

# 小迈步第一课：MATLAB深度学习入门课堂

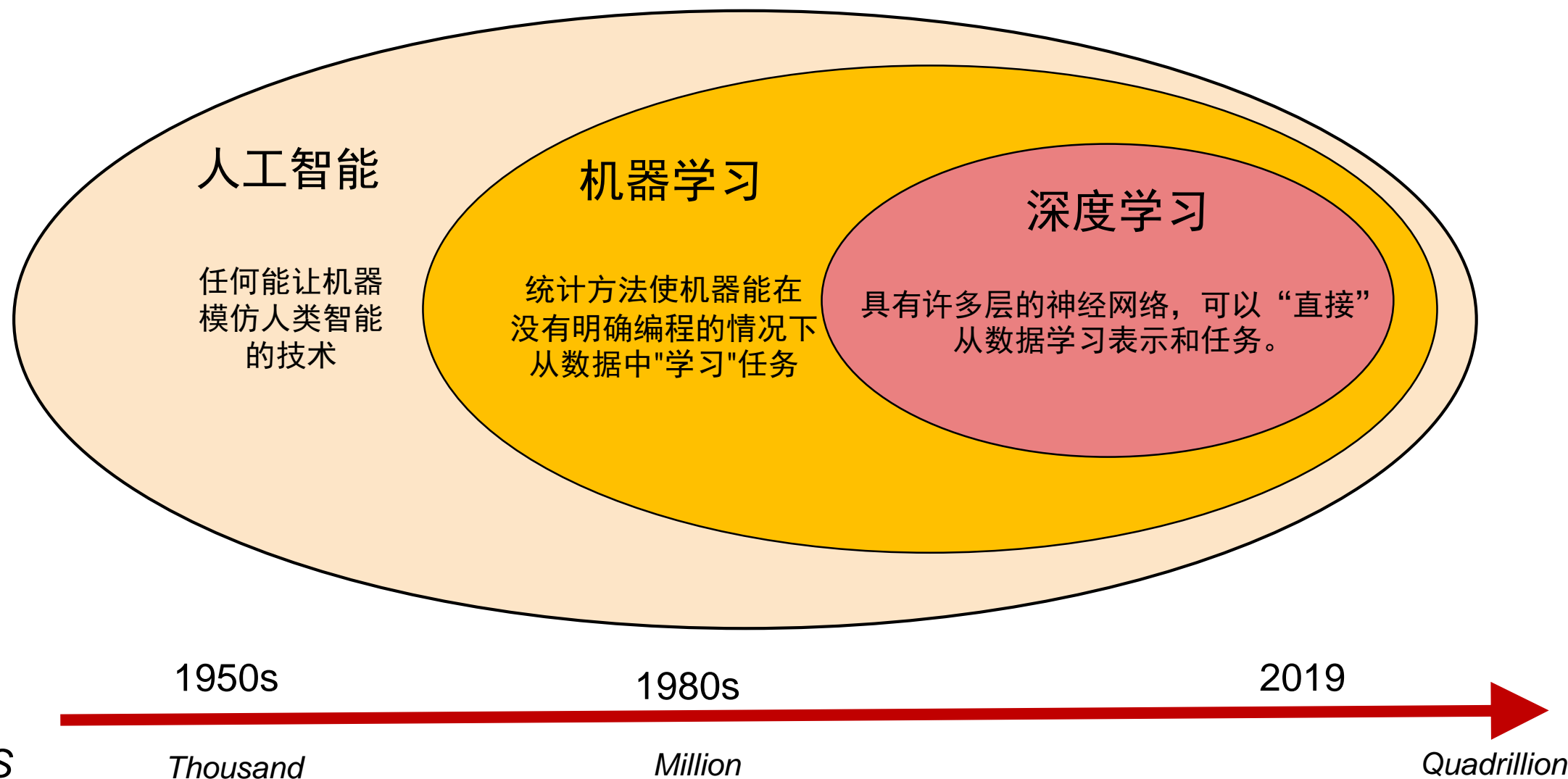
杜文涛

MathWorks中国技术支持工程师



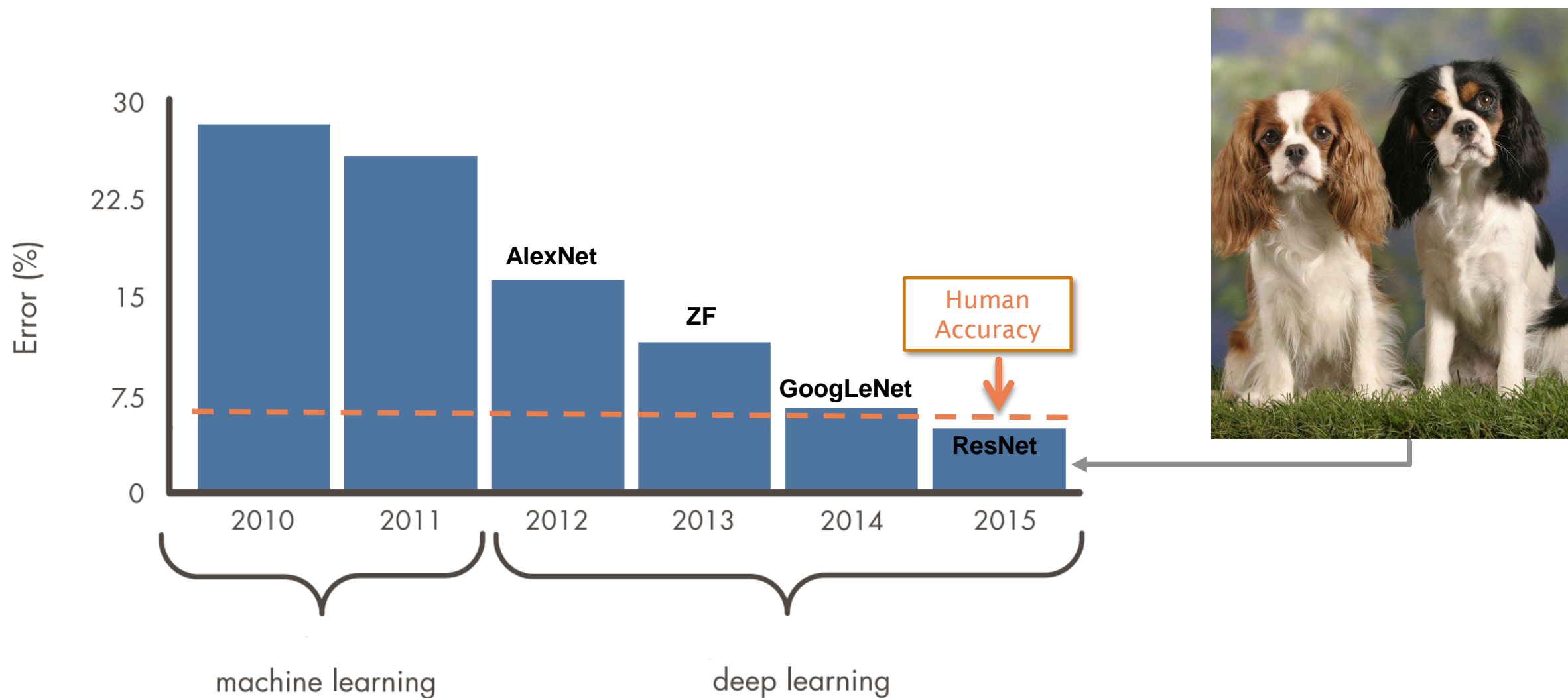
什么是深度学习？

# 人工智能，机器学习和深度学习



# 为什么深度学习如此炙手可热？

## ImageNet Challenge



# 对应不同的数据类型

## 时间序列/ 文本数据



循环神经网络  
Recurrent Neural Network  
(RNN)

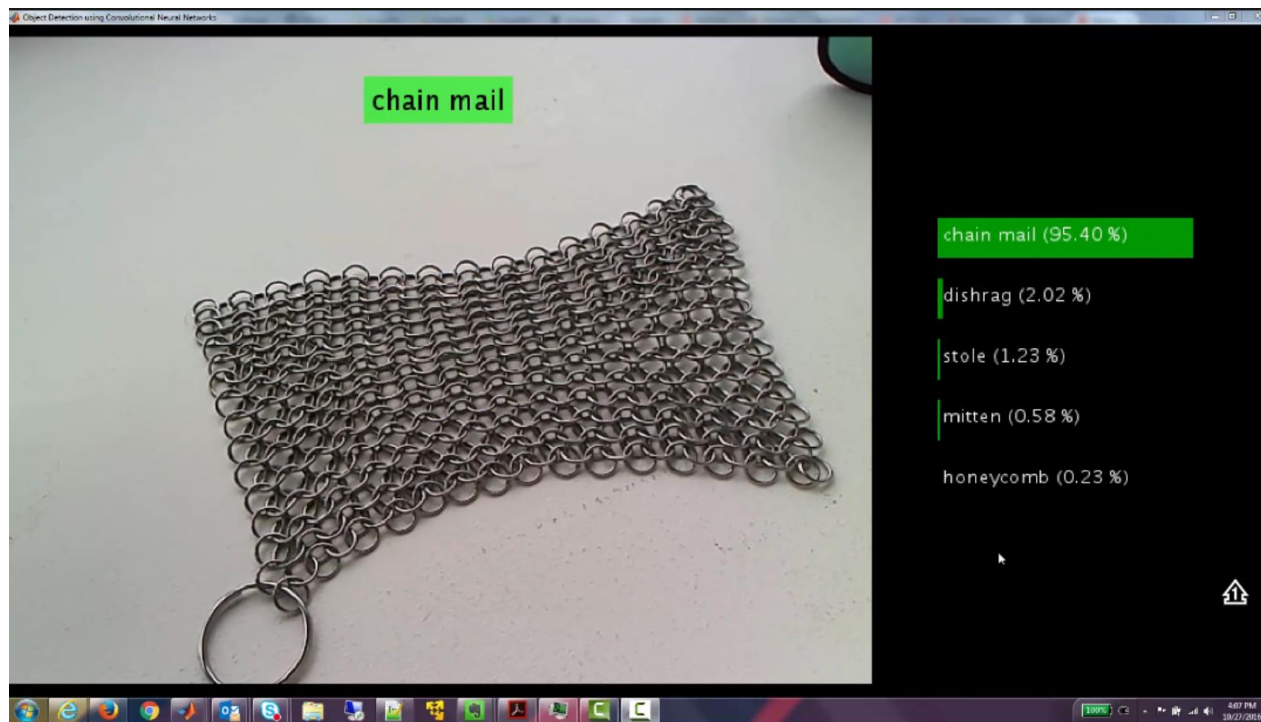
## 图像数据



卷积神经网络  
Convolutional Neural Network  
(CNN/ConvNet)



# 示例1：使用深度学习实现物体识别



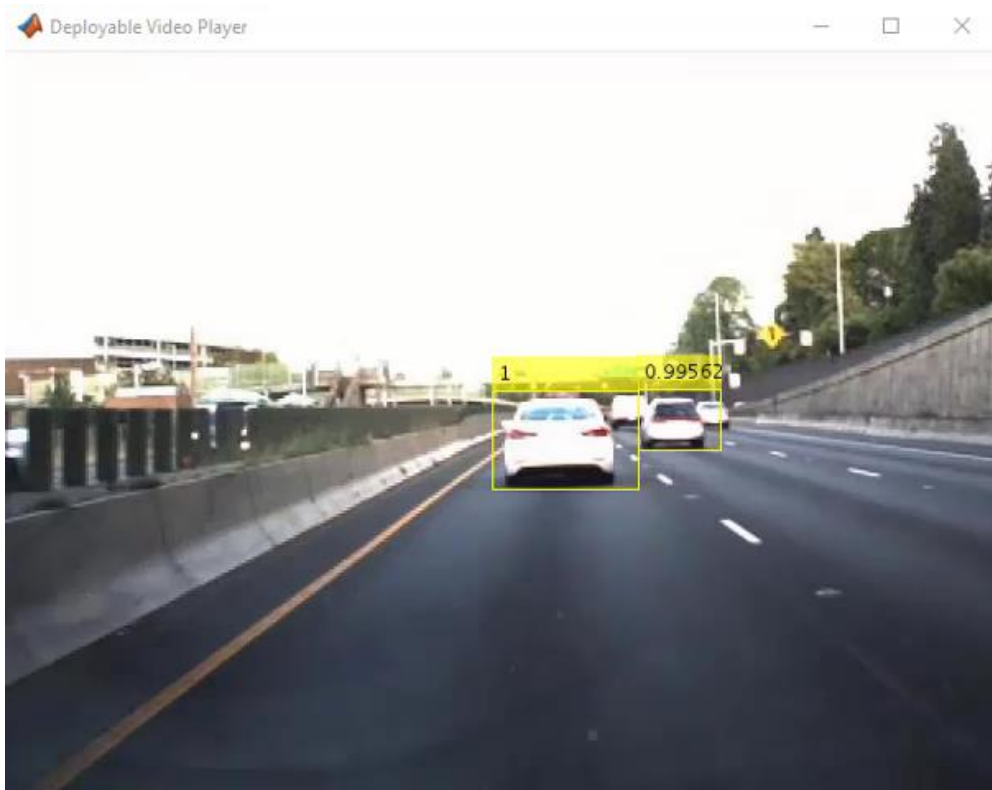
**训练  
(GPU)**

百万张图像，1000种分类

**预测**

用连接到笔记本的摄像头进行实时的目标识别

## 示例2：基于深度学习的计算机视觉



基于 R-CNN 的目标检测



基于 SegNet 的语义分割

为什么选择 MATLAB?

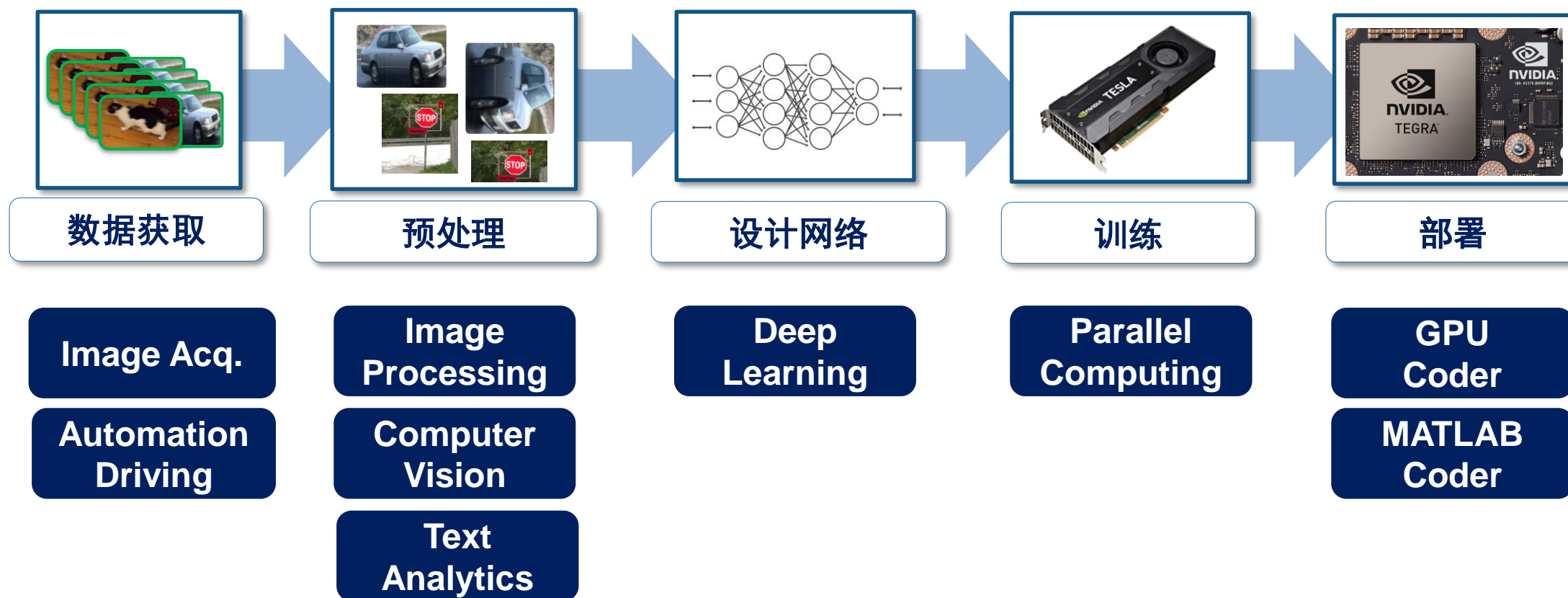


## 支持与开源框架之间的协作

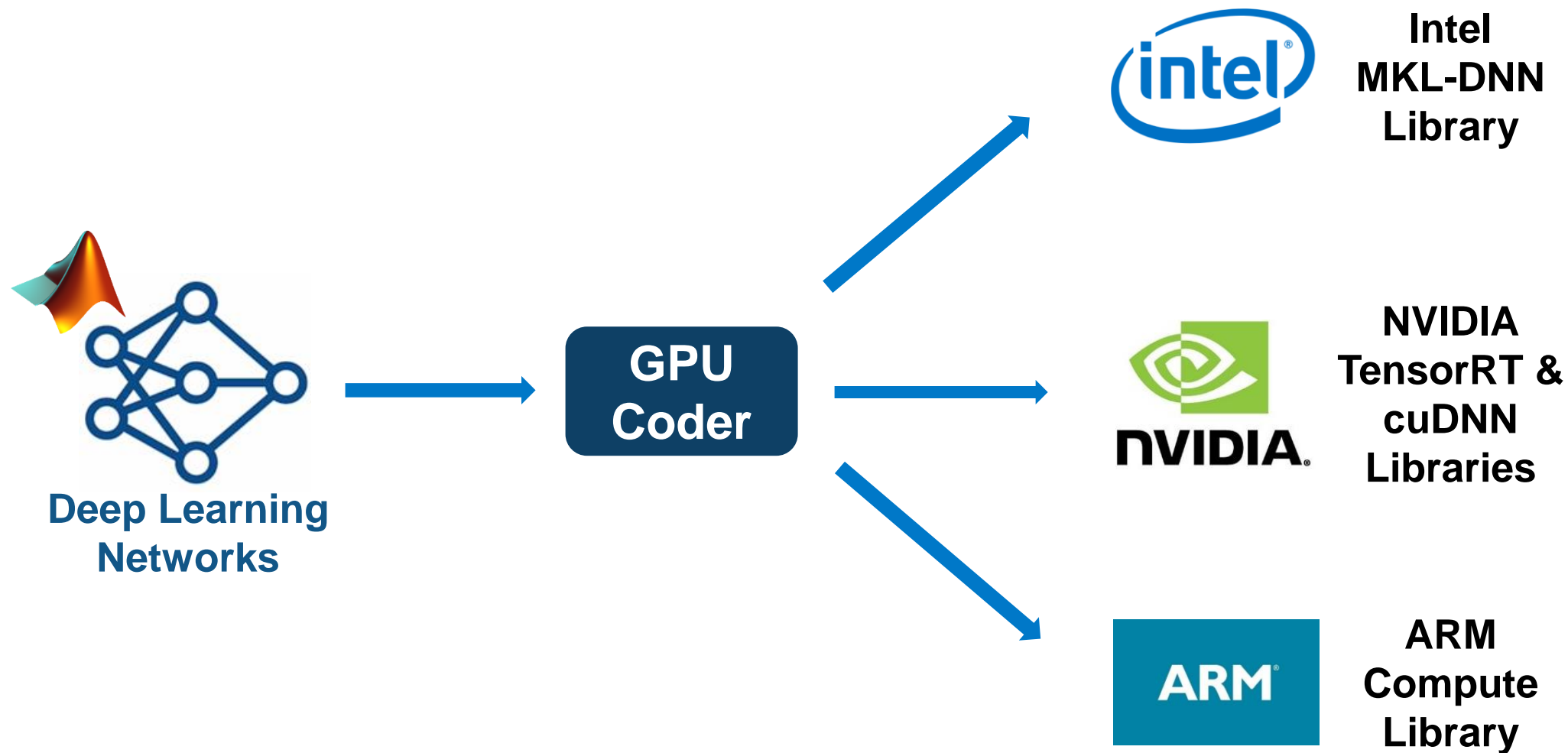
- Caffe Model Importer
- TensorFlow-Keras Model Importer
- ONNX - Importer/ Exporter

▼ Import and Export Networks	
<code>importKerasNetwork</code>	Import a pretrained Keras network and weights
<code>importKerasLayers</code>	Import layers from Keras network
<code>importCaffeNetwork</code>	Import pretrained convolutional neural network models from Caffe
<code>importCaffeLayers</code>	Import convolutional neural network layers from Caffe
<code>importONNXNetwork</code>	Import pretrained ONNX network
<code>importONNXLayers</code>	Import layers from ONNX network
<code>exportONNXNetwork</code>	Export network to ONNX model format

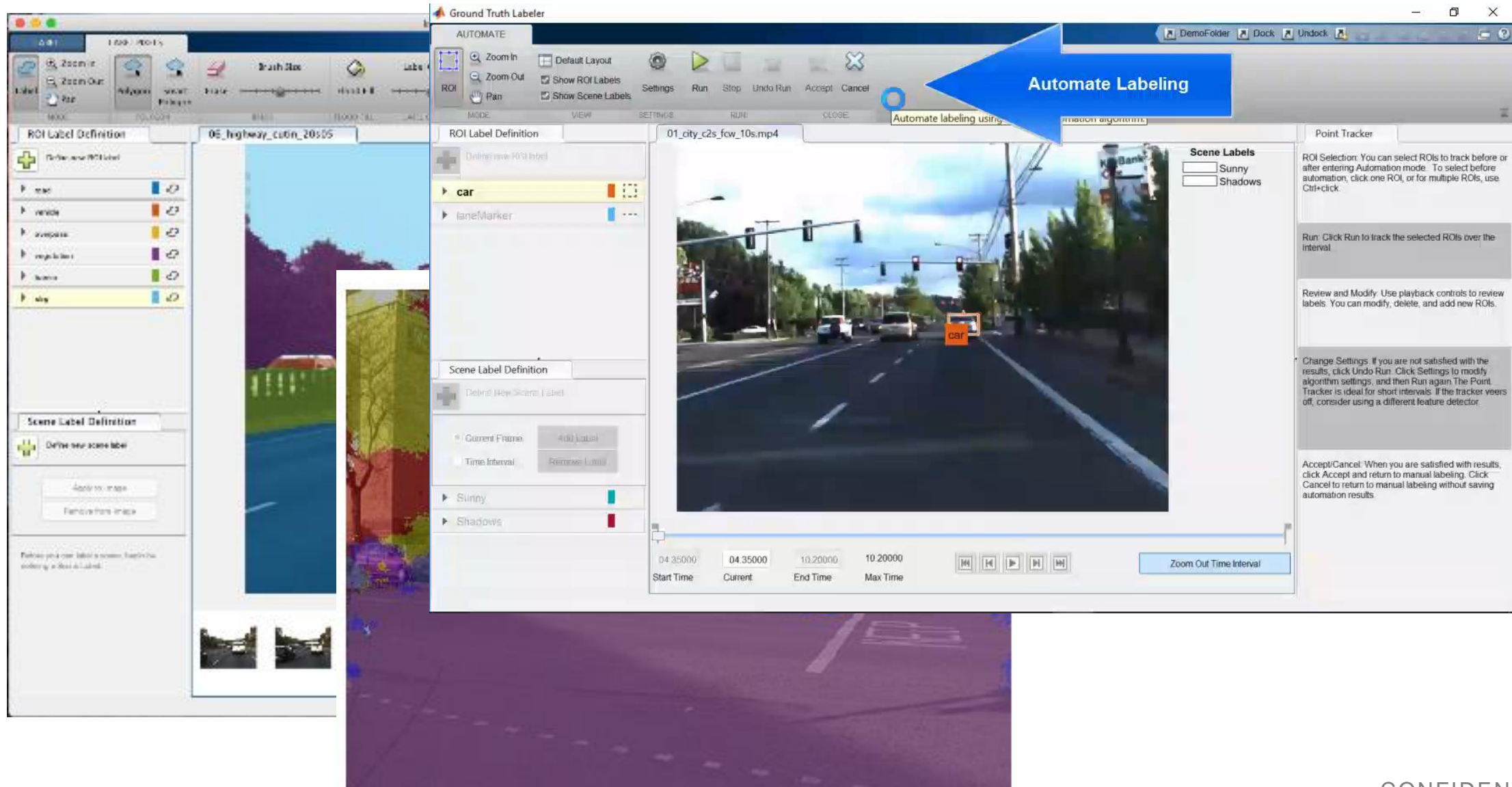
# 完整的工具链，高效的开发平台



# 生成代码，轻松部署深度学习模型



# 实用的数据标注工具，减轻劳动力







# 简单易学，快速上手

## - 高质量的帮助文档和大量示例



### Semantic Segmentation Using Deep Learning

Train a semantic segmentation network using deep learning.

[Open Live Script](#)



### Object Detection Using Faster R-CNN Deep Learning

Train an object detector using a deep learning technique named Faster R-CNN (Regions with Convolutional Neural Networks).

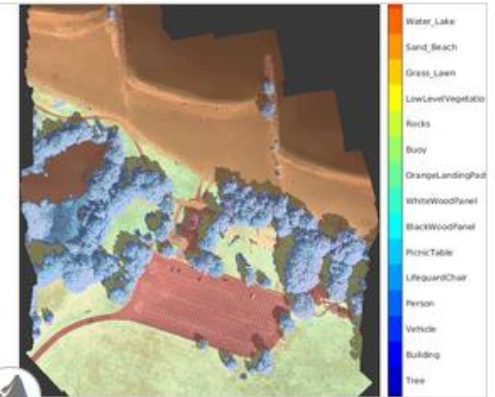
[Open Live Script](#)



### Single Image Super-Resolution Using Deep Learning

Train a Very-Deep Super-Resolution (VDSR) neural network, then use a VDSR network to estimate a high-resolution image from a single low-resolution image.

[Open Live Script](#)



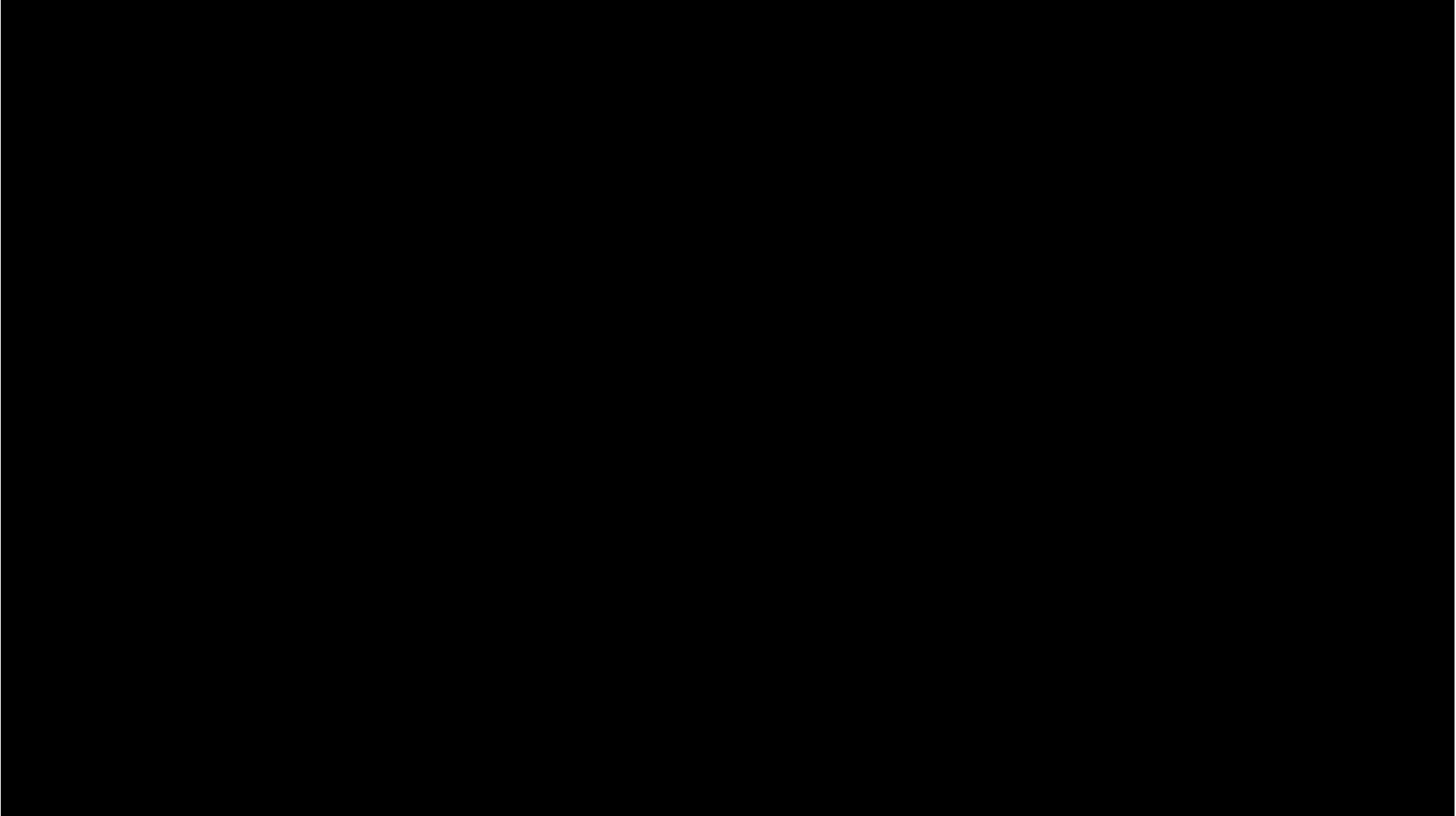
### Semantic Segmentation of Multispectral Images Using Deep Learning

Train a U-Net convolutional neural network to perform semantic segmentation of a multispectral image with seven channels: three visible and four near-infrared.

[Open Live Script](#)

# 图像分类示例

## 使用 AlexNet 分类常见物体



# 11行 MATLAB 代码实现

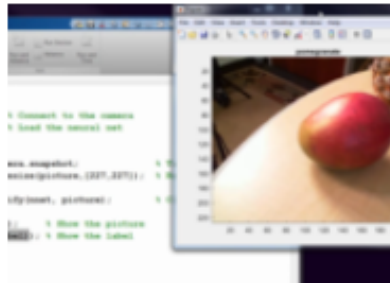
```
clear
```

```
came  
nnet
```

```
whil
```


[Products](#)
[Solutions](#)
[Academia](#)
[Support](#)
[Community](#)
[Events](#)

## File Exchange

[MATLAB Central](#)
[Files](#)
[Authors](#)
[My File Exchange](#)
[Contribute](#)
[About](#)


## Deep Learning in 11 Lines of MATLAB Code

version 1.0.0.0 (469 Bytes) by [MathWorks Deep Learning Toolbox Team](#) **STAFF**

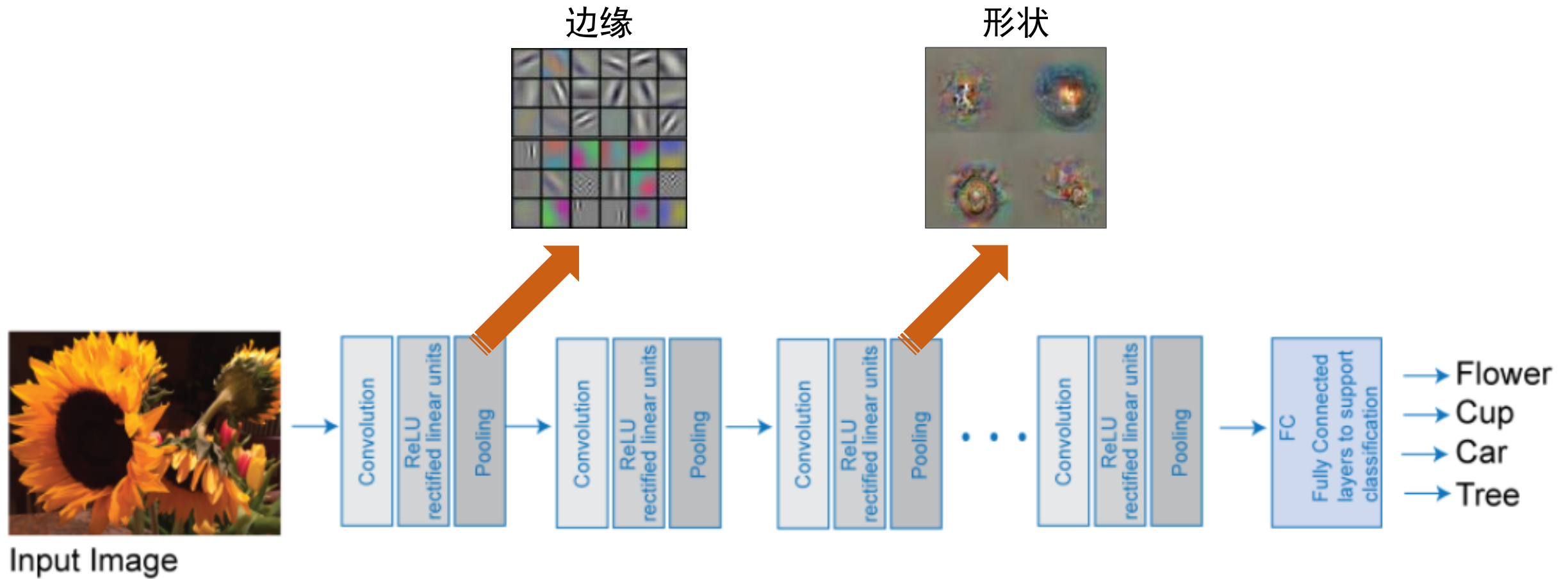
Use MATLAB®, a simple webcam, and a deep neural network to identify objects in your surroundings.

```
title(char(label)); % Show the label
```

```
drawnow;
```

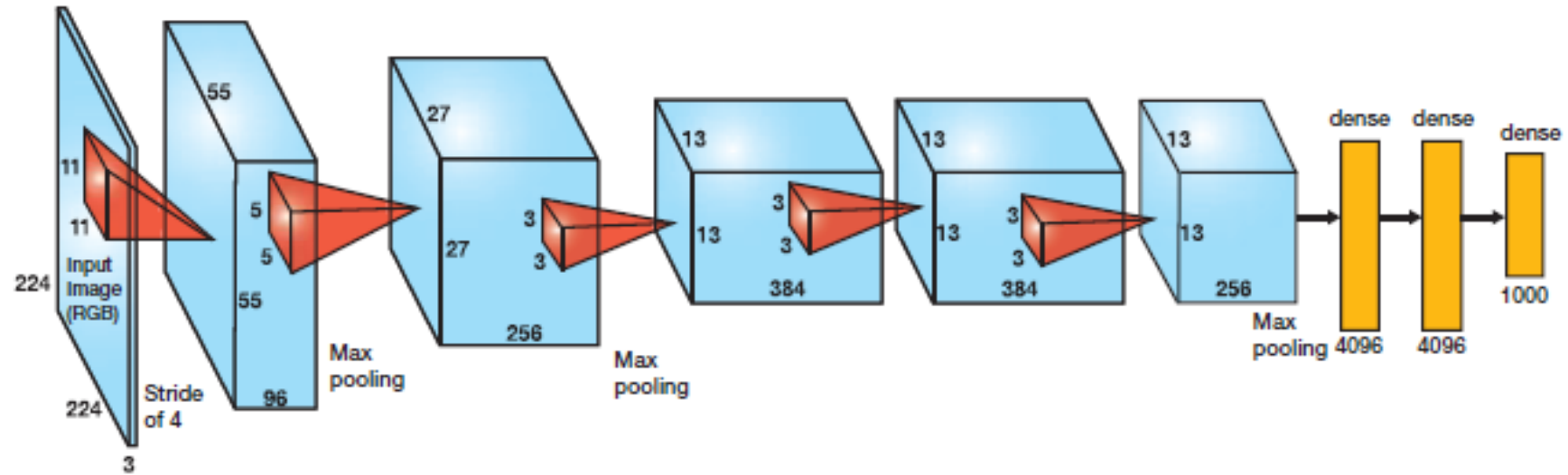
```
end
```

# 卷积神经网络 (CNN/ConvNet)





# 卷积神经网络 (CNN/ConvNet) 的基本结构



Input Image



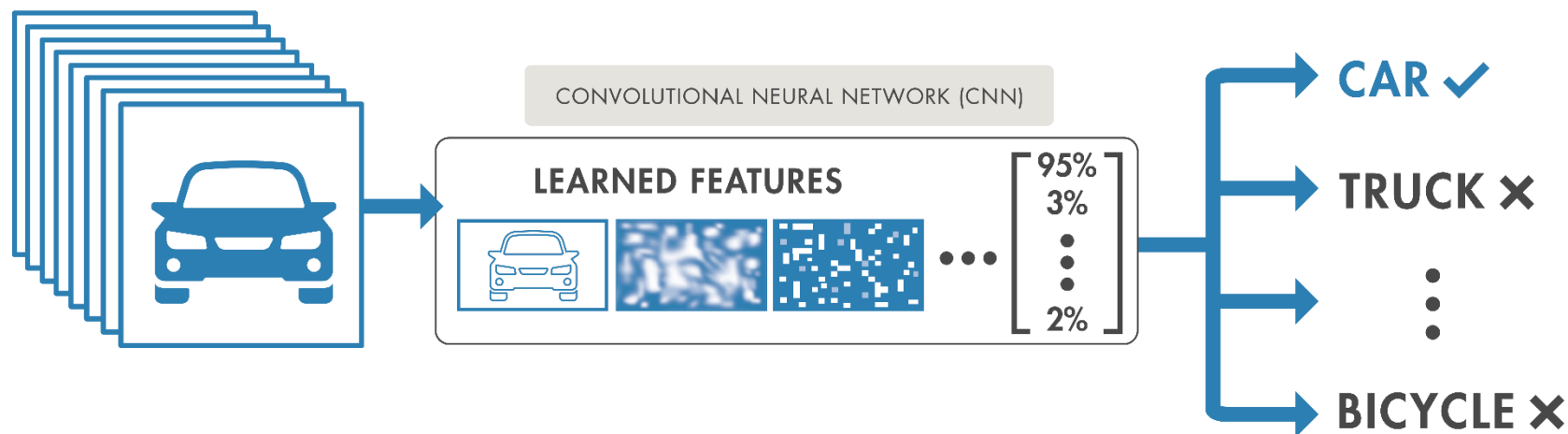
# Demo

# 中场答疑环节

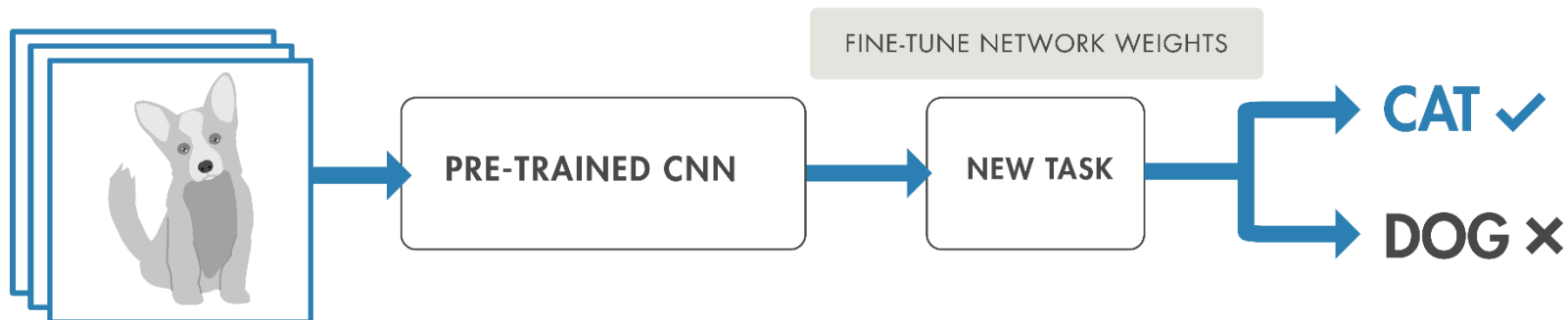
# 迁移学习的力量

# 进行深度学习的两种方法

## 1. 从头开始训练一个深度神经网络



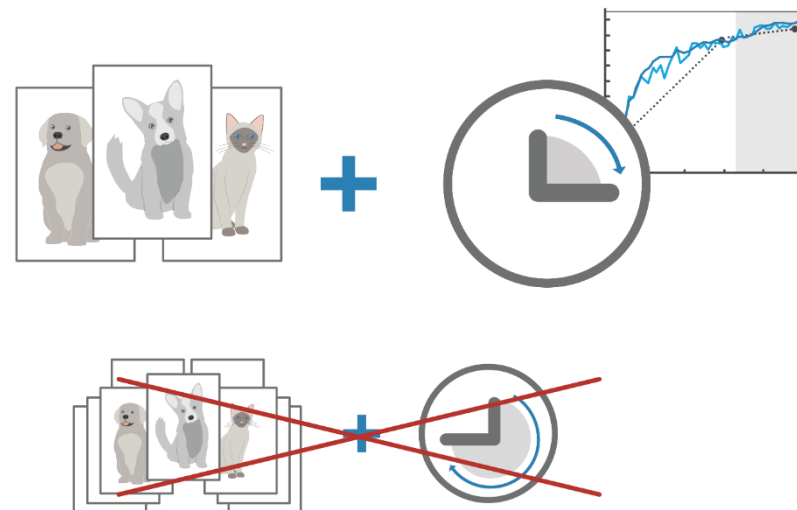
## 2. 微调一个已经训练好的模型（迁移学习）





# 为什么使用迁移学习？

- 所需数据集大幅减少，训练时间也随之减少
- 参考模型（如AlexNet, VGG-16, VGG-19）是强有力的特征提取器
- 以顶级研究者的最佳网络模型为基础



## 流行的预训练模型

- DenseNet-201
- SqueezeNet
- ResNet-18
- ResNet-50
- ResNet-101
- Inception-v3
- Inception-resnet-v2
- VGG-16/19
- GoogLeNet
- AlexNet

### Import Models from Frameworks

- Caffe Model Importer
- TensorFlow-Keras Model Importer
- ONNX - Importer/ Exporter

AlexNet  
PRETRAINED  
MODEL

VGG-16  
PRETRAINED  
MODEL

ResNet-50  
PRETRAINED MODEL

ResNet-101  
PRETRAINED MODEL

Caffe  
IMPORTER

GoogLeNet  
PRETRAINED  
MODEL

TensorFlow-  
Keras  
IMPORTER

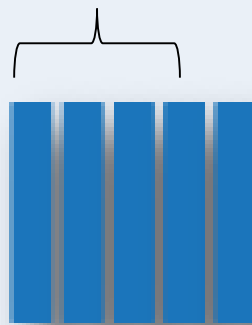
Inception-v3  
MODELS

\* 一行代码获取模型

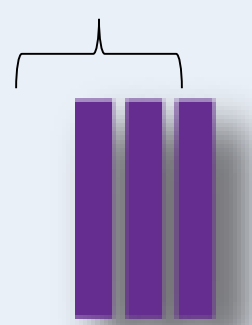
# 迁移学习的工作流程

## Load pretrained network

Early layers learn low-level features (edges, blobs, colors)



Last layers learn task-specific features



...

1 million images  
1000s classes

### Network

`alexnet`

`vgg16`

`vgg19`

`squeezenet`

`googlenet`

`inceptionv3`

`resnet18`

`resnet50`

`resnet101`

`inceptionresnetv2`

# 迁移学习的工作流程

## Load pretrained network

Early layers that learned  
low-level features  
(edges, blobs, colors)

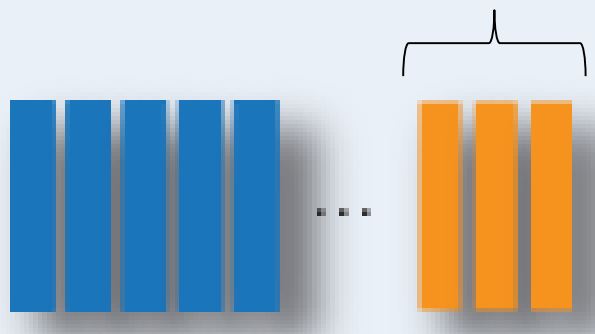
Last layers that  
learned task  
specific features



1 million images  
1000s classes

## Replace final layers

New layers learn  
features specific  
to your data



Fewer classes  
Learn faster



# 迁移学习的工作流程

## Load pretrained network

Early layers that learned low-level features (edges, blobs, colors)      Last layers that learned task specific features



1 million images  
1000s classes

## Replace final

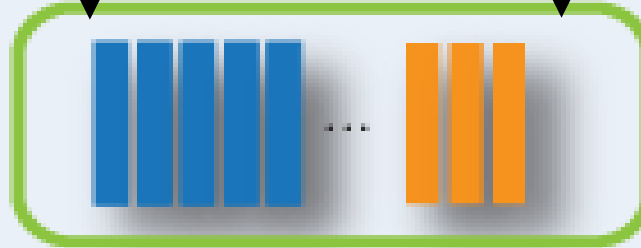


Fewer class  
Learn fast

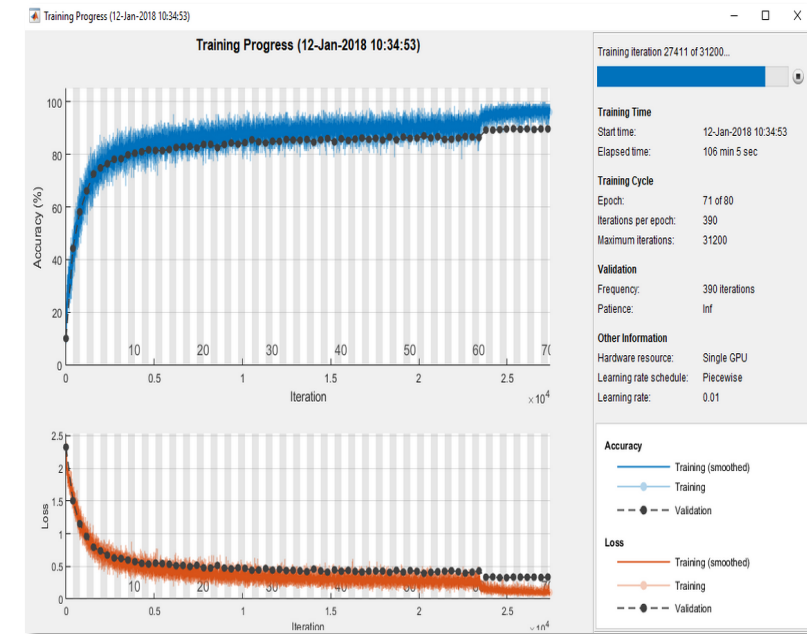
## Train network

Training images

Training options



100s images  
10s classes





# 迁移学习的工作流程

## Load pretrained network

Early layers that learned low-level features (edges, blobs, colors)      Last layers that learned task specific features



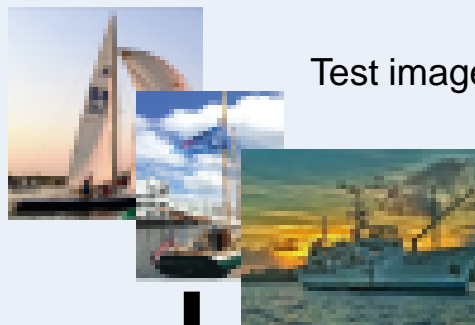
1 million images  
1000s classes

## Replace final



Fewer classes  
Learn faster

## Predict and assess network accuracy



Test images

Trained Network

CIFAR-10 Confusion Matrix

True class \ Predicted class	airplane	automobile	bird	cat	deer	dog	frog	horse	ship	truck	Accuracy	Macro Avg
	airplane	automobile	bird	cat	deer	dog	frog	horse	ship	truck	Accuracy	Macro Avg
airplane	923	4	21	8	4	1	5	5	23	6	92.3%	7.7%
automobile	5	972	2					1	5	15	97.2%	2.8%
bird	26	2	892	30	13	8	17	5	4	3	89.2%	10.8%
cat	12	4	32	826	24	48	30	12	5	7	82.6%	17.4%
deer	5	1	28	24	898	13	14	14	2	1	89.8%	10.2%
dog	7	2	28	111	18	801	13	17		3	80.1%	19.9%
frog	5		16	27	3	4	943	1	1		94.3%	5.7%
horse	9	1	14	13	22	17	3	915	2	4	91.5%	8.5%
ship	37	10	4	4		1	2	1	931	10	93.1%	6.9%
truck	20	39	3	3			2	1	9	923	92.3%	7.7%
	88.0%	93.9%	85.8%	79.0%	91.4%	89.7%	91.6%	94.1%	94.8%	95.0%		
	12.0%	6.1%	14.2%	21.0%	8.6%	10.3%	8.4%	5.9%	5.2%	5.0%		

# 迁移学习的工作流程

## Load pretrained network

Early layers that learned low-level features (edges, blobs, colors)      Last layers that learned task specific features



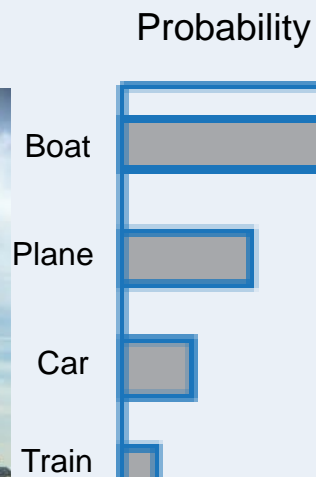
1 million images  
1000s classes

## Replace final

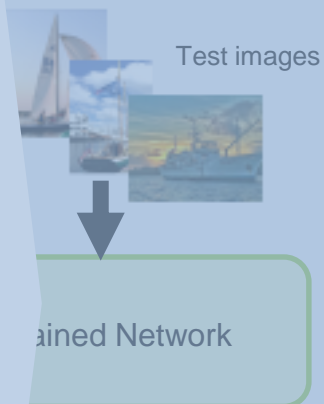


Fewer classes  
Learn faster

## Deploy results



## Predict and assess network accuracy



# 迁移学习的工作流程

## Load pretrained network

Early layers that learned low-level features (edges, blobs, colors)    Last layers that learned task specific features



1 million images  
1000s classes

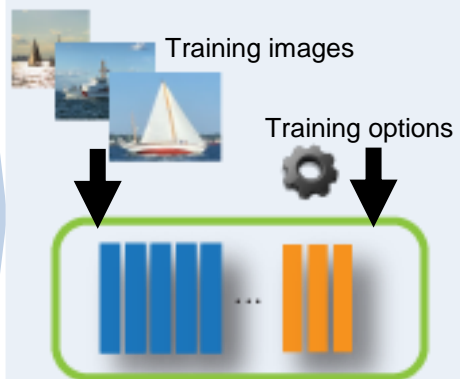
## Replace final layers

New layers to learn features specific to your data



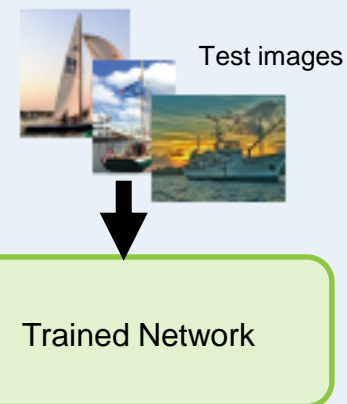
Fewer classes  
Learn faster

## Train network

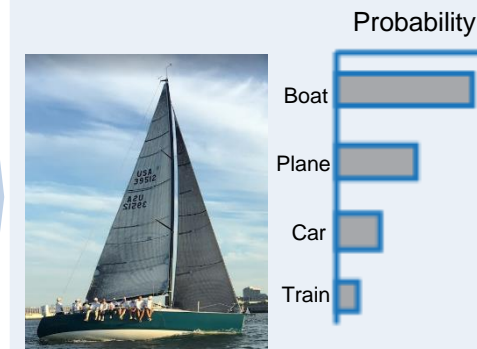


100s images  
10s classes

## Predict and assess network accuracy



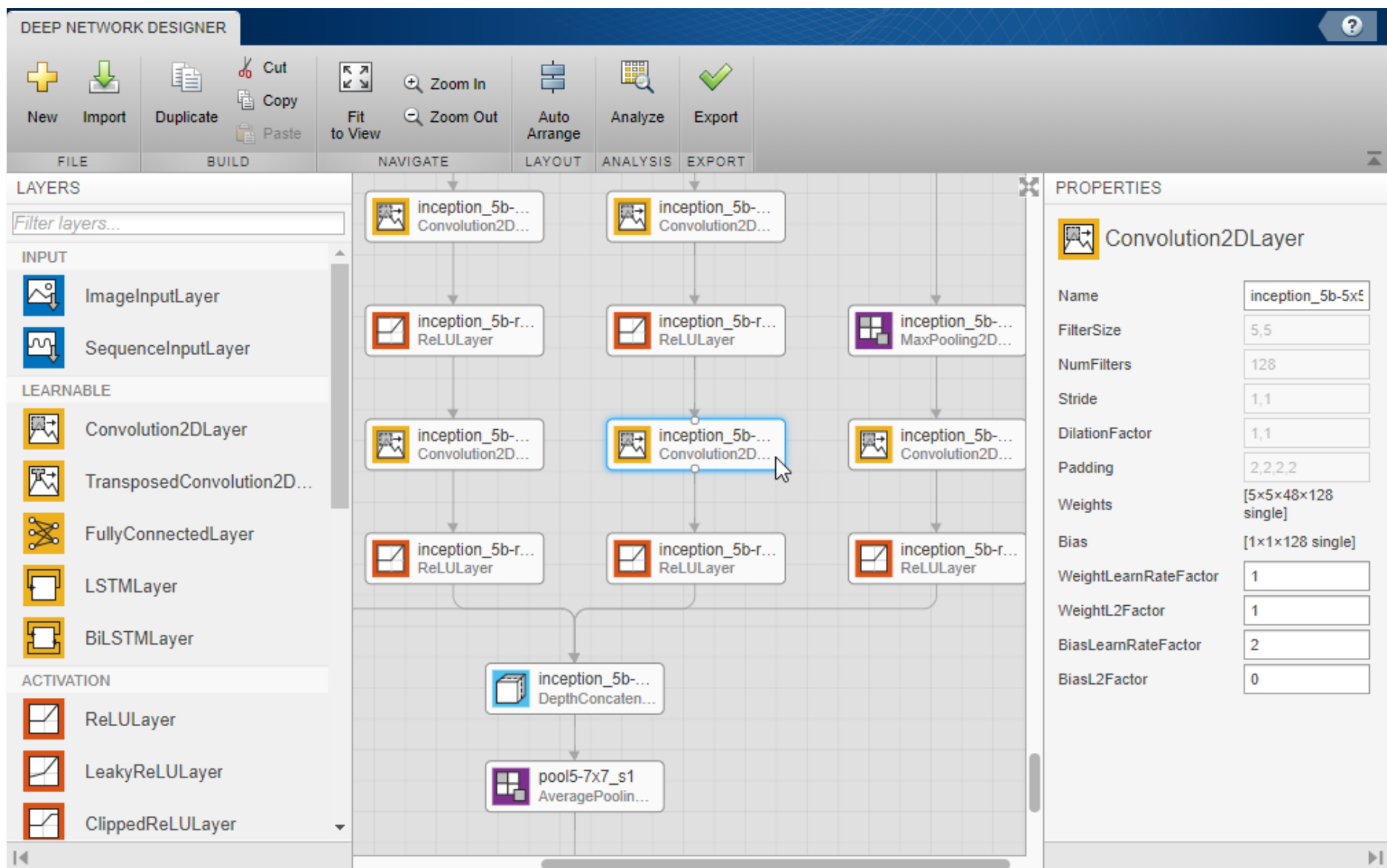
## Deploy results



Demo

# Deep Network Designer

# 设计复杂网络的利器



Demo



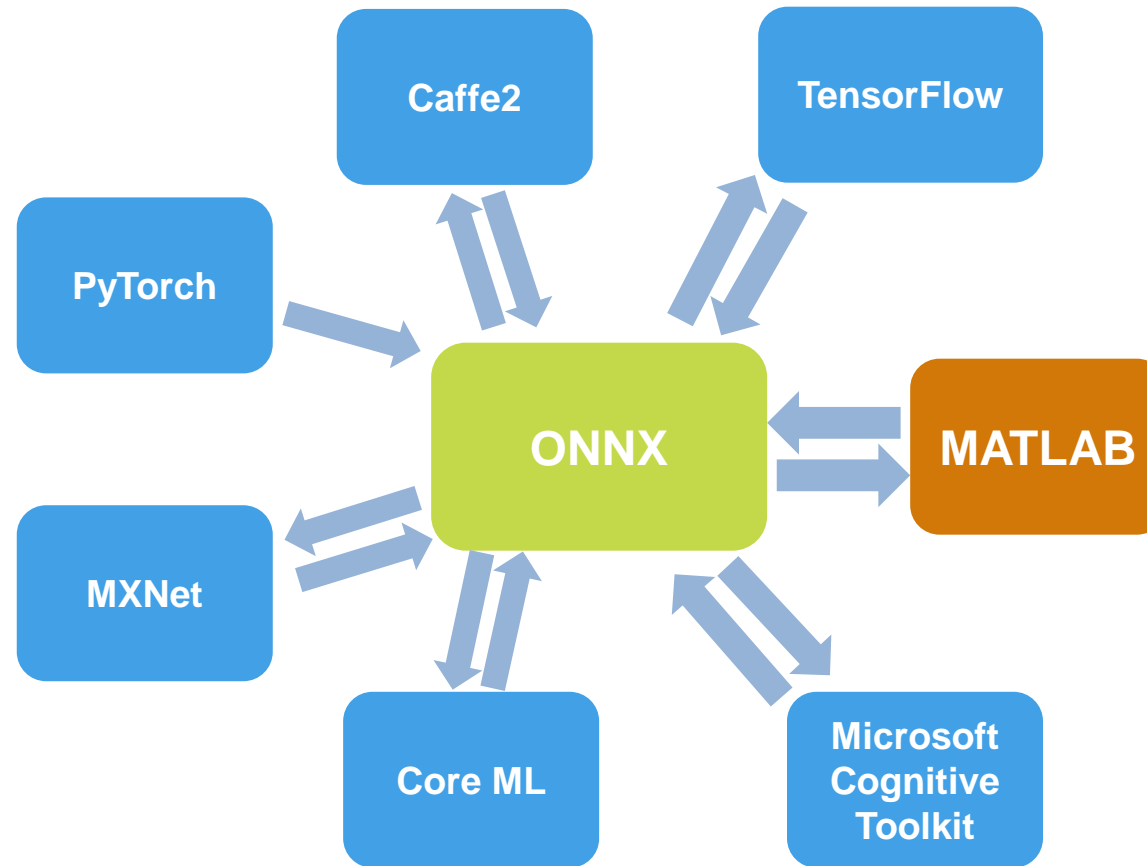
# 与开源框架的协作

## 从其他框架导入模型

- DenseNet-201
- SqueezeNet
- ResNet-18
- ResNet-50
- ResNet-101
- Inception-v3
- Inception-resnet-v2
- VGG-16/19
- GoogLeNet
- AlexNet

- Caffe Model Importer
- TensorFlow-Keras Model Importer
- ONNX - Importer/ Exporter

# Open Neural Network eXchange (ONNX)



<https://onnx.ai/>

# Deep Learning Toolbox Converter for ONNX Model Format

```
>> importONNXNetwork
```

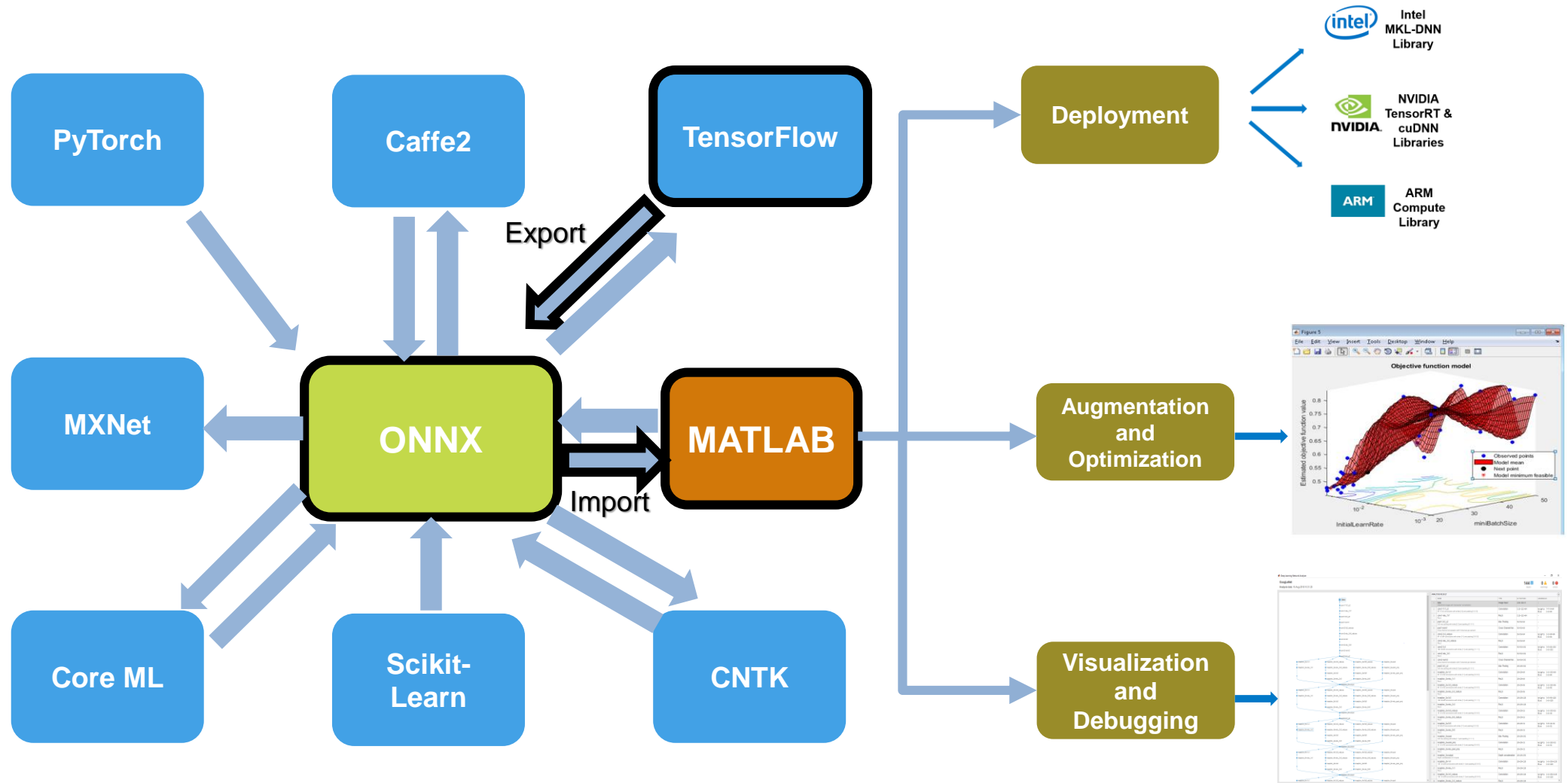
Error using **importONNXNetwork** (line 48)

importONNXNetwork requires the Deep Learning Toolbox Converter for ONNX Model Format  
install this support package, use the Add-On Explorer.



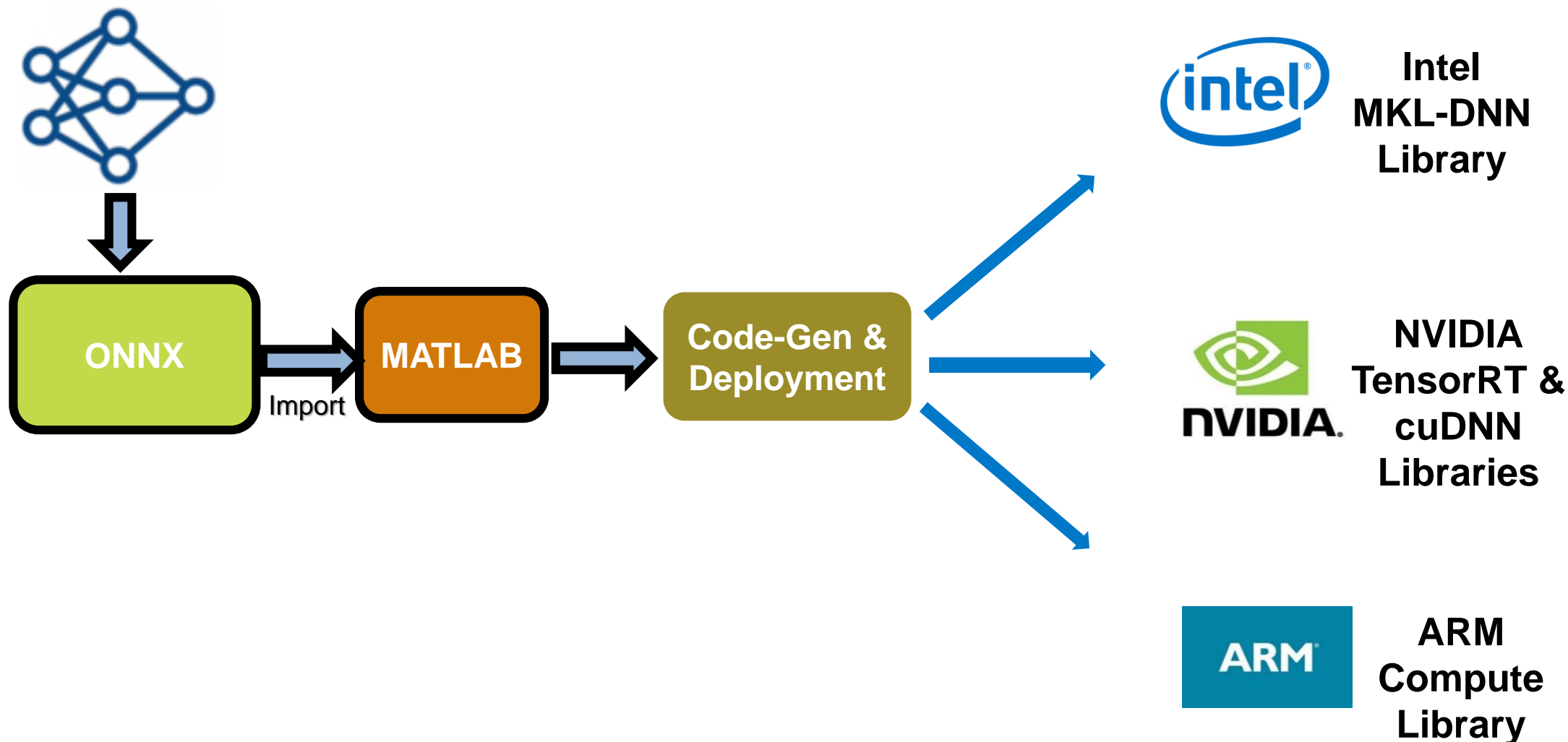
The screenshot shows the 'Add-On Explorer' window. At the top, there's a dark blue header with 'Contribute' and 'Manage Add-Ons' links. Below the header is a search bar labeled 'Search for add-ons'. The main content area displays the 'Deep Learning Toolbox Converter for ONNX Model Format' add-on. It features a green 'Installed' badge, a red 'Conv' logo, and the text 'ONNX mod'. The add-on is by the 'MathWorks Deep Learning Toolbox Team' and is marked as a 'STAFF' recommendation. The description states: 'Import and export ONNX™ models within MATLAB for interoperability with other deep learning frameworks'. It also shows '0 Ratings', '52 Downloads', and 'Updated 27 Feb 2019'. A 'Manage' button is visible. At the bottom left, there's a tab labeled 'Overview'. A 'MathWorks Optional Feature' badge is also present.

# 有了ONNX之后



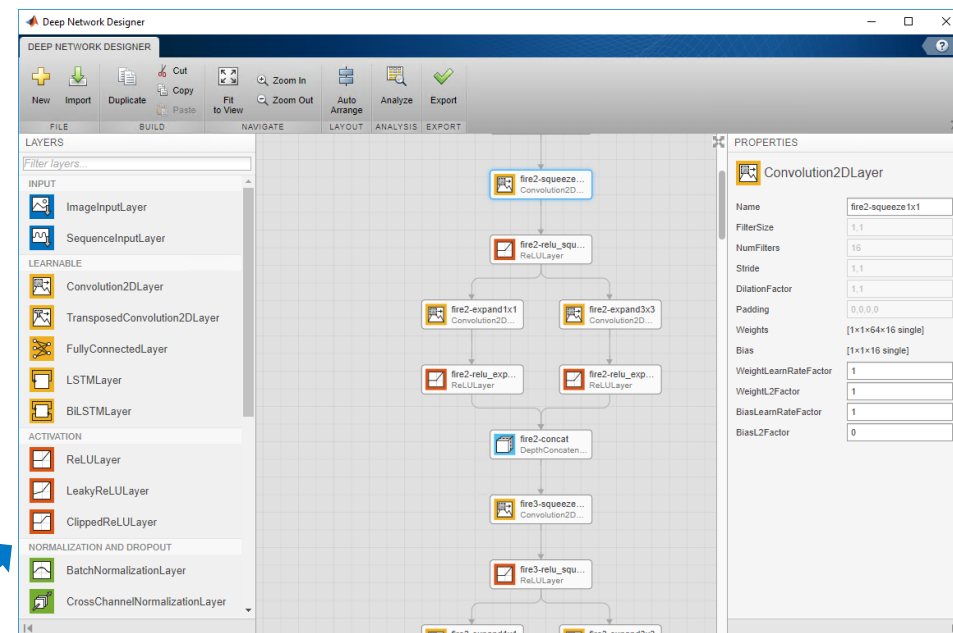
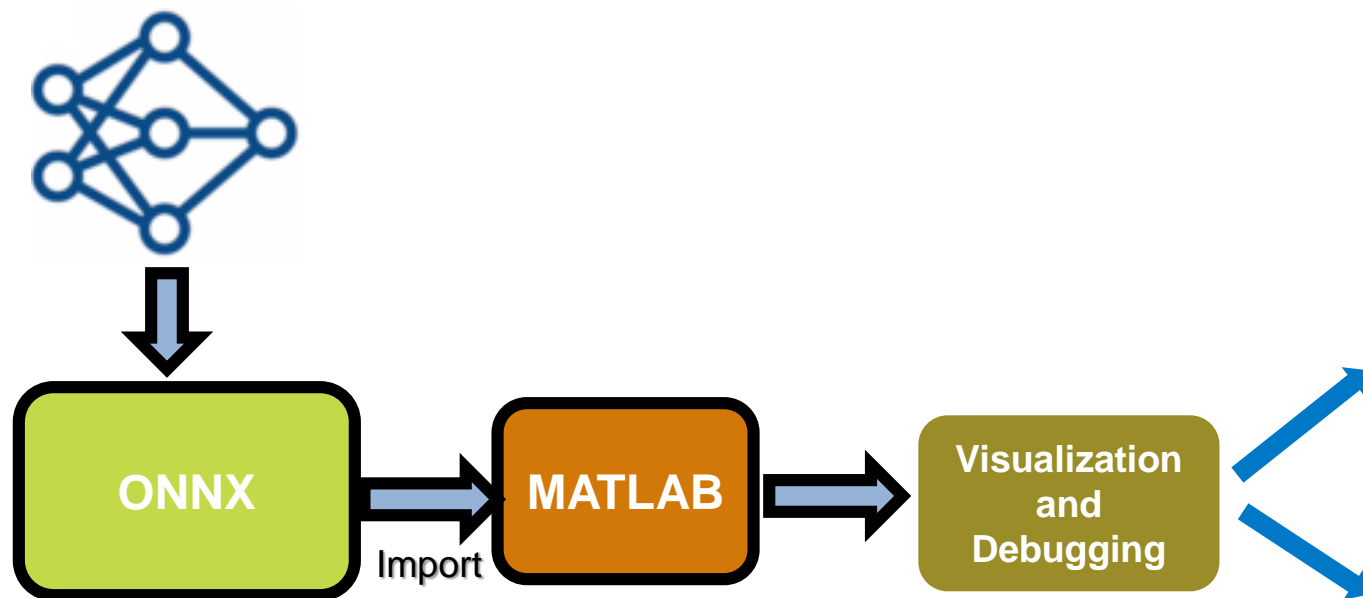
# 将 ONNX 模型导入 MATLAB 的三大理由

## 1. 代码生成和多平台部署

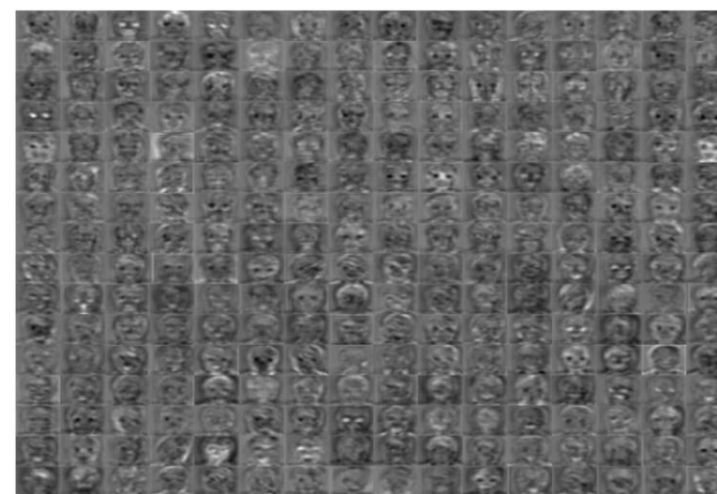


# 将 ONNX 模型导入 MATLAB 的三大理由

## 2. 可视化和调试



Network Designer



Visualize Layer Activations



# 将 ONNX 模型导入 MATLAB 的三大理由

## 3. 模型优化

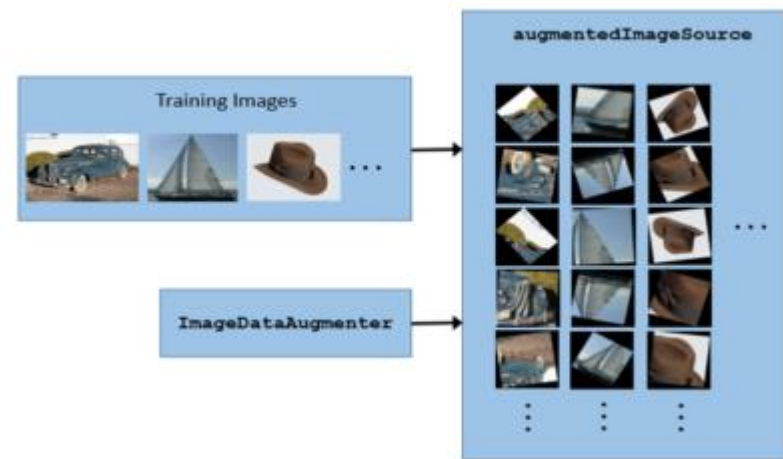
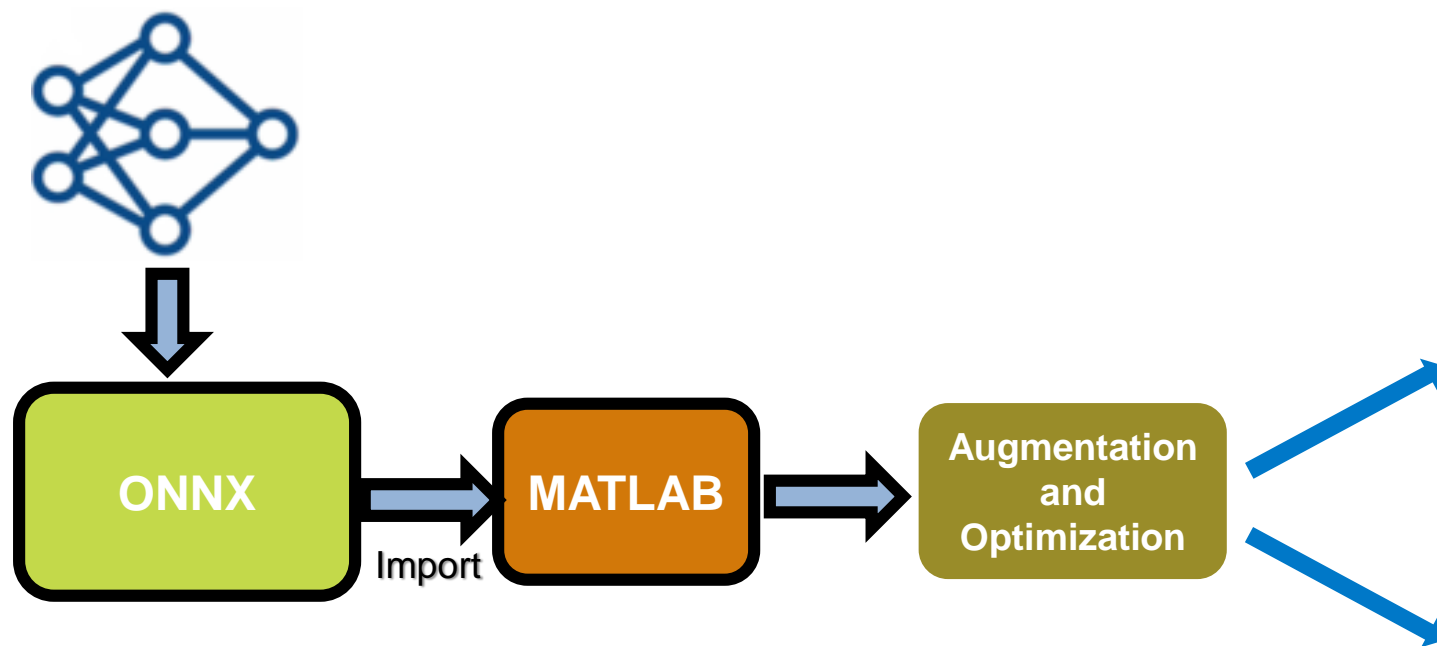
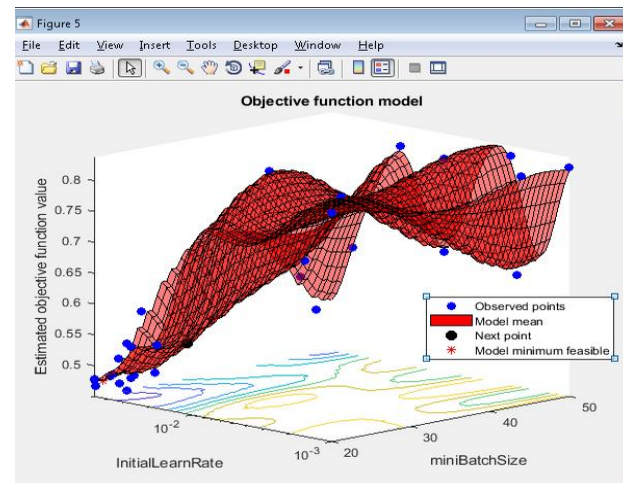


Image Augmentation



Hyperparameter tuning using Bayesian Optimization

Demo

# 确认您的学校是否已经拥有Campus-Wide License?

- 了解您所在学校是否拥有 Campus-Wide License (即 MATLAB 全校授权许可) :
- <https://ww2.mathworks.cn/academia/tah-support-program/eligibility.html>



Academia

## Campus-Wide License

### 授权咨询

Campus-Wide License 为全校教职员工、研究人员以及学生提供了一个高效的方法来访问 MATLAB 和 Simulink 的全面通用配置。要了解您所在学校是否拥有 Campus-Wide License, 请填写下表。

\* 表示必填信息

#### 联系信息

\* 大学

输入正式名称

\* 电子邮件

请使用正式大学邮箱地址以便通过验证

提交



# 跟随 MATLAB 和 Simulink 教程学习

- 通过免费自定进度的在线课程，获得交互式的 MATLAB 具体操作介绍。
- <https://ww2.mathworks.cn/support/learn-with-matlab-tutorials.html>

## 快速入门



## 微直播（免费）：

2019年4月25日 10:00AM  
MATLAB 最前线- R2019a新特性

2019年5月28日  
MATLAB EXPO 2019

## 进阶培训课程（收费）： *Deep Learning with MATLAB*

时间： 2019年5月15-16日

地点： 北京

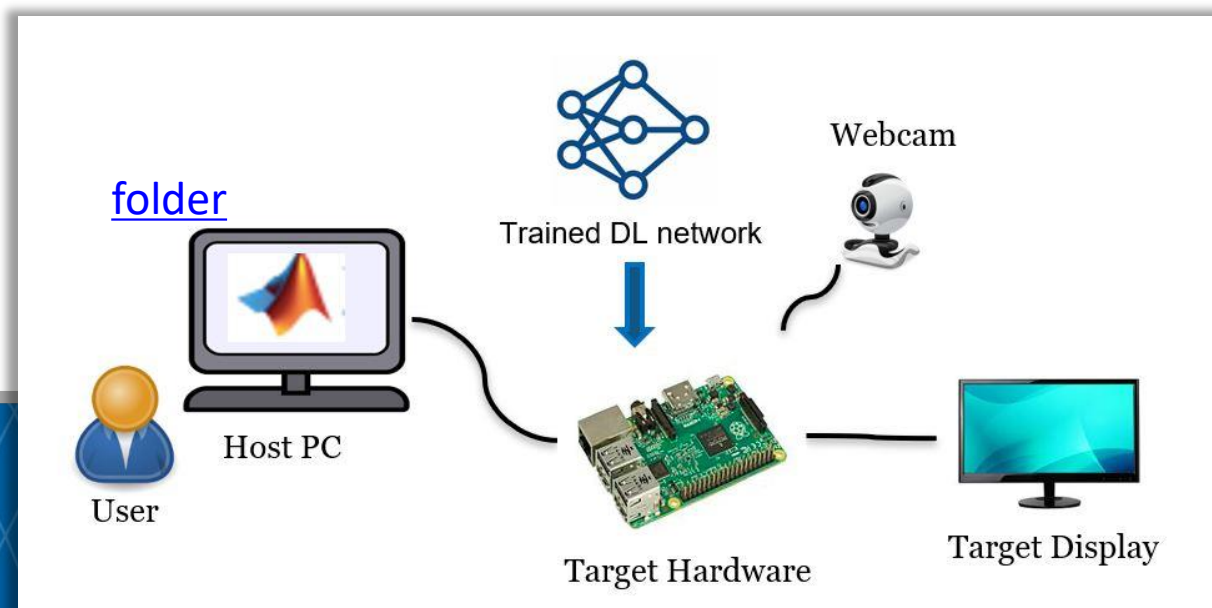
形式： 教师现场指导

- 更多免费学习资源，也可以在 MATLAB 中文论坛>学习资源获取：
- <http://www.ilovematlab.cn/resources/>

# 小迈步第二课：MATLAB深度学习入门之树莓派与GPU应用

阮卡佳

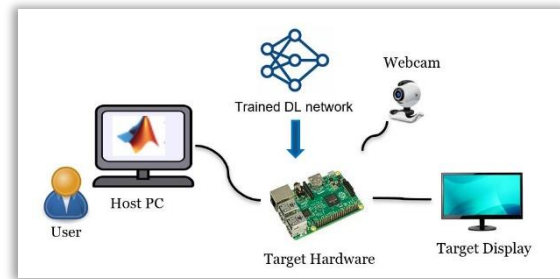
MathWorks 中国高校团队高级工程师





## 小迈步第二课：MATLAB深度学习入门之树莓派与GPU应用 **NEW!**

- 深度学习在训练阶段常用GPU来加速，在推断阶段可以用**CPU、GPU、FPGA**等硬件实现。
- 紧跟“小迈步第一课：MATLAB深度学习入门课堂”，通过具体MATLAB代码演示与操作，带领大家学习在树莓派（Raspberry Pi）ARM CPU和NVIDIA GPU上实现深度学习目标检测。
- 学习如何将预训练网络自动生成**C++** 或者**CUDA**代码，跨越手写代码的障碍。学会如何使用MATLAB快速对树莓派编程。
- 课程内容
  - 前期“深度学习入门”小迈步课堂回顾
  - 在ARM CPU上实现深度学习目标检测
  - 深度学习目标检测实例 - 自动售卖机商品识别
  - 在NVIDIA GPU上实现深度学习目标检测
  - 目标检测性能比较与流程优势





《小迈步第一课：MATLAB深度学习入门课堂》

填写调查问卷，  
立即下载小迈步课件！  
上 MATLAB 中文论坛，  
讨论 MATLAB 问题。

直达小迈步课程讨论帖 ↓



>> <http://www.ilovematlab.cn/thread-565281-1-1.html>

如果您有关于正版产品或服务的其他问题  
请与我们联系

中国区  
迈斯沃克软件（北京）有限公司 (MathWorks China)  
网站: [cn.mathworks.com](http://cn.mathworks.com)  
电话: 86-10-5982-7000  
email: [marketing\\_cn@mathworks.cn](mailto:marketing_cn@mathworks.cn)  
[academic\\_cn@mathworks.cn](mailto:academic_cn@mathworks.cn) (高校课程开发及协助支持)