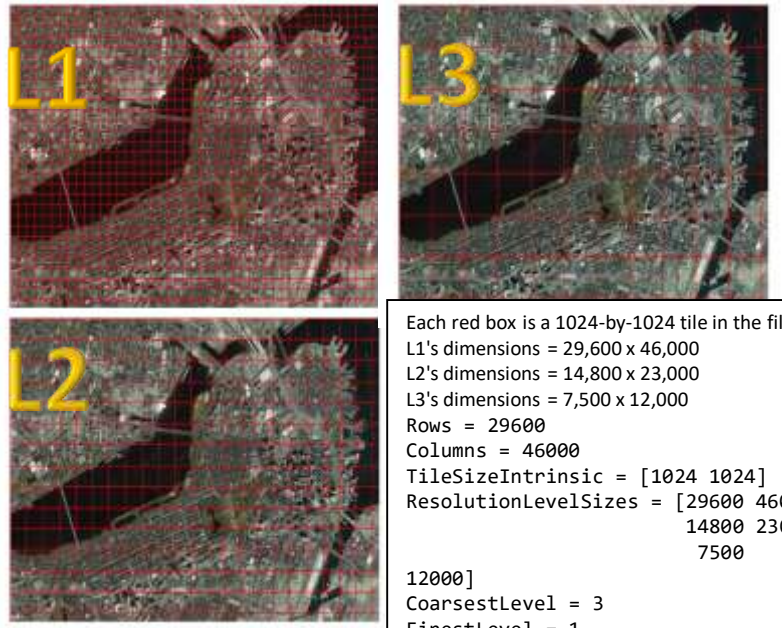
Work with out-of-memory numeric data

- Train deep neural networks for numeric arrays



BigImage

Work with very large, tiled and multi-resolution images



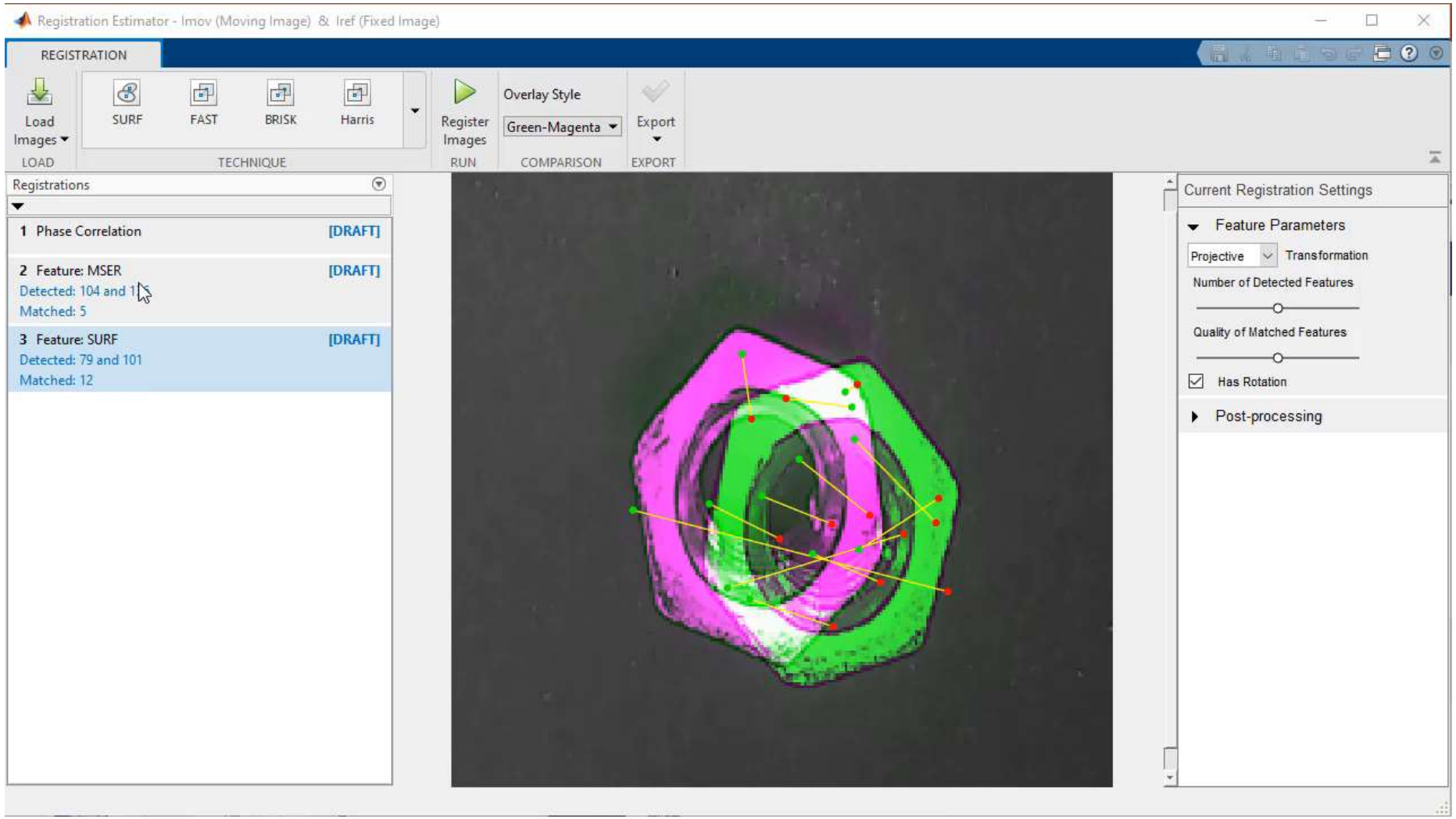
Each red box is a 1024-by-1024 tile in the file.
L1's dimensions = 29,600 x 46,000
L2's dimensions = 14,800 x 23,000
L3's dimensions = 7,500 x 12,000

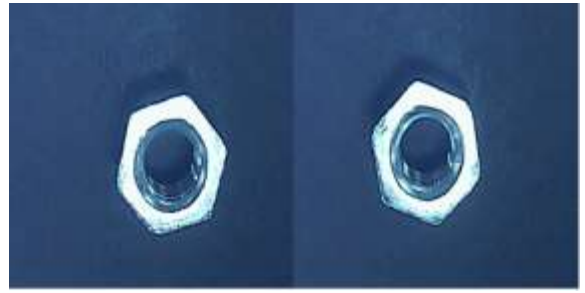
```
Rows = 29600
Columns = 46000
TileSizeIntrinsic = [1024 1024]
ResolutionLevelSizes = [29600 46000
                        14800 23000
                         7500
12000]
CoarsestLevel = 3
FinestLevel = 1
PixelSpacings = [1 1; 2 2; 3.947
3.833]
```

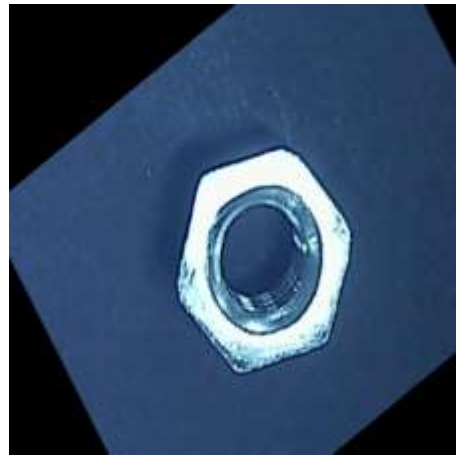
数据访问和预处理 – 共同挑战

如何预处理数据，并找到恰当特征?

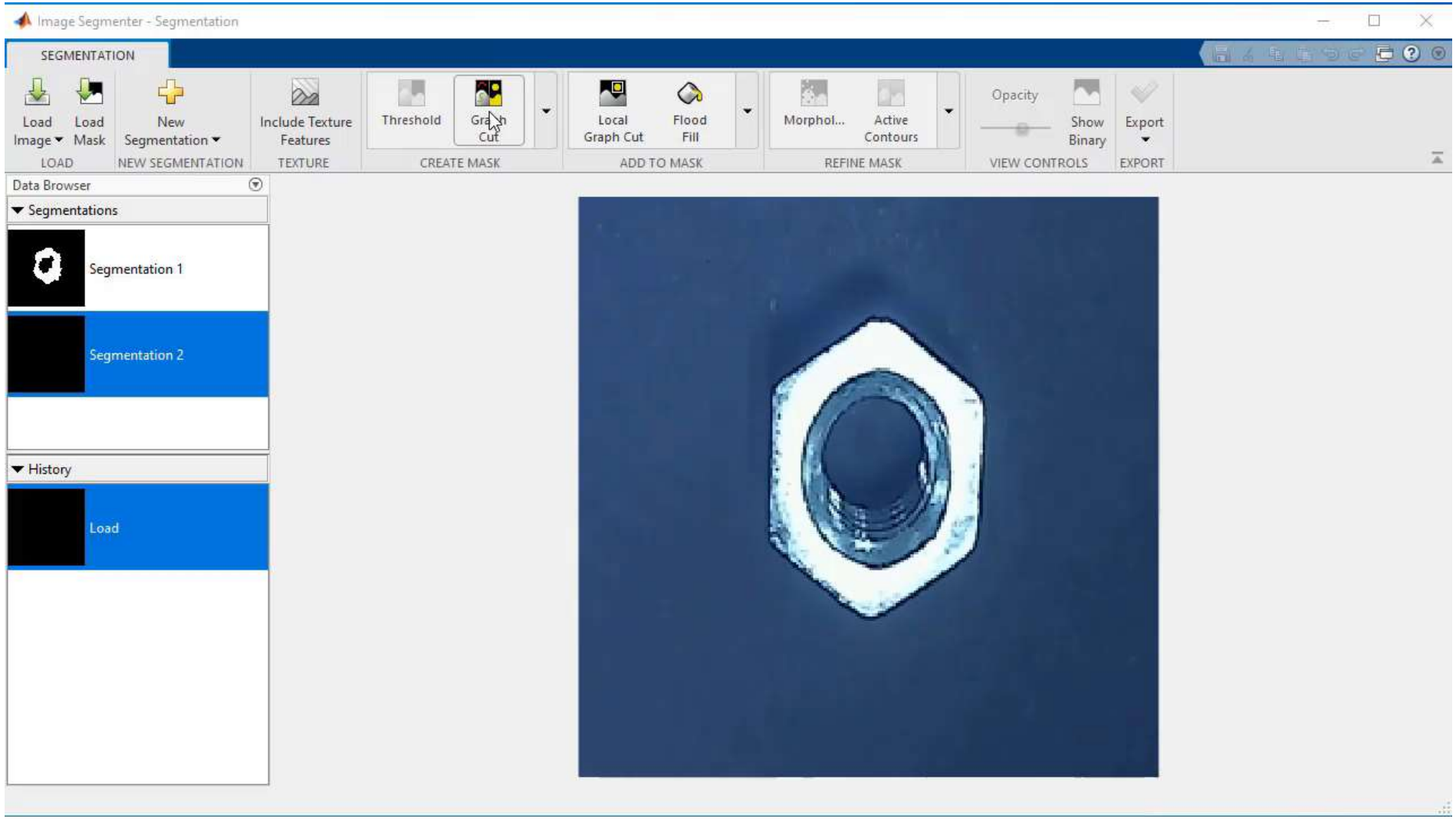
数据预处理– Registration Estimator App



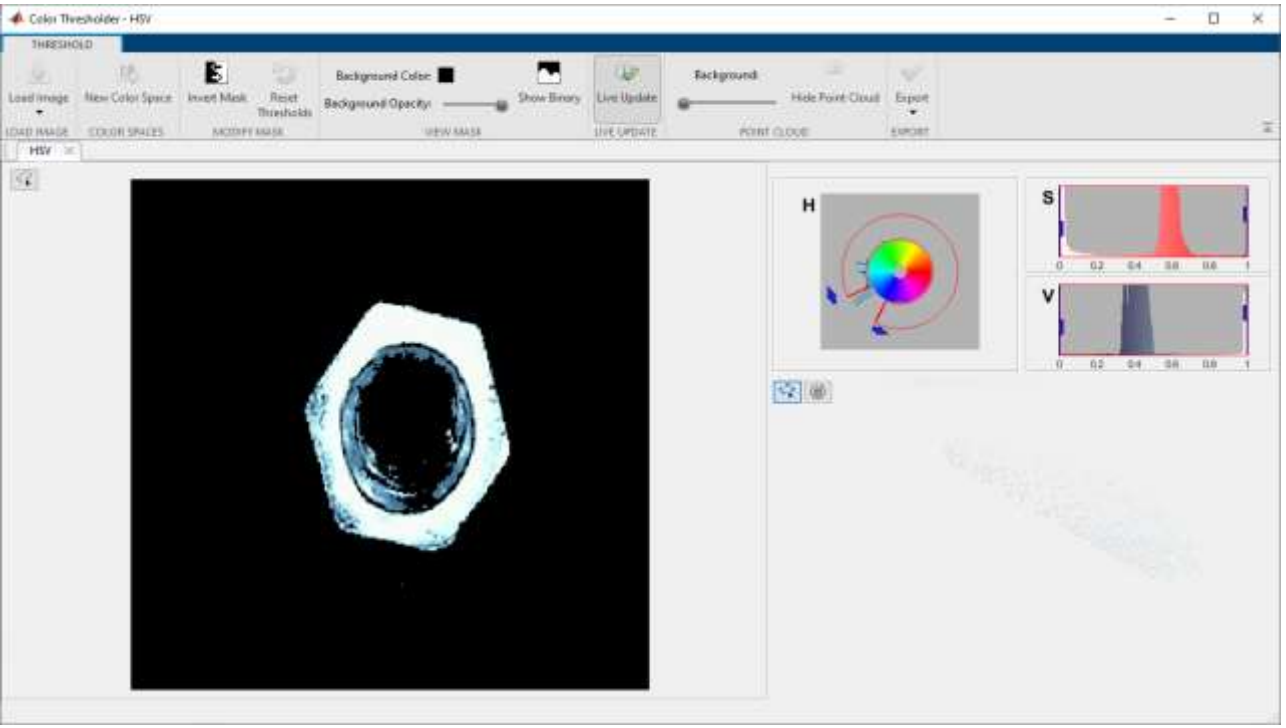




数据预处理– Image Segmenter App



数据预处理- Apps



Color Thresholder

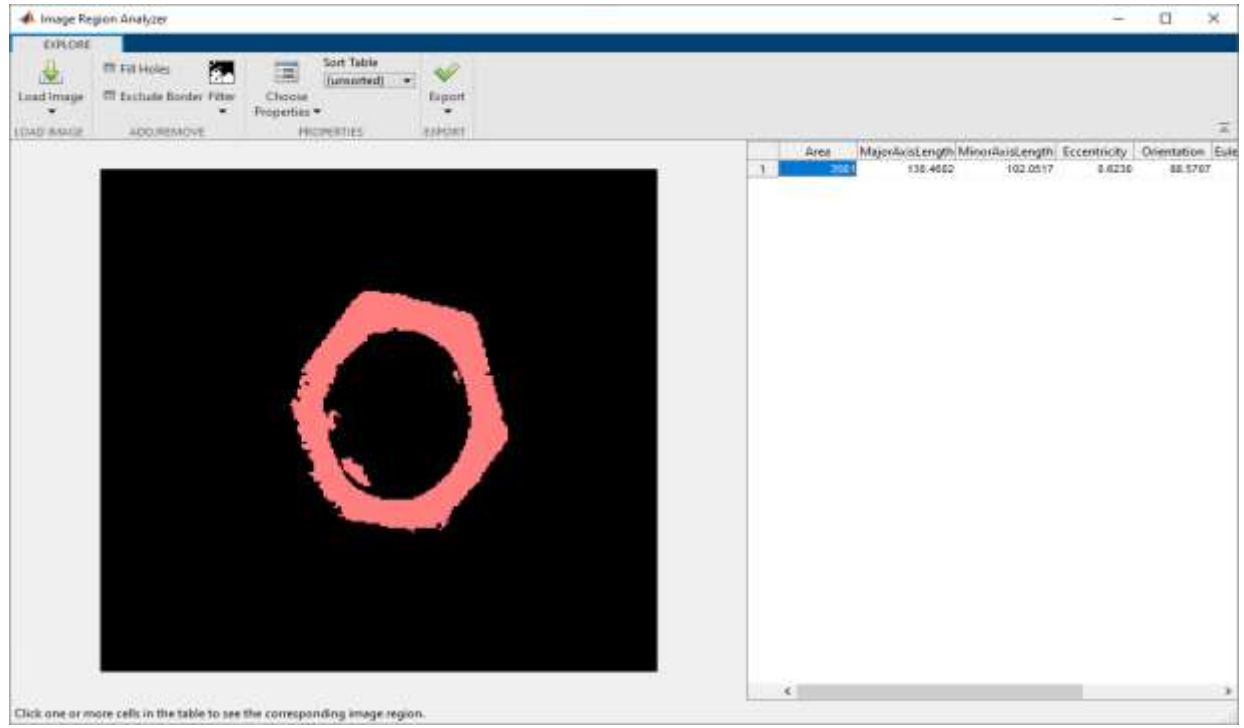
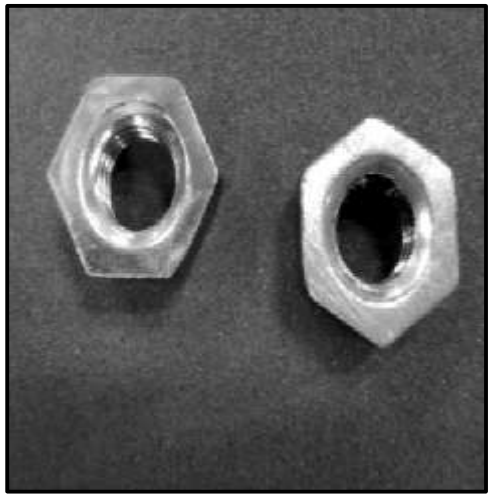


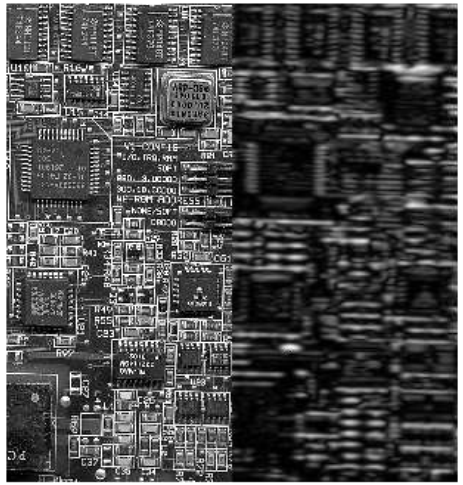
Image Region Analyzer

数据预处理– 内置算法

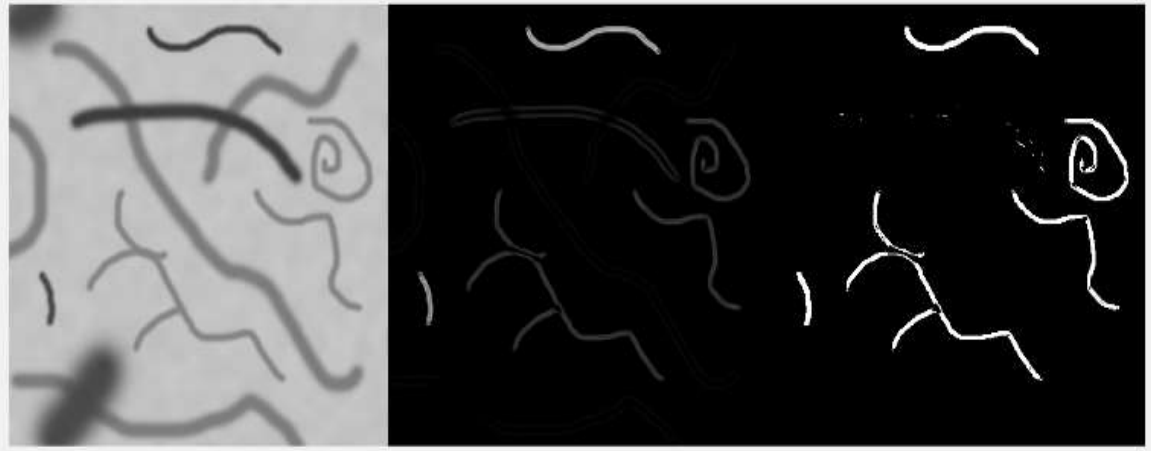
imadjust



imgaborfilt



fibermetric



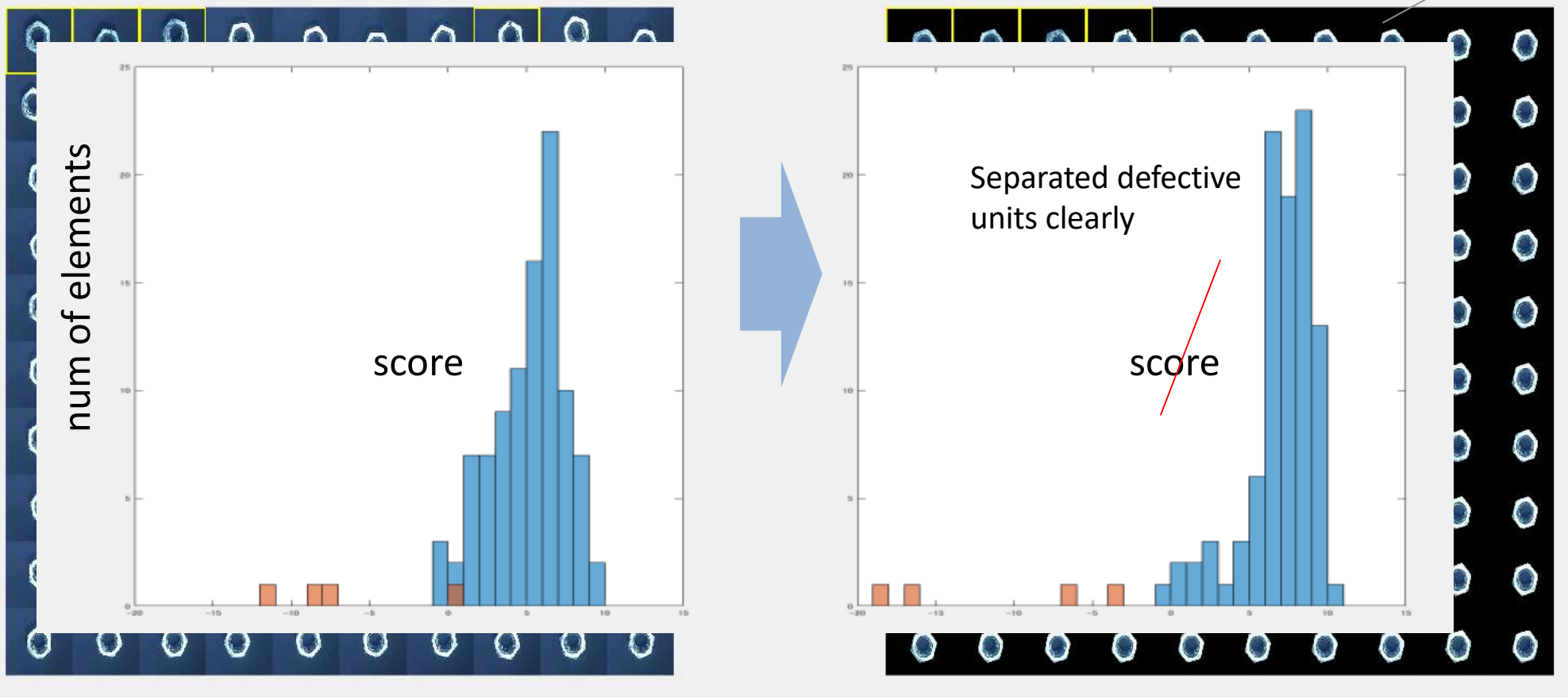
Histogram of predicted scores

Defect detection using AlexNet: Results with preprocessing

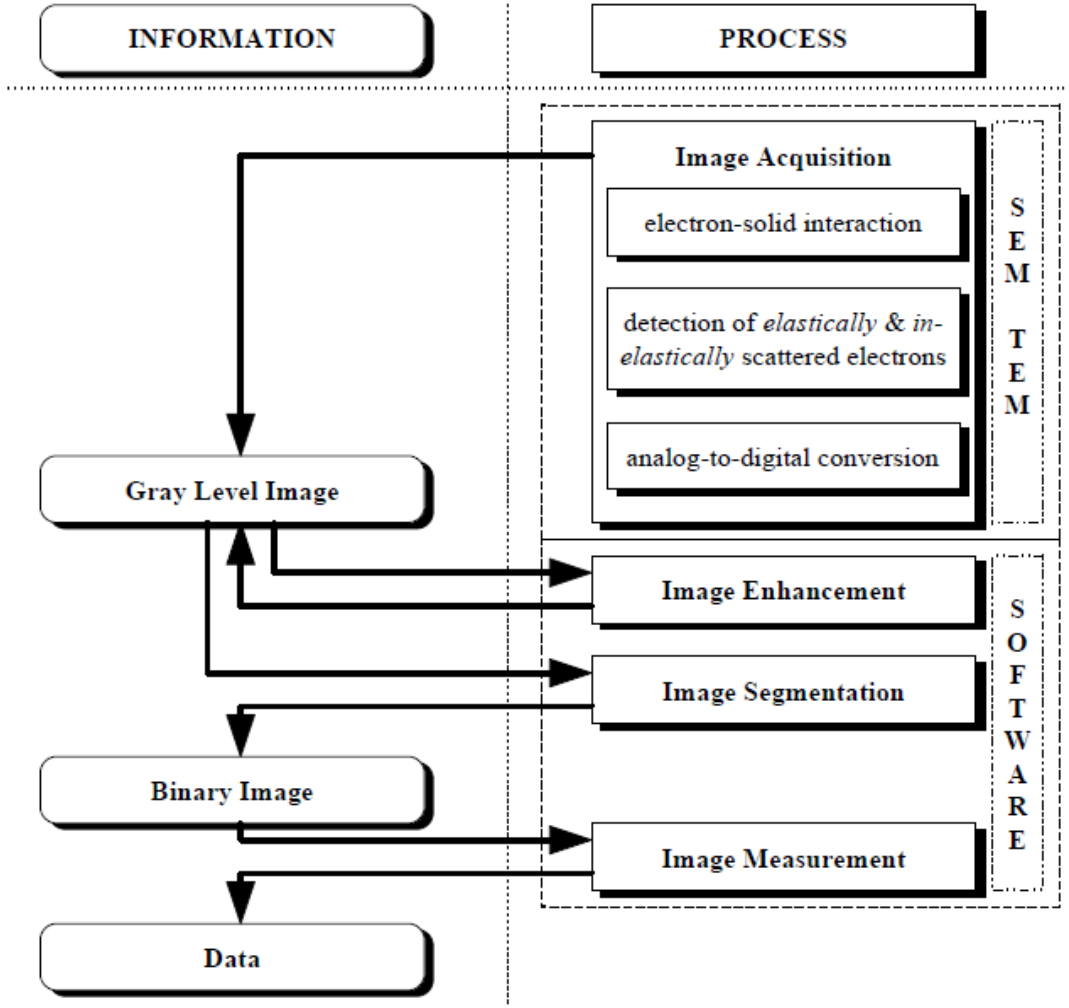
Without pre-processing

With pre-processing

Peak of normal score shifts right (Sufficient margin from abnormal units)



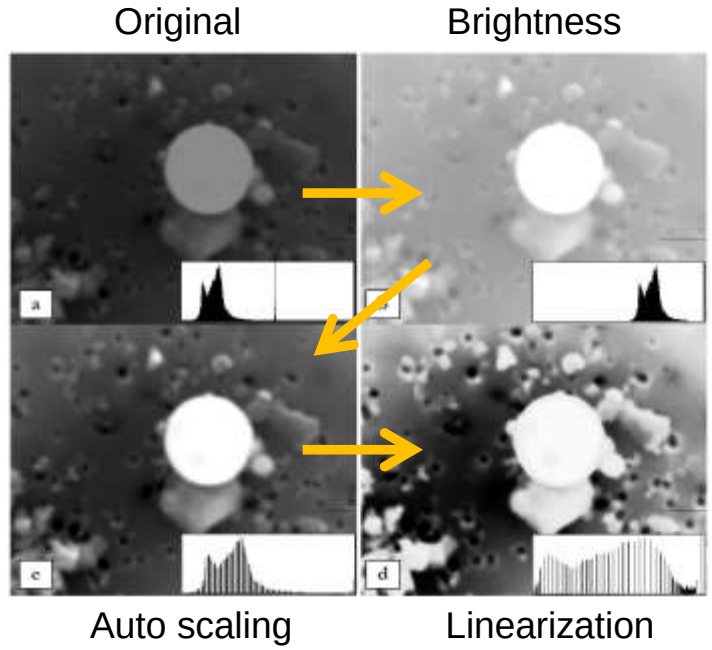
电子扫描显微镜：图像处理算法开发
SEM：Image processing algorithm development



Ref. P.Espen, Development and Application of Image Analysis Techniques for Identification and Classification of Microscopic Particles, UNIVERSITEIT ANTWERPEN, ANTWERPEN,1997

Image Enhancement

Gray level histogram modifications



Smoothing

Sharpening

Scanning Electron Microscope (SEM): Image processing algorithm development

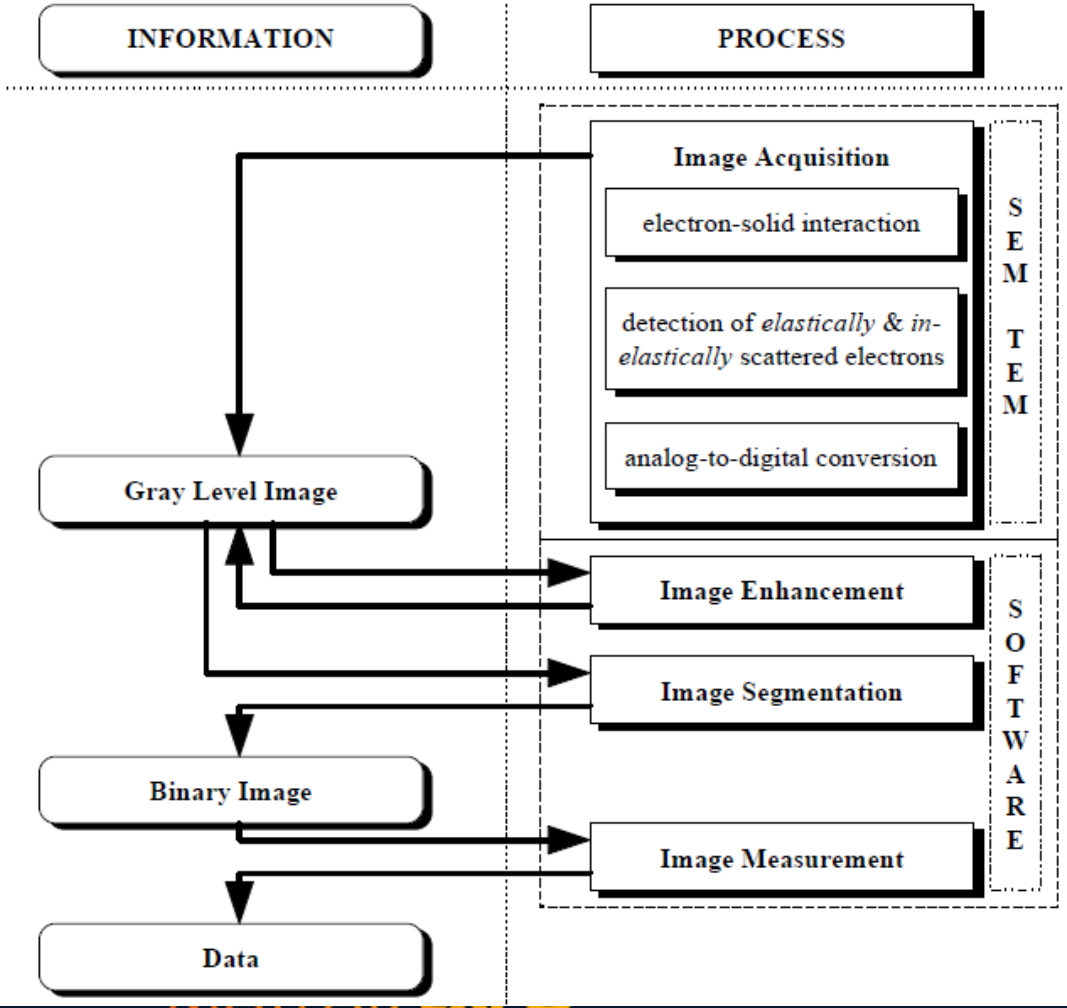
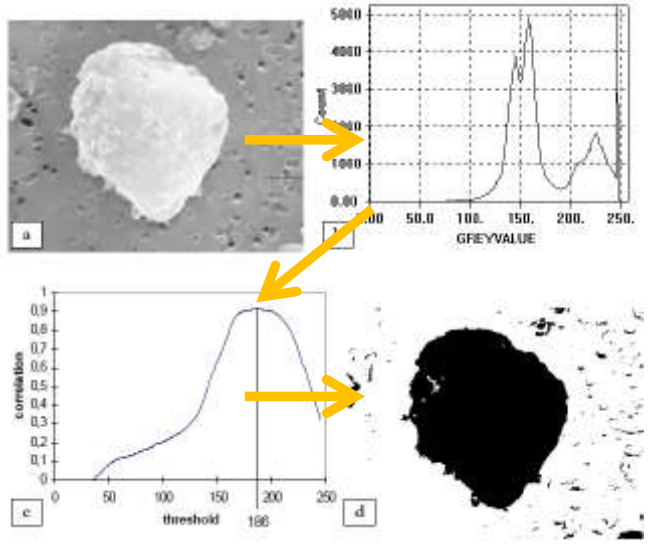


Image Segmentation

Original

Gray level histogram



Threshold

Binary image

Data Access and Preprocessing – Common Challenges

如何更快标注我的数据?

数据预处理- 标注

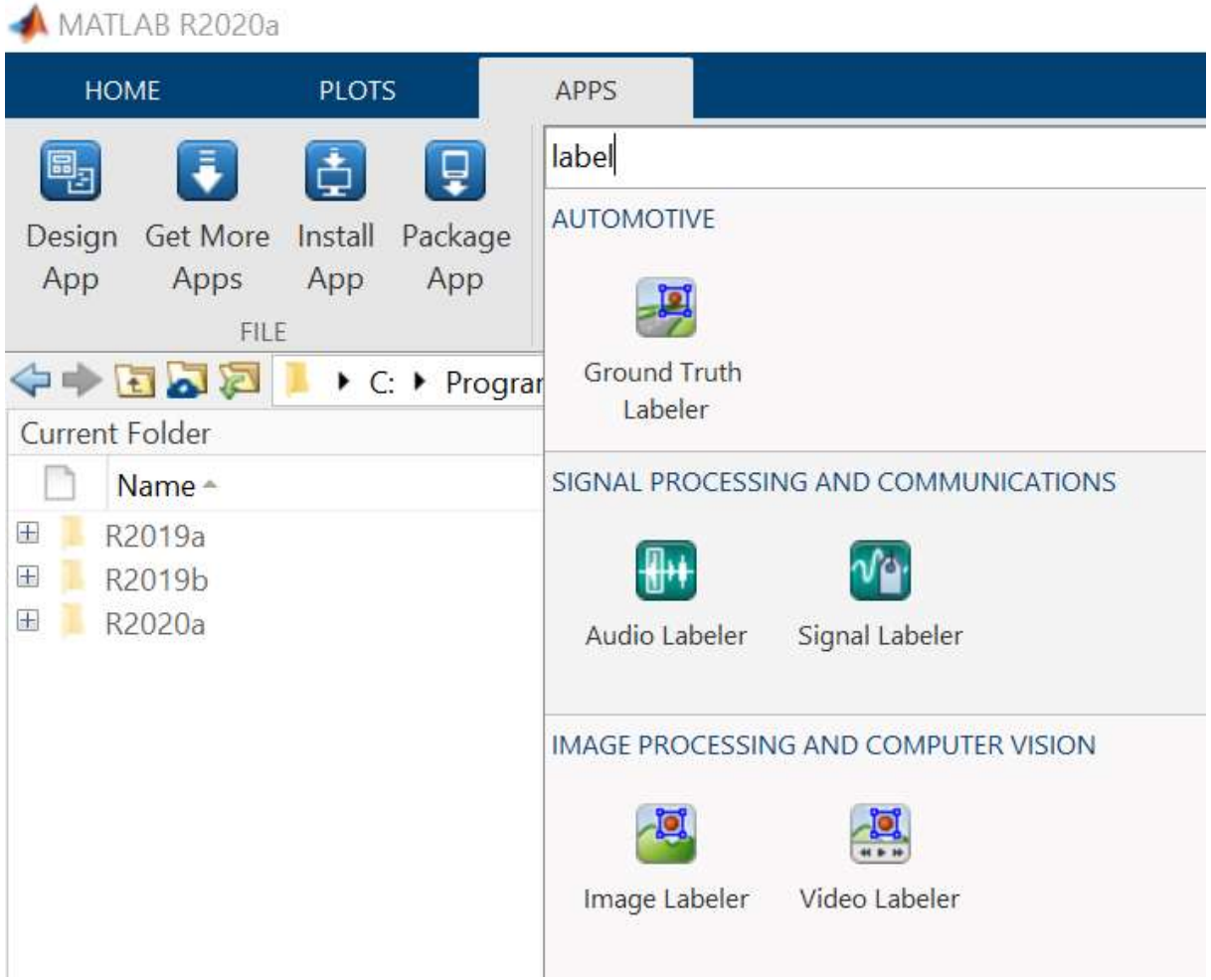
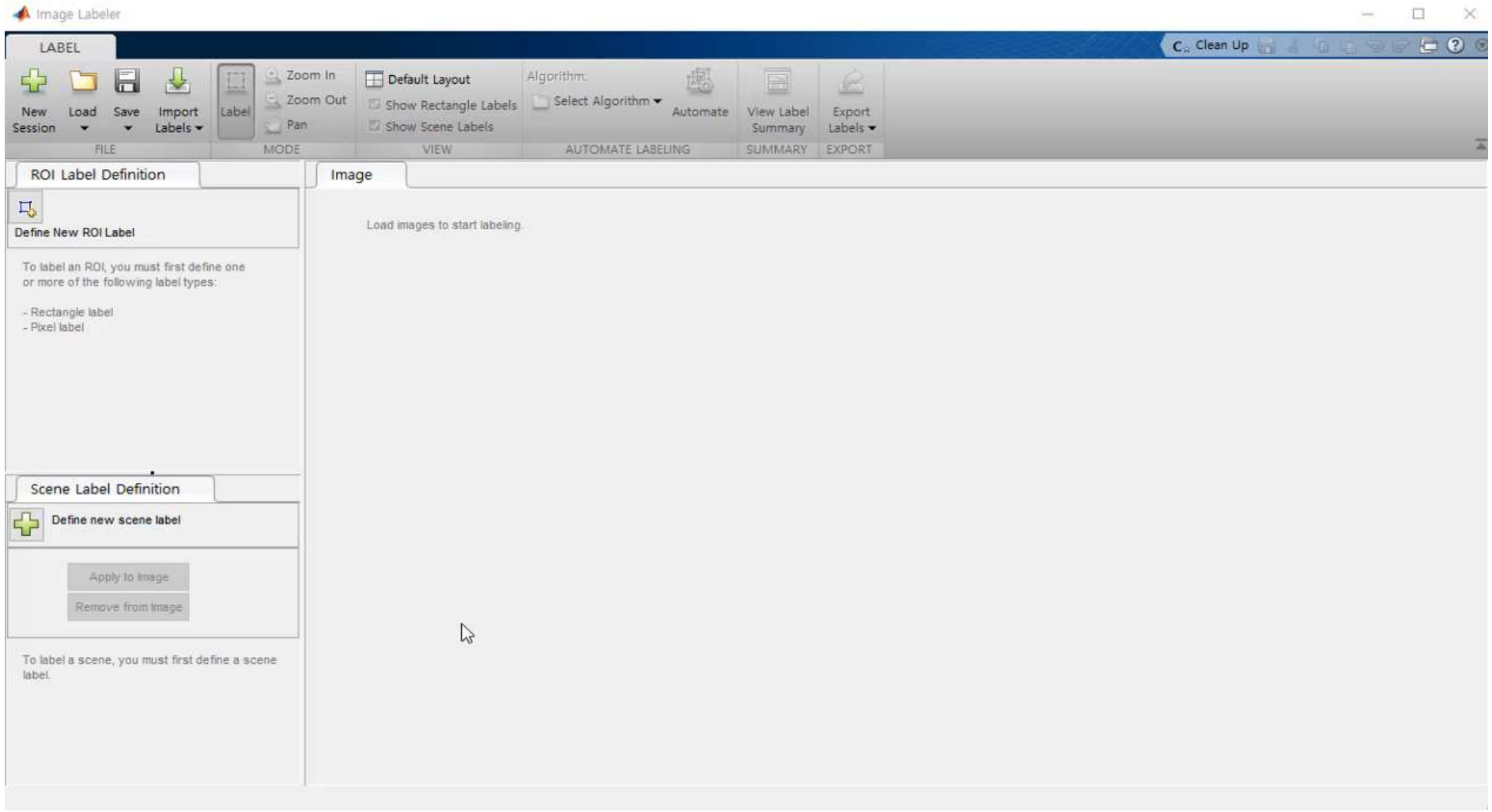

MATLAB R2020a
HOME
PLOTS
APPS
Design App
Get More Apps
Install App
Package App
FILE
label
AUTOMOTIVE
Ground Truth Labeler
SIGNAL PROCESSING AND COMMUNICATIONS
Audio Labeler
Signal Labeler
IMAGE PROCESSING AND COMPUTER VISION
Image Labeler
Video Labeler
C:
Current Folder
Name
R2019a
R2019b
R2020a

Image & Video Labeler

Image Labeler
+ Video labeler

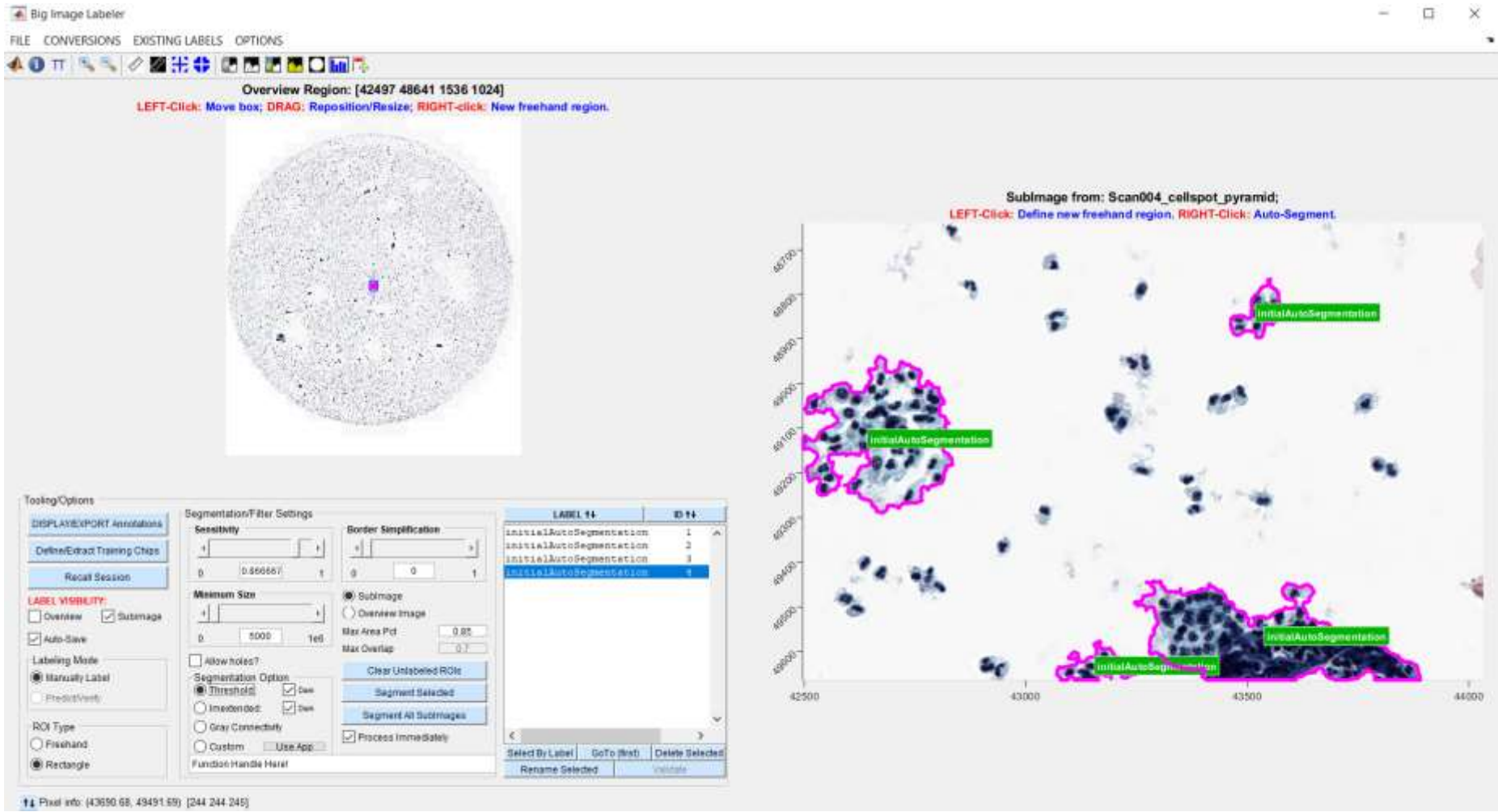
Big-Image
Labeler



Big Image Labeler

Image Labeler
+ Video labeler

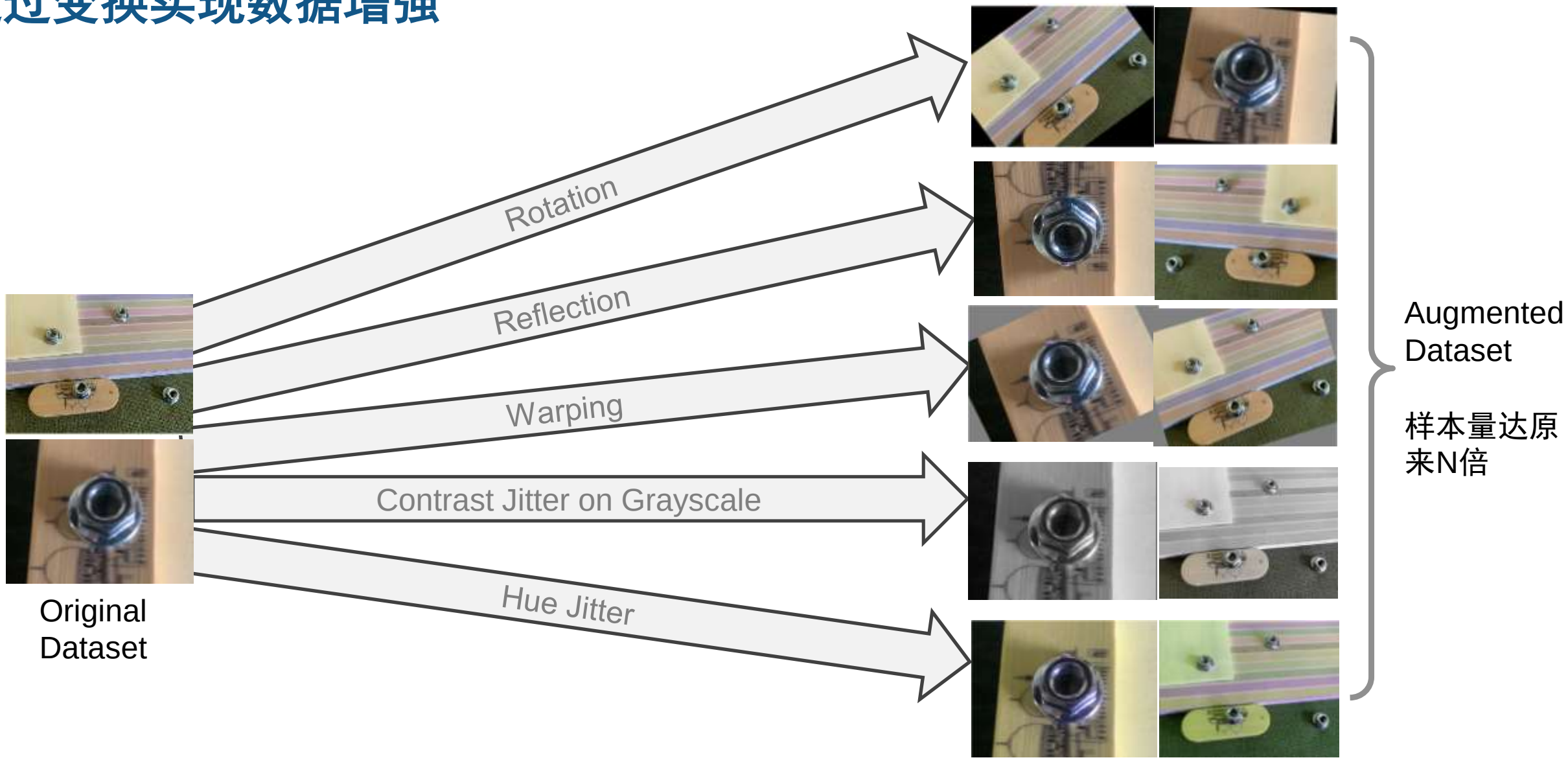
Big-Image
Labeler



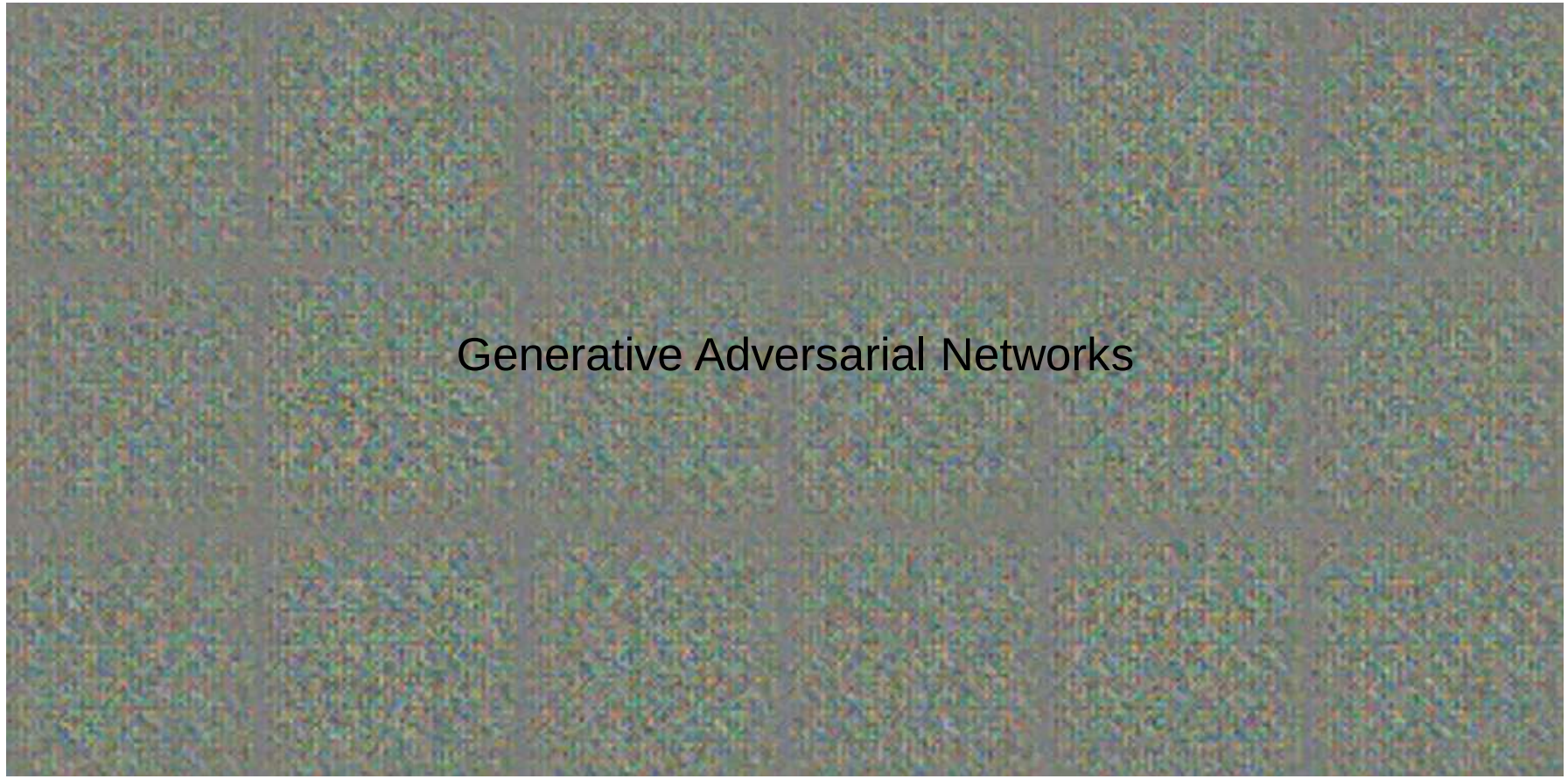
数据访问和预处理– 共同挑战

数据集不平衡或者数据量不足，怎么办?

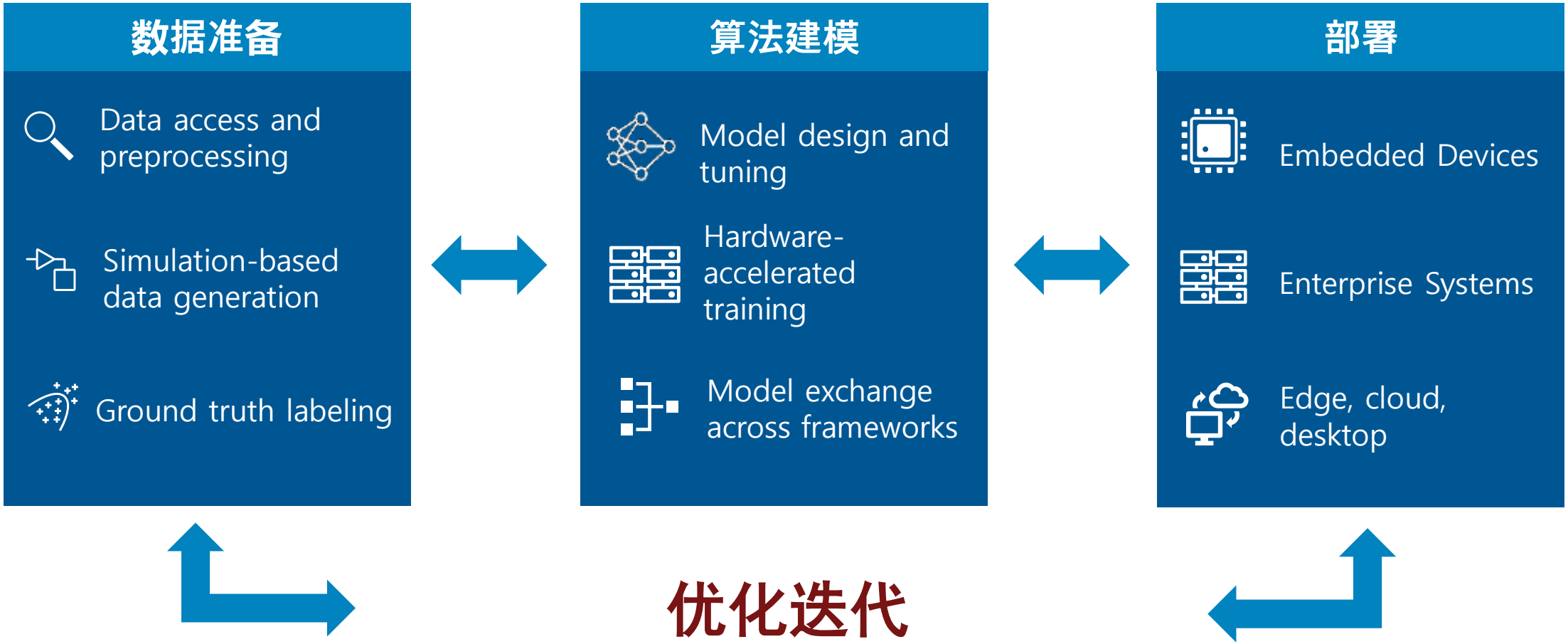
通过变换实现数据增强


Rotation
Reflection
Warping
Contrast Jitter on Grayscale
Hue Jitter
Original Dataset
Augmented Dataset
样本量达原来N倍

数据增强: 生成对抗网络 (GANs)



缺陷检测流程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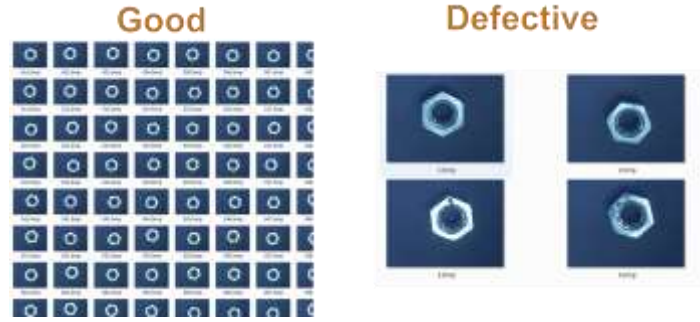
深度学习用于缺陷检测

深度学习用于分类



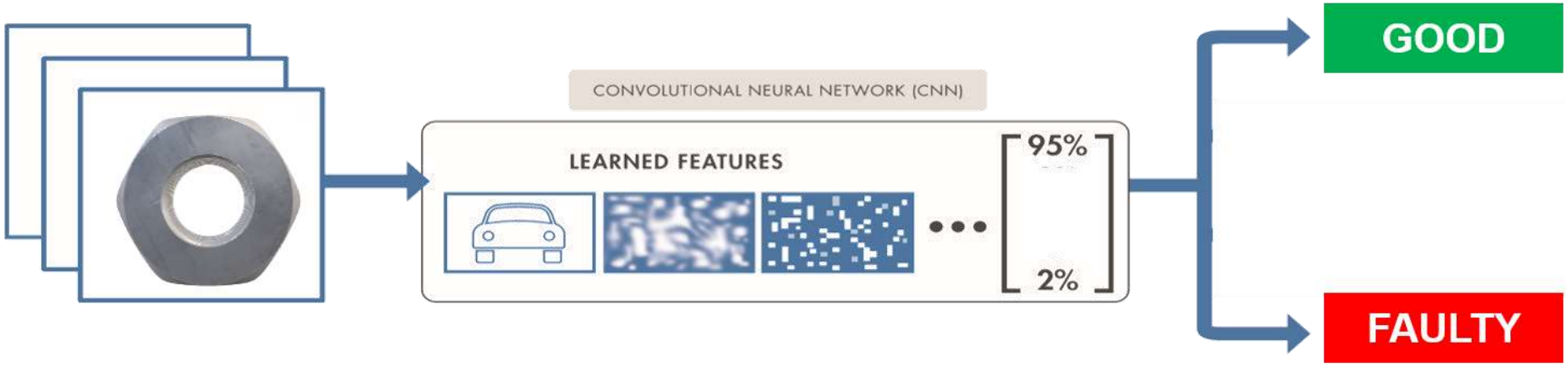
深度学习用于目标检测

深度学习用于缺陷检测– 多种技术

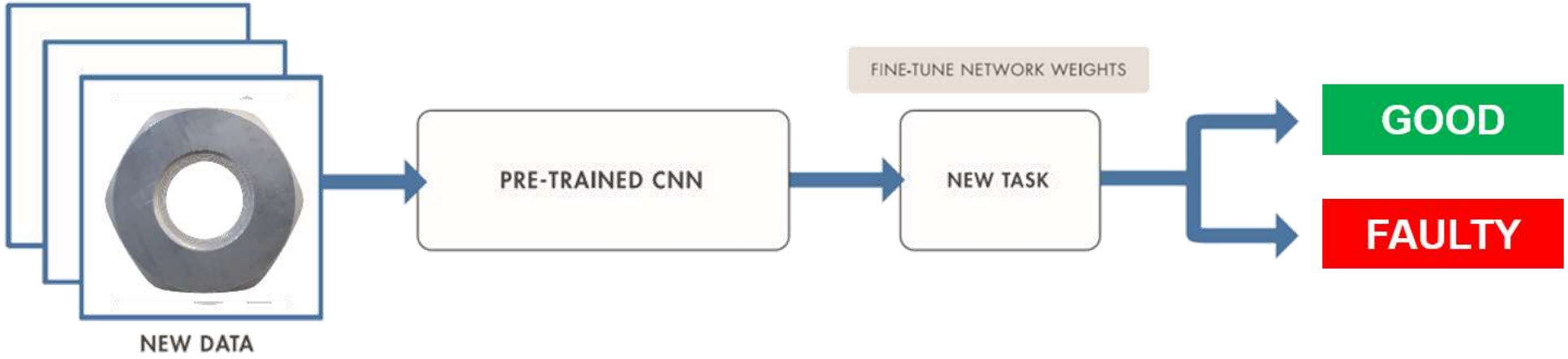
深度学习用于分类

深度学习的两种方式

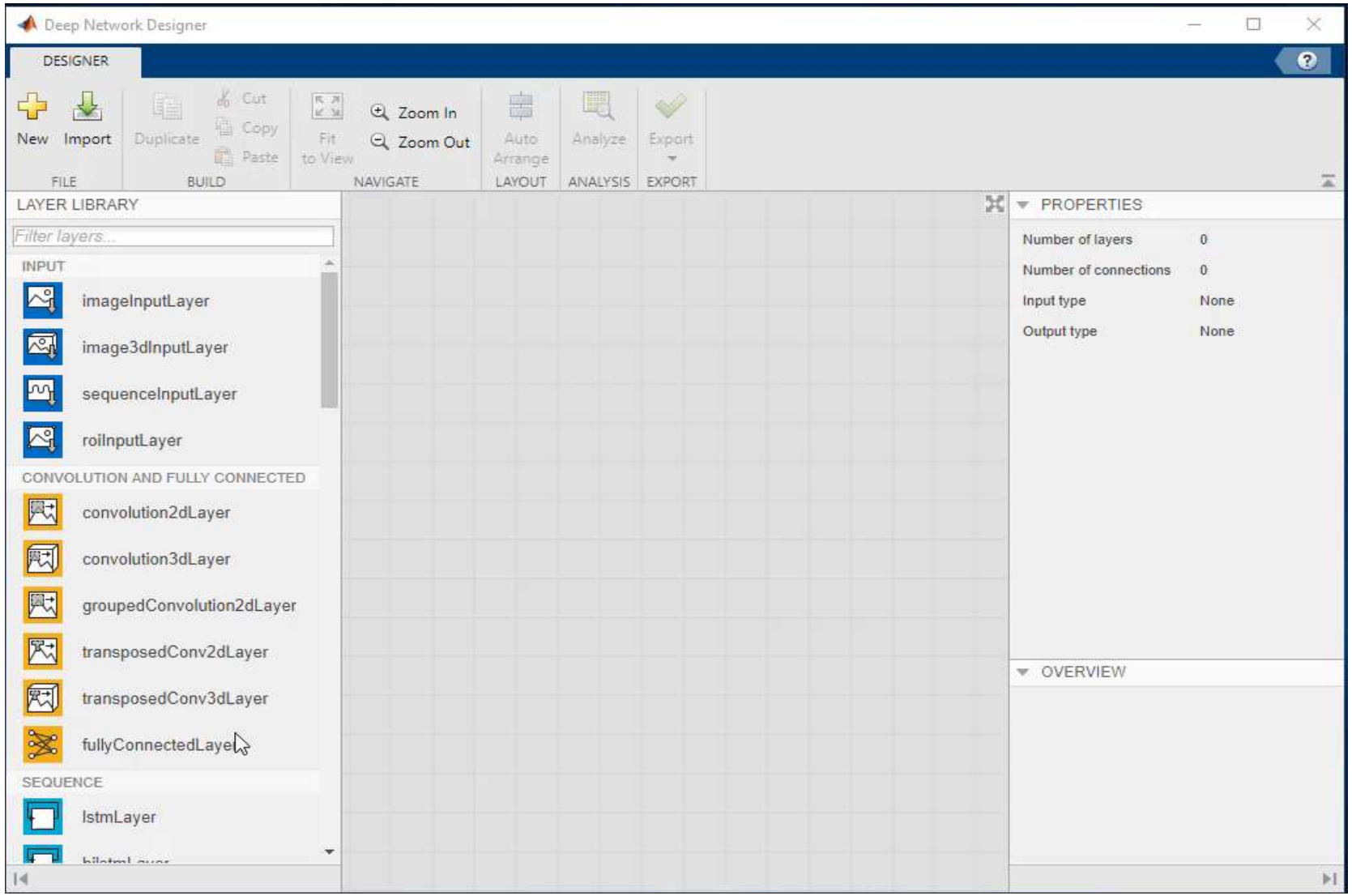
1. 从零开始训练一个神经网络



2. 对预训练网络调优 (迁移学习）

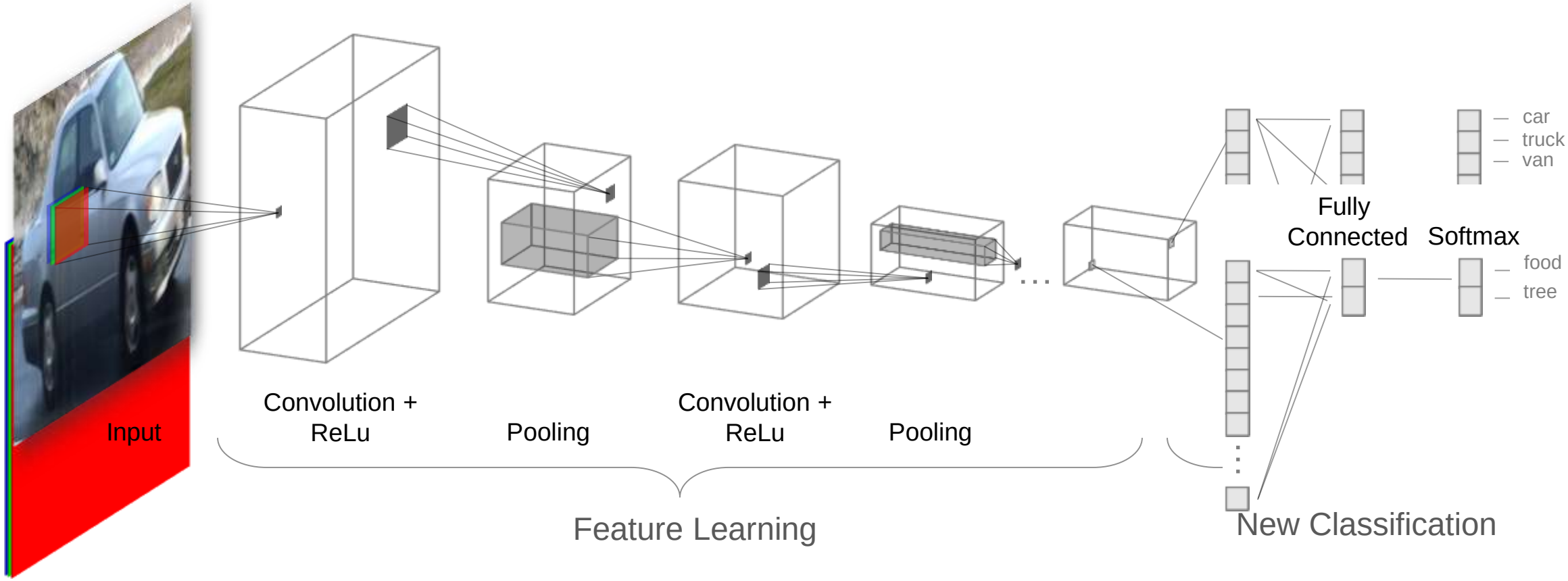


从零开始训练神经网络

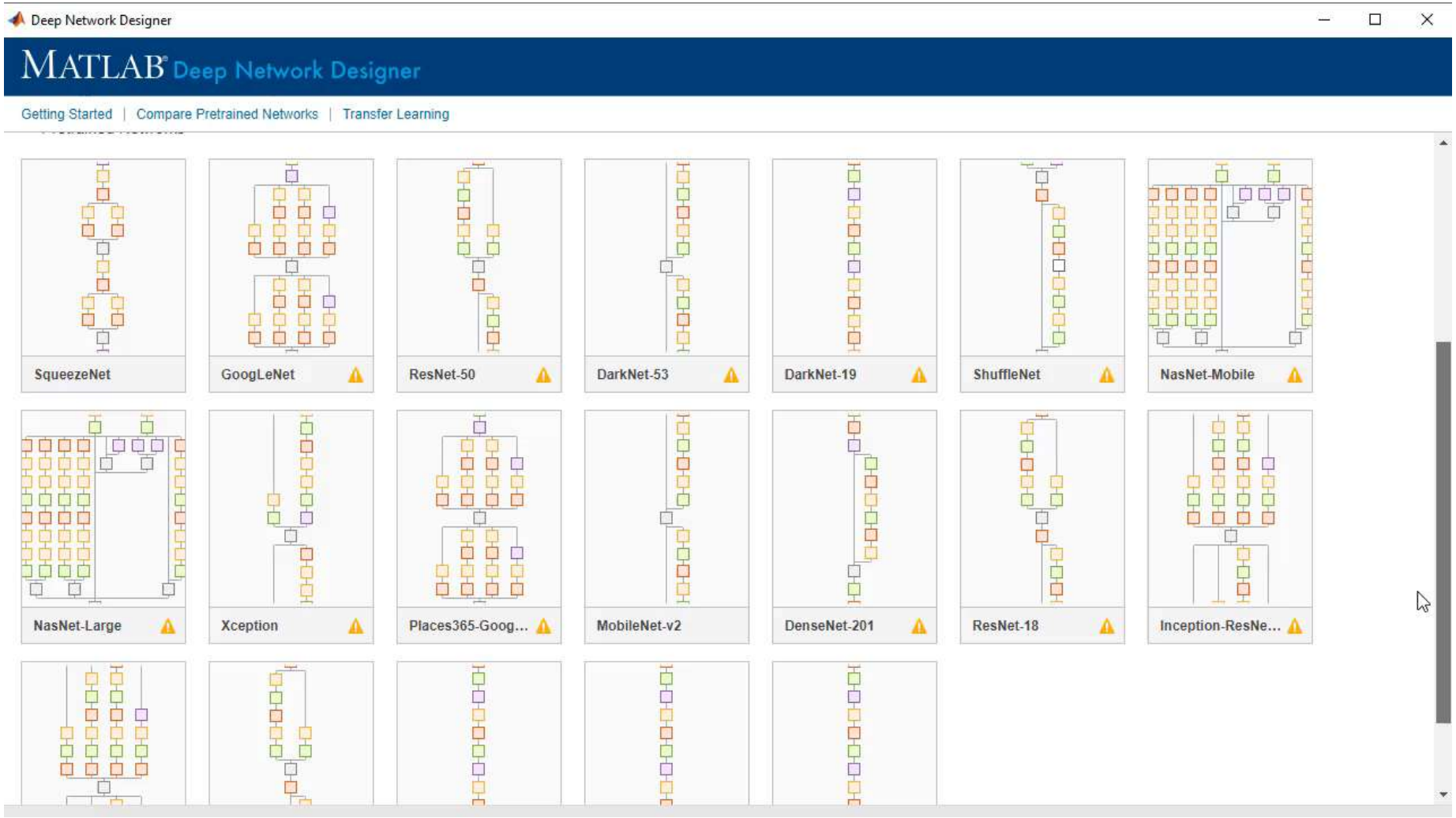

Deep Network Designer
DESIGNER
New
Import
Duplicate
Cut
Copy
Paste
FILE
BUILD
Fit to View
Zoom In
Zoom Out
NAVIGATE
Auto Arrange
LAYOUT
Analyze
ANALYSIS
Export
EXPORT
LAYER LIBRARY
Filter layers...
INPUT
imageInputLayer
image3dInputLayer
sequenceInputLayer
roiInputLayer
CONVOLUTION AND FULLY CONNECTED
convolution2dLayer
convolution3dLayer
groupedConvolution2dLayer
transposedConv2dLayer
transposedConv3dLayer
fullyConnectedLayer
SEQUENCE
lstmLayer
PROPERTIES
Number of layers 0
Number of connections 0
Input type None
Output type None
OVERVIEW

深度学习的两种方式

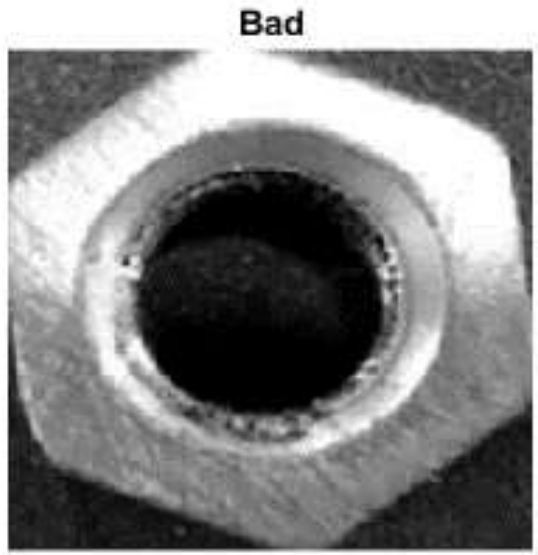
方法2.对预训练网络调优 (迁移学习）



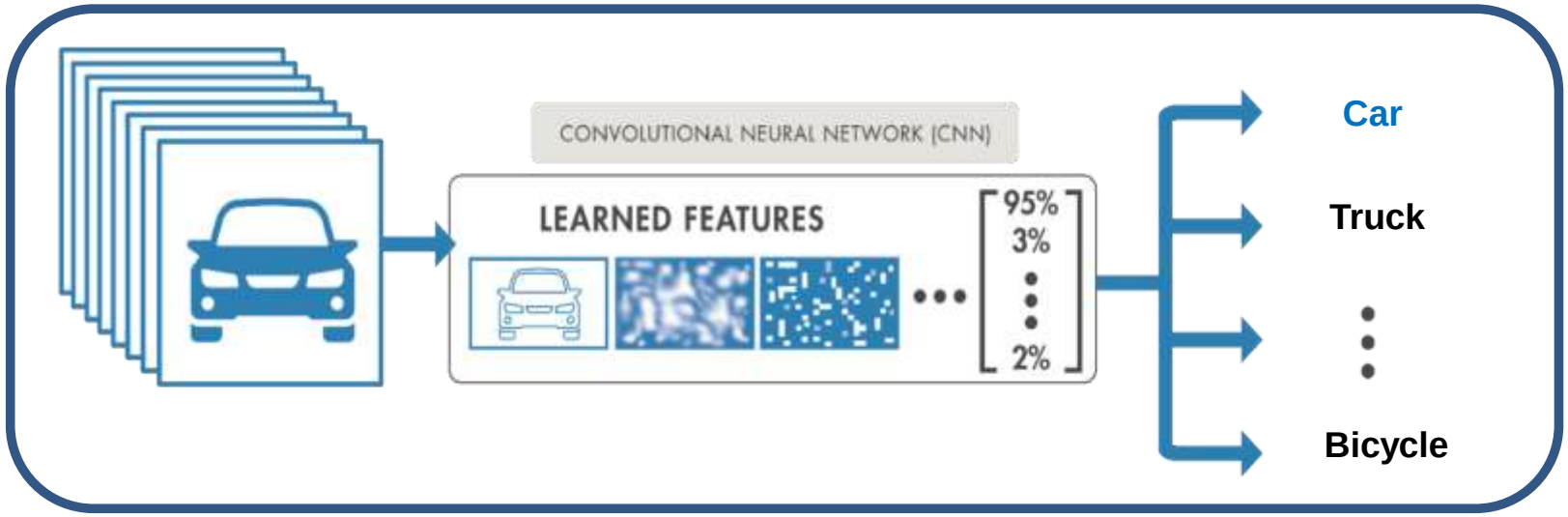
对预训练网络调优 (迁移学习）



测试基于MobileNetV2分类网络



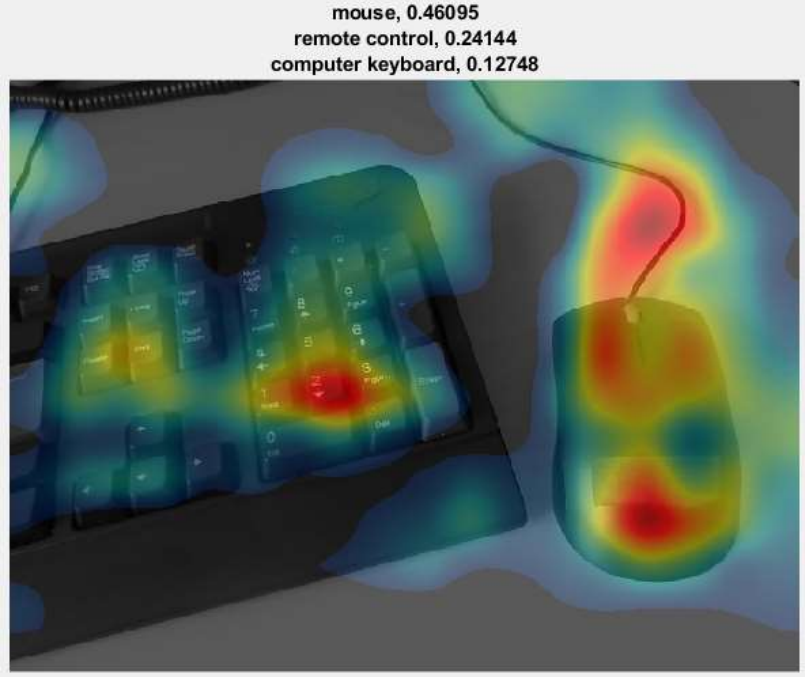
深度学习模型的挑战



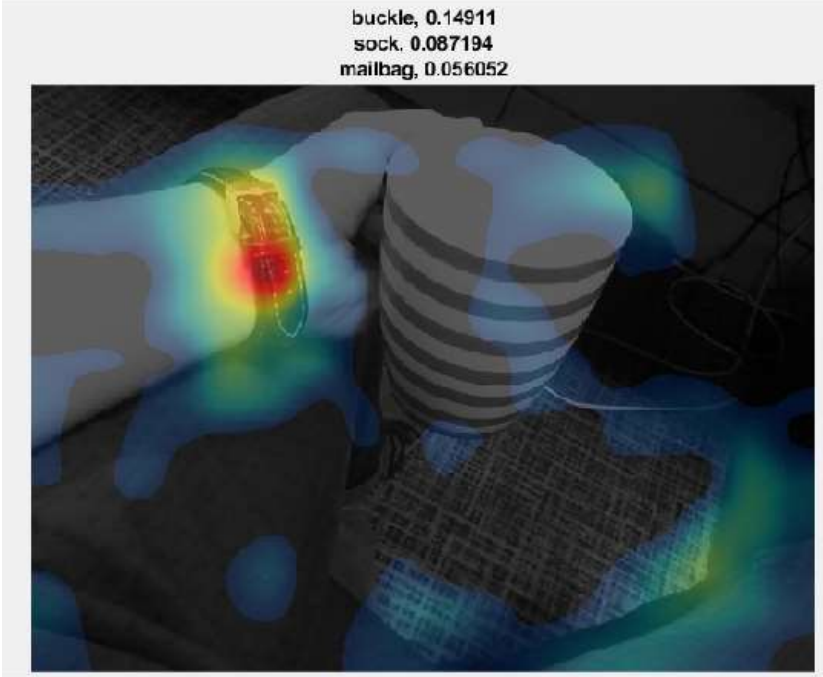
Explainable AI is required

- Class Activation Mapping（CAM）
- Grad-CAM

使用类激活图（CAM）来检查和解释网络的预测



因出现鼠标，而被错误识别的键盘

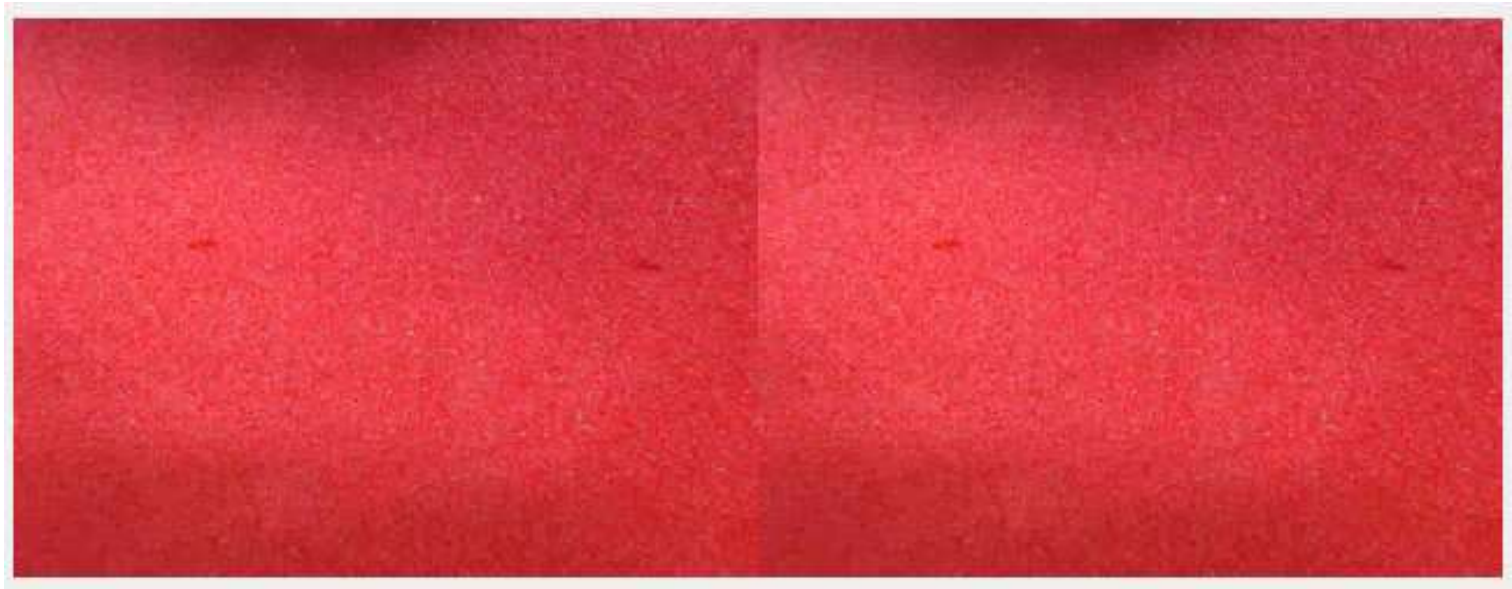


因出现手表，而被误识别成手环的咖啡杯

Visualization of Features with CAM

Captured Image

Classification and CAM



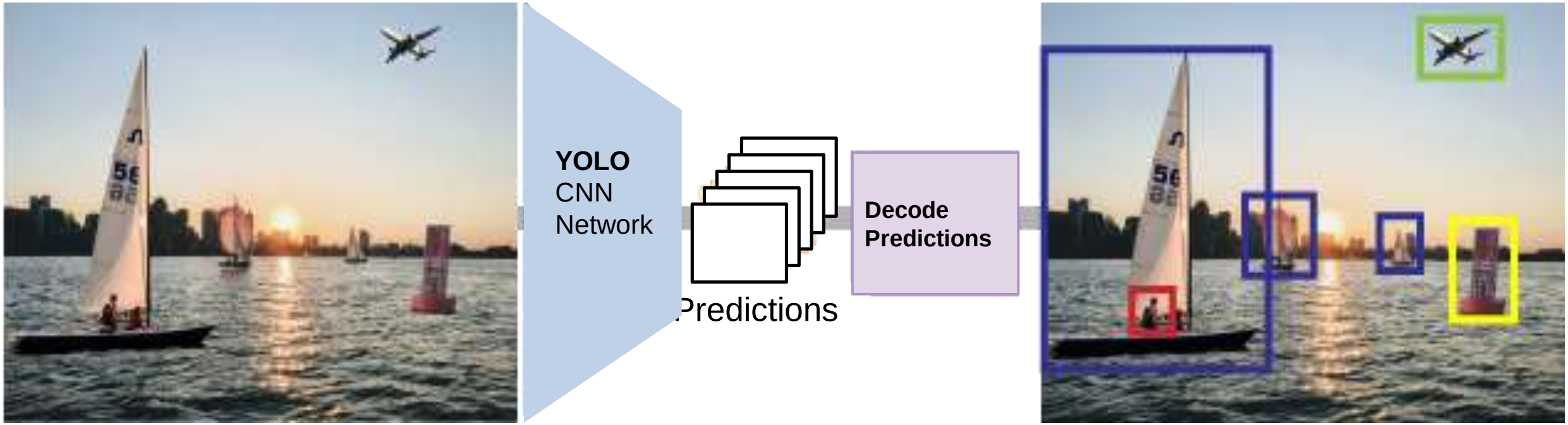
OK → Reacts to whole surface

Bad→ Reacts to the scratch

Deep Learning for Defect Detection

深度学习用于目标检测

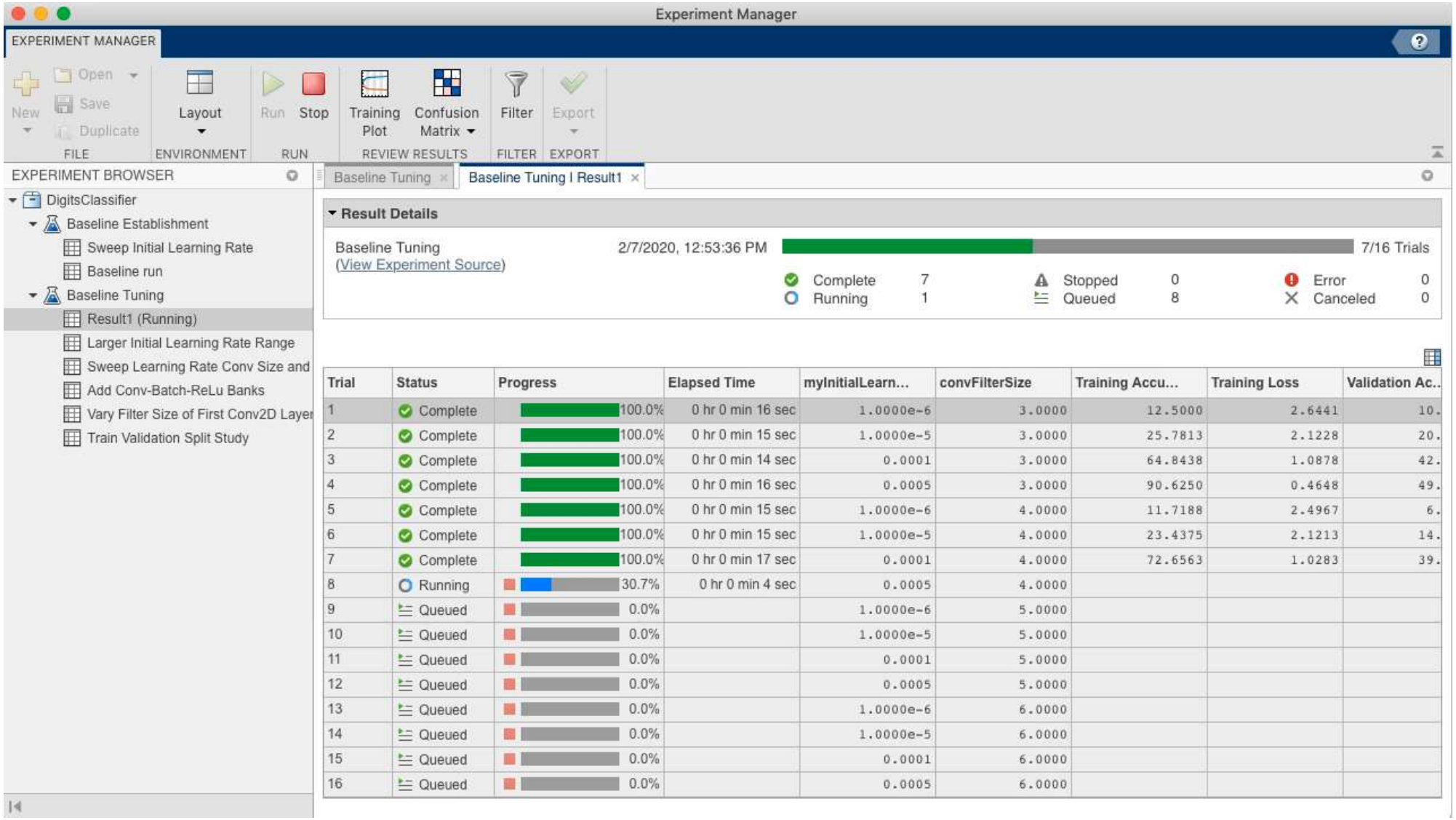
Detecting Objects with You Only Look Once (YOLO) v2



Build, test, and deploy a deep learning solution that can detect objects in images and video

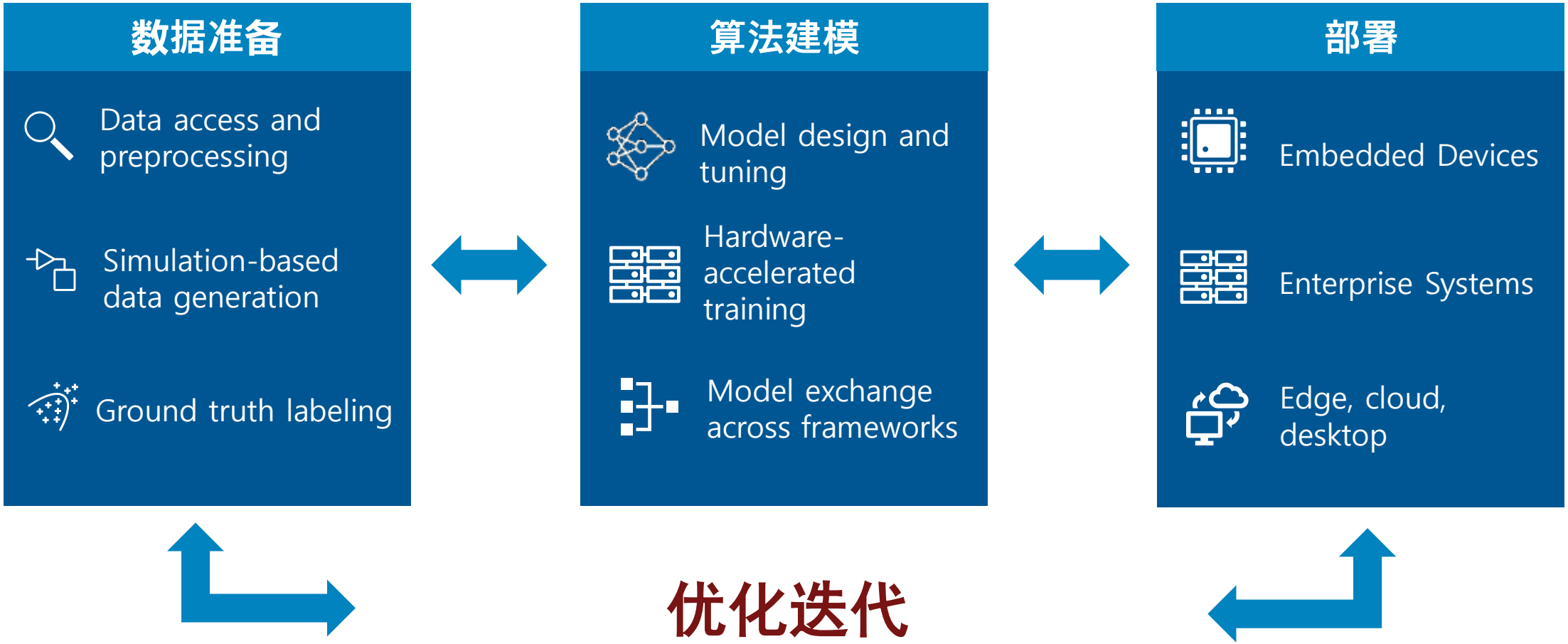
基于YOLO v2的口罩检测

Experiment Manager

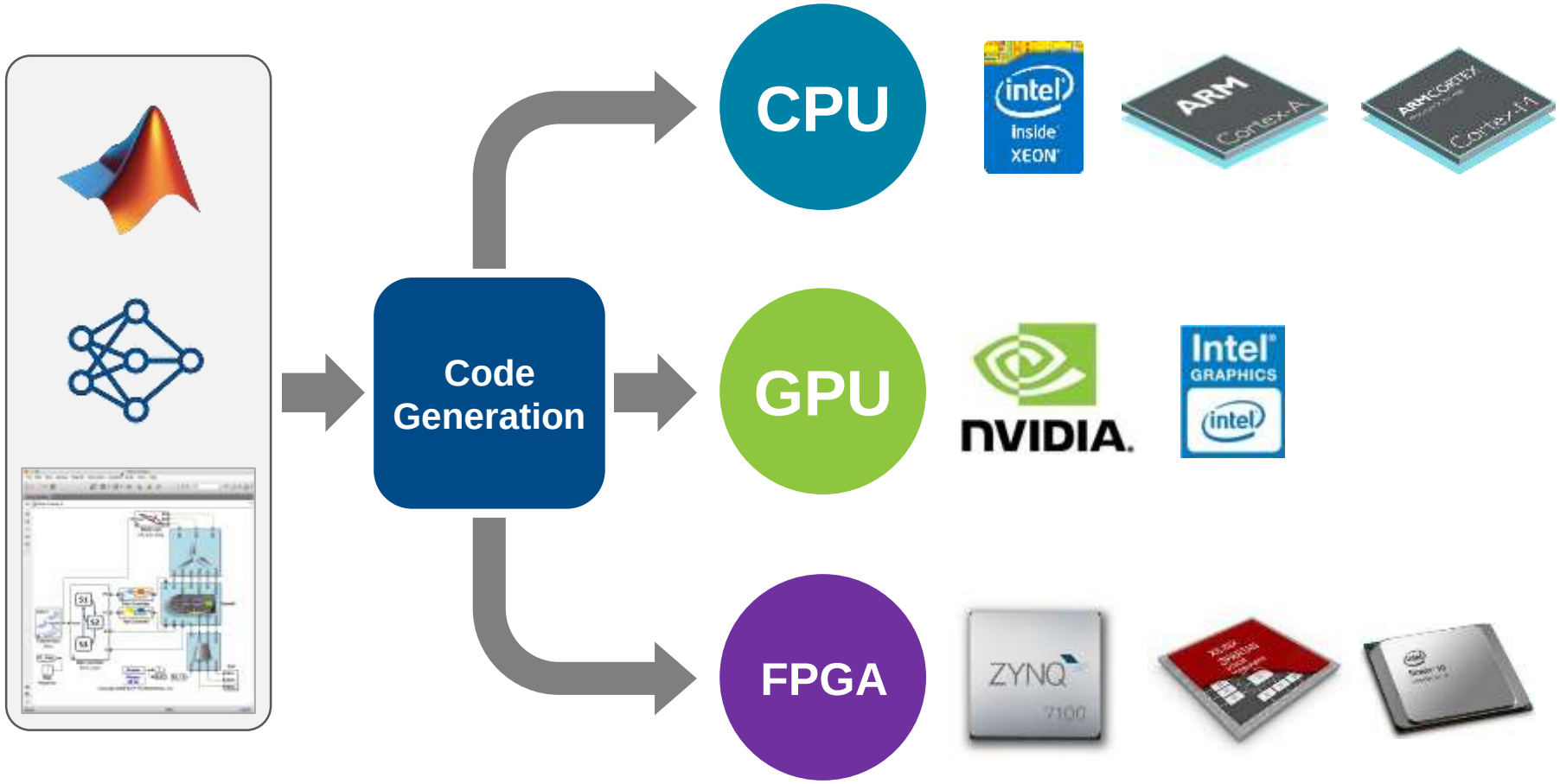


Trial	Status	Progress	Elapsed Time	myInitialLearn...	convFilterSize	Training Accu...	Training Loss	Validation Ac..
1	Complete	100.0%	0 hr 0 min 16 sec	1.0000e-6	3.0000	12.5000	2.6441	10.
2	Complete	100.0%	0 hr 0 min 15 sec	1.0000e-5	3.0000	25.7813	2.1228	20.
3	Complete	100.0%	0 hr 0 min 14 sec	0.0001	3.0000	64.8438	1.0878	42.
4	Complete	100.0%	0 hr 0 min 16 sec	0.0005	3.0000	90.6250	0.4648	49.
5	Complete	100.0%	0 hr 0 min 15 sec	1.0000e-6	4.0000	11.7188	2.4967	6.
6	Complete	100.0%	0 hr 0 min 15 sec	1.0000e-5	4.0000	23.4375	2.1213	14.
7	Complete	100.0%	0 hr 0 min 17 sec	0.0001	4.0000	72.6563	1.0283	39.
8	Running	30.7%	0 hr 0 min 4 sec	0.0005	4.0000			
9	Queued	0.0%		1.0000e-6	5.0000			
10	Queued	0.0%		1.0000e-5	5.0000			
11	Queued	0.0%		0.0001	5.0000			
12	Queued	0.0%		0.0005	5.0000			
13	Queued	0.0%		1.0000e-6	6.0000			
14	Queued	0.0%		1.0000e-5	6.0000			
15	Queued	0.0%		0.0001	6.0000			
16	Queued	0.0%		0.0005	6.0000			

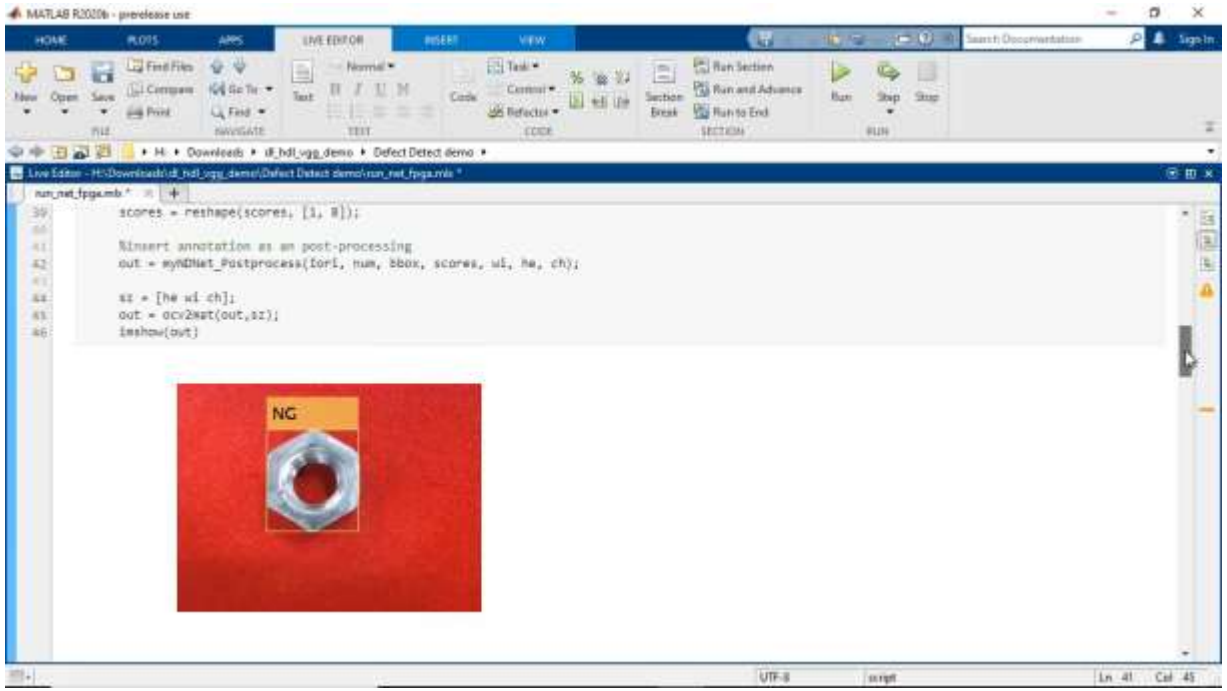
缺陷检测流程


数据准备
Data access and preprocessing
Simulation-based data generation
Ground truth labeling
算法建模
Model design and tuning
Hardware-accelerated training
Model exchange across frameworks
部署
Embedded Devices
Enterprise Systems
Edge, cloud, desktop
优化迭代

快速部署于任何处理器，并获得最佳性能



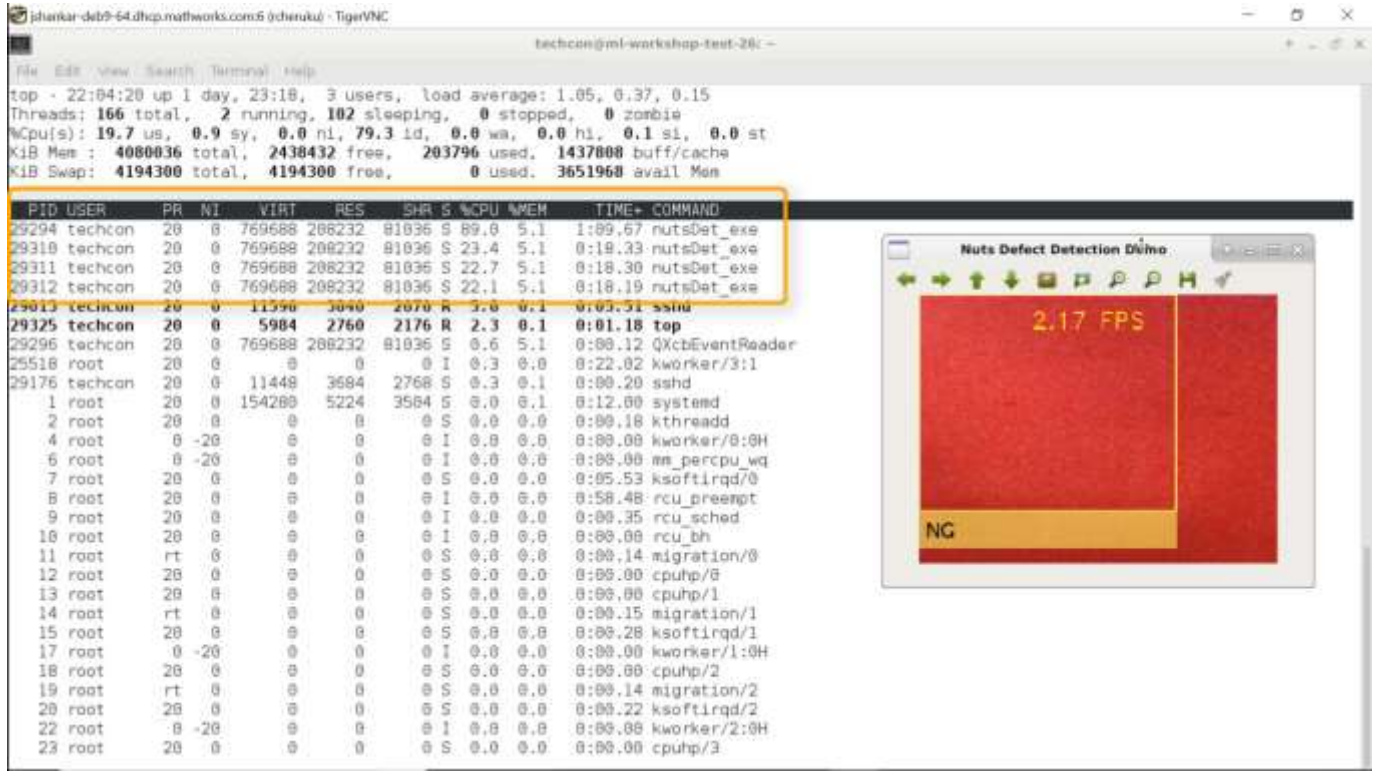
硬件部署



Deploy defect detection algorithms from MATLAB to ZCU102 board from Xilinx

Deploy defect detection algorithms from MATLAB to Jetson AGX Xavier

硬件部署



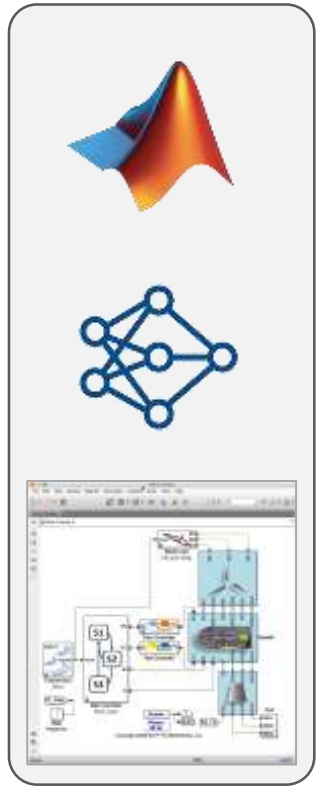
Defect detection deployed on

ARM Cortex-A microprocessor

Resources:

- Deploying Deep Neural Networks to GPUs and CPUs Using MATLAB Coder and GPU Coder
- Using GPU Coder to Prototype and Deploy on NVIDIA Drive, Jetson
- Real-Time Object Detection with YOLO v2 Using GPU Coder
- Image Classification on ARM CPU: SqueezeNet on Raspberry Pi
- Deep Learning on an Intel Processor with MKL-DNN

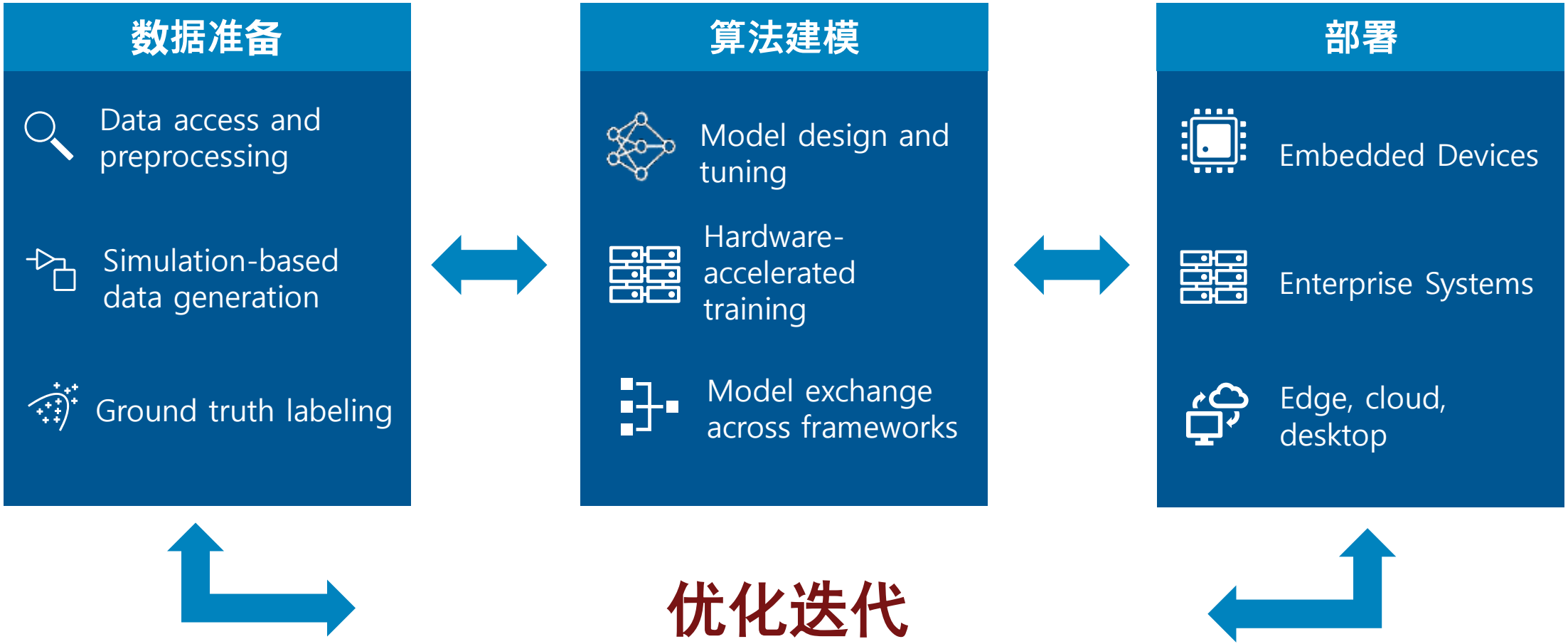
部署于企业级IT设施



MATLAB
Production Server

Databases
Streaming
Cloud Storage
Dashboards
Containers
Custom Tools
Cloud & Datacenter
Infrastructure

缺陷检测流程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Perform image processing, visualization, and analysis
Watch video
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Computer Vision Toolbox
Design and test computer vision, 3D vision, and video processing systems
Watch video
Download a free trial
Pedestrian
Vehicle


Deep Learning Toolbox
Design, train, and analyze deep learning networks
Watch video
Download a free trial
Training Progress (14-Aug-2018 08
100
90
80
70
60

谢谢!