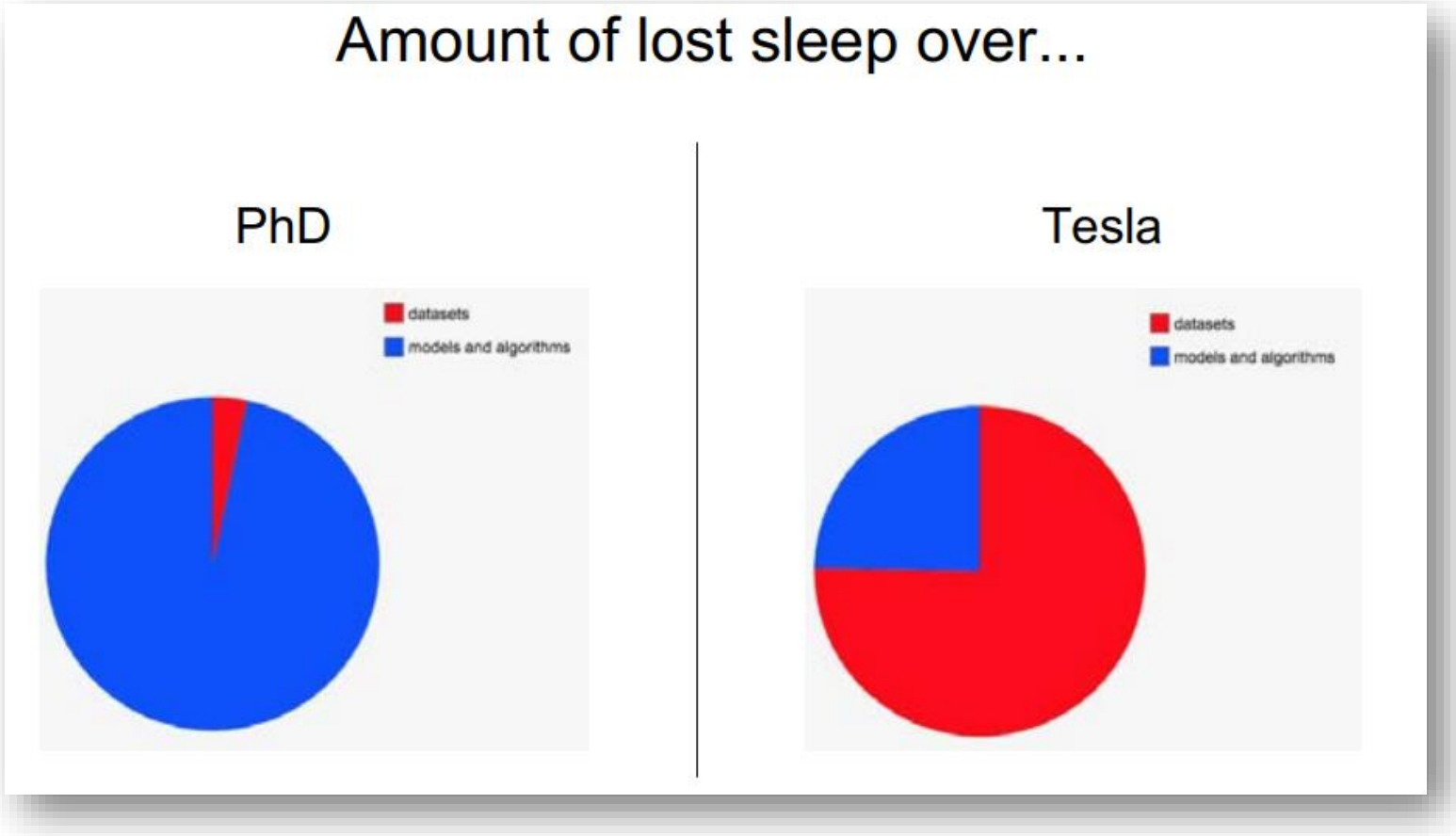
MATLAB EXPO

以数据为中心的人工智能在信号处理中的应用

陈宜欣

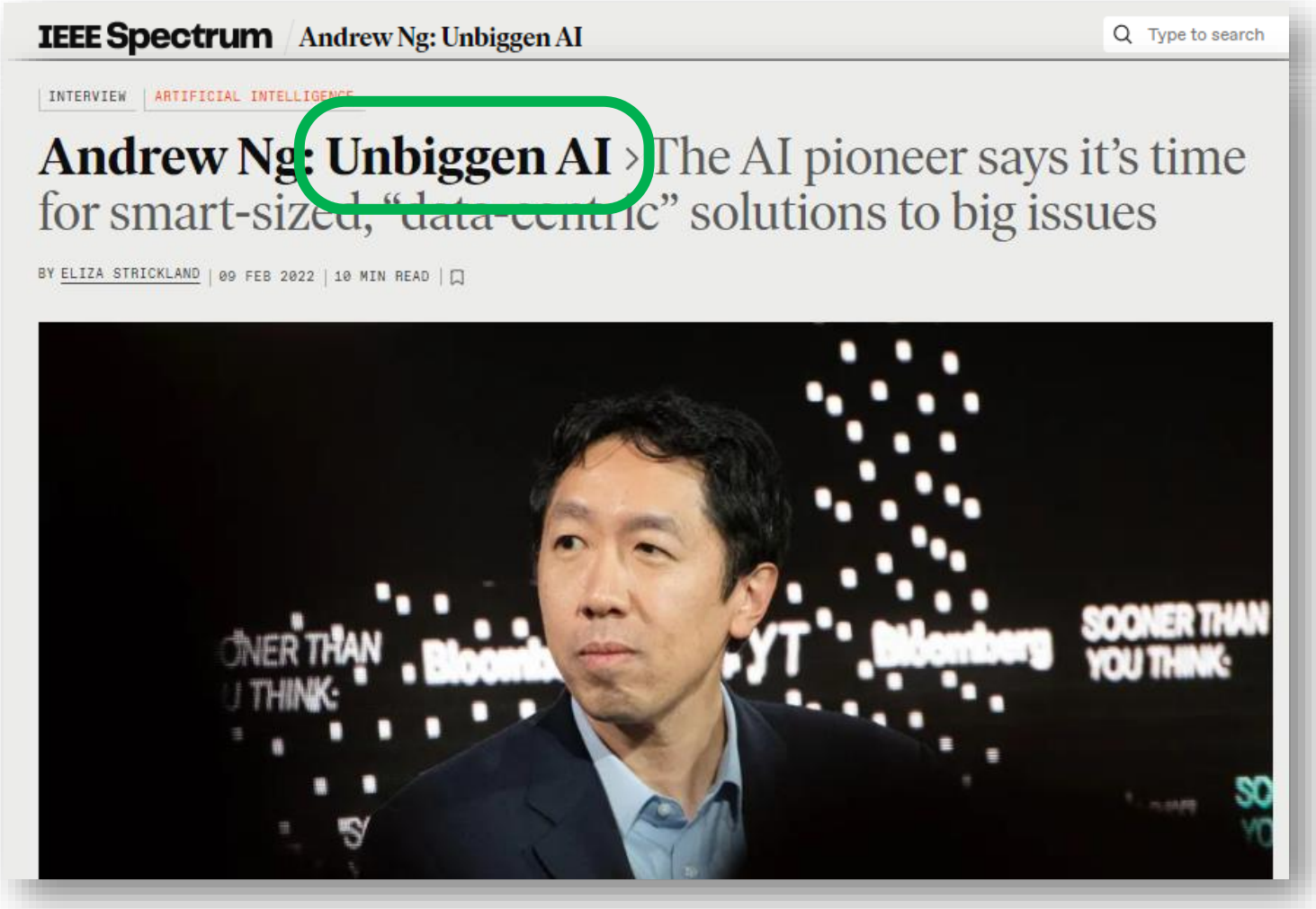
MathWorks®

学术界和工业界以不同的方式投资AI
更优的模型还是更优的数据？



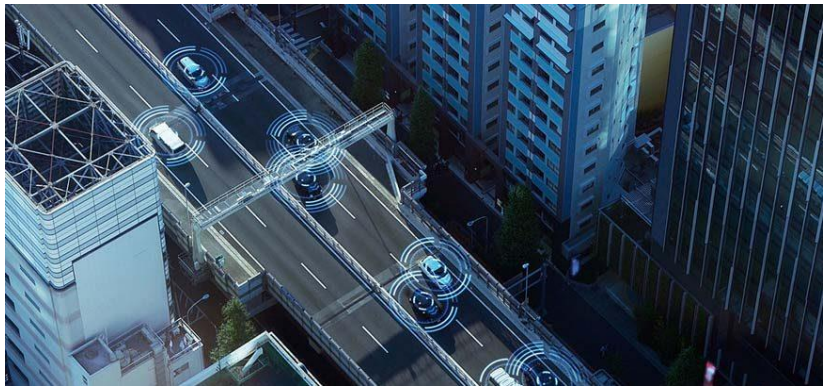
Andrej Karpathy – Building the Software 2.0 Stack (Spark+AI Summit 2018)

2022 以数据为中心的AI – 这一趋势加快步伐并为人所知



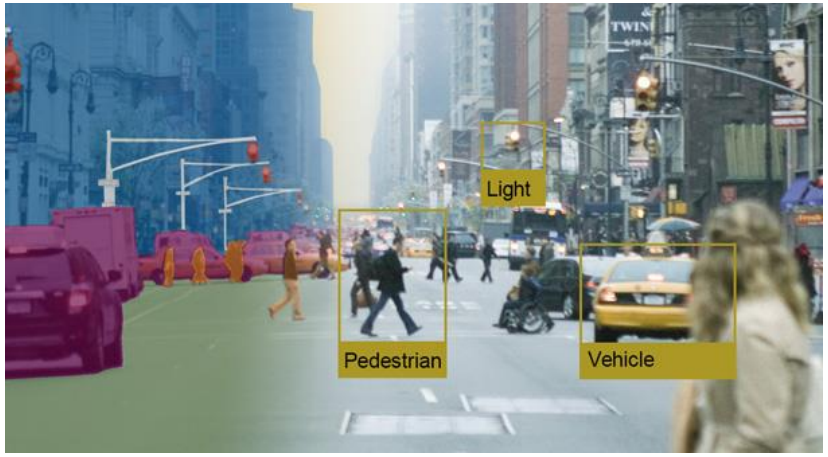
https://spectrum.ieee.org/andrew-ng-data-centric-ai

大多数现有的AI资源仅支持了少数应用



Autonomous driving

Language modeling

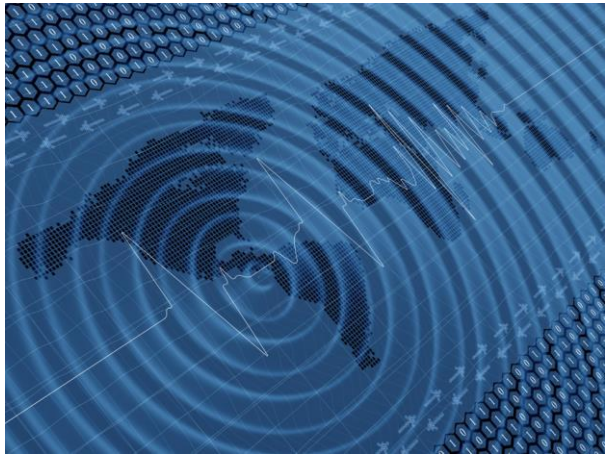


Computer vision

Speech recognition

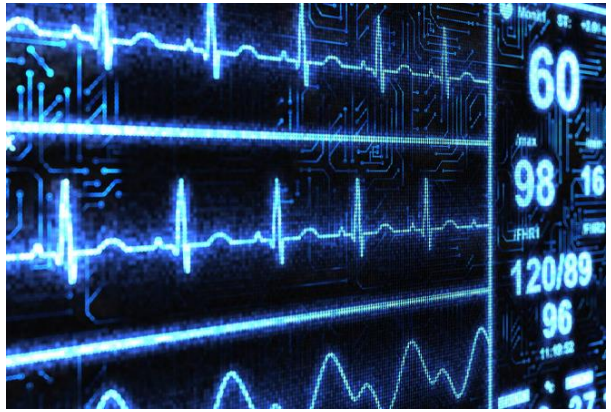
大多数信号处理应用不能依赖于现有的AI资源

Vibration analysis



Seismic analysis

Predictive maintenance



Digital health

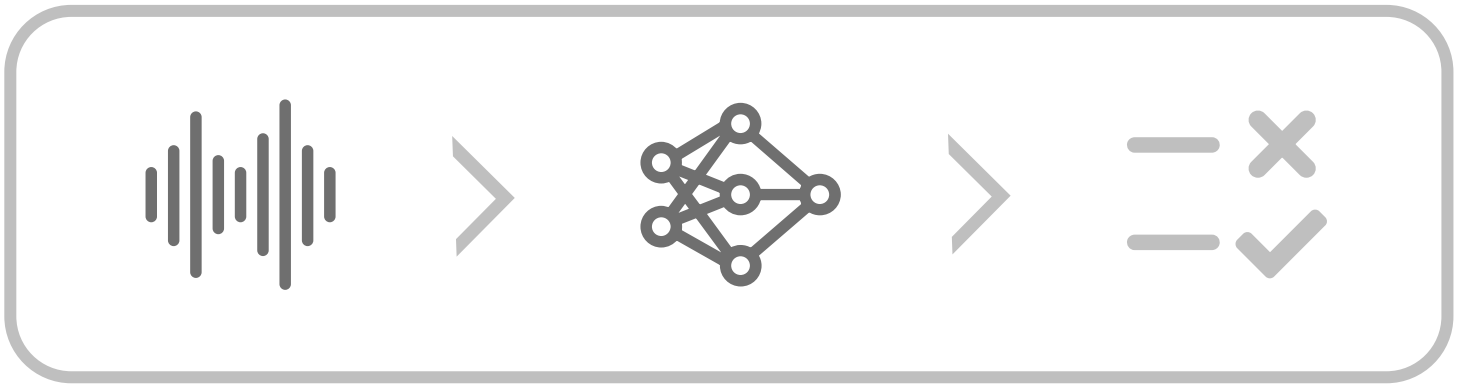
Machine health

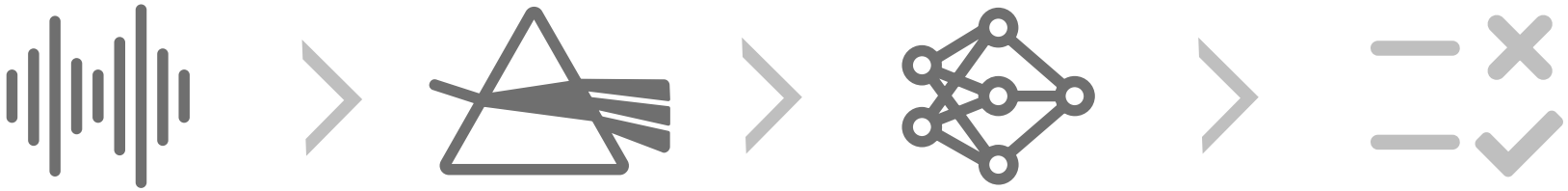
...

调查时间

以下哪一项最能描述您的 AI 相关挑战？

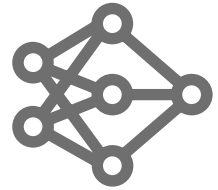
- ○ Model Complexity
- ○ Data Complexity
- ○ AI Expertise



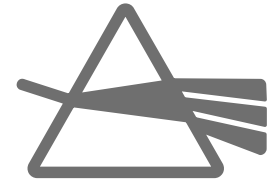


以数据为中心的人工智能在信号处理中的应用
议程 — 3个实际工程应用方法

1. 使用预训练AI模型进行迁移学习



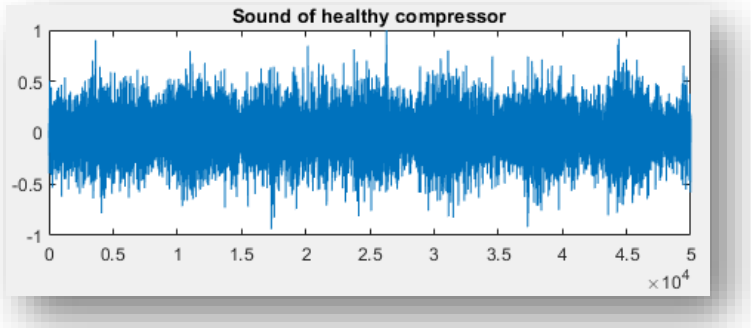
2. 借助特征工程使用更小更简单的AI模型

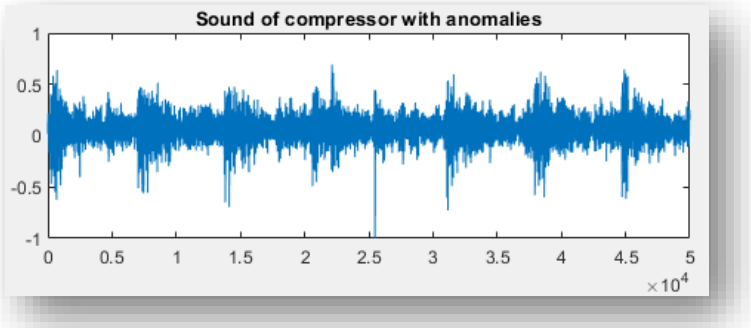


3. 更优的信号数据集，真实或生成的

如何将迁移学习应用于基于噪声检测空气压缩机故障

- Have dataset with labeled sound recordings
- One “healthy” class
- 7 different classes of faults
- 1800.wav files, 225 per class

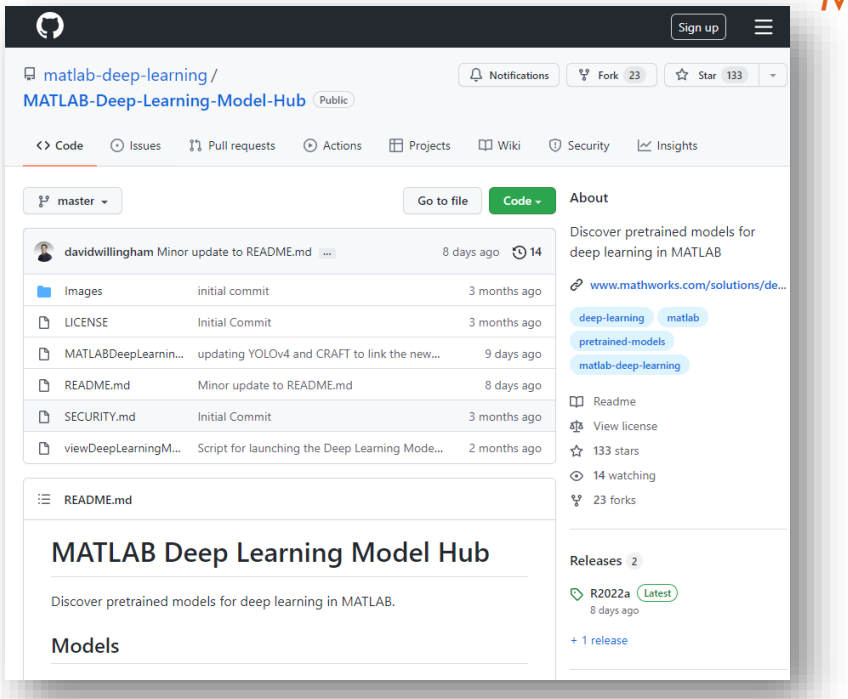




[Example: Transfer Learning with Pretrained Audio Networks in Deep Network Designer]

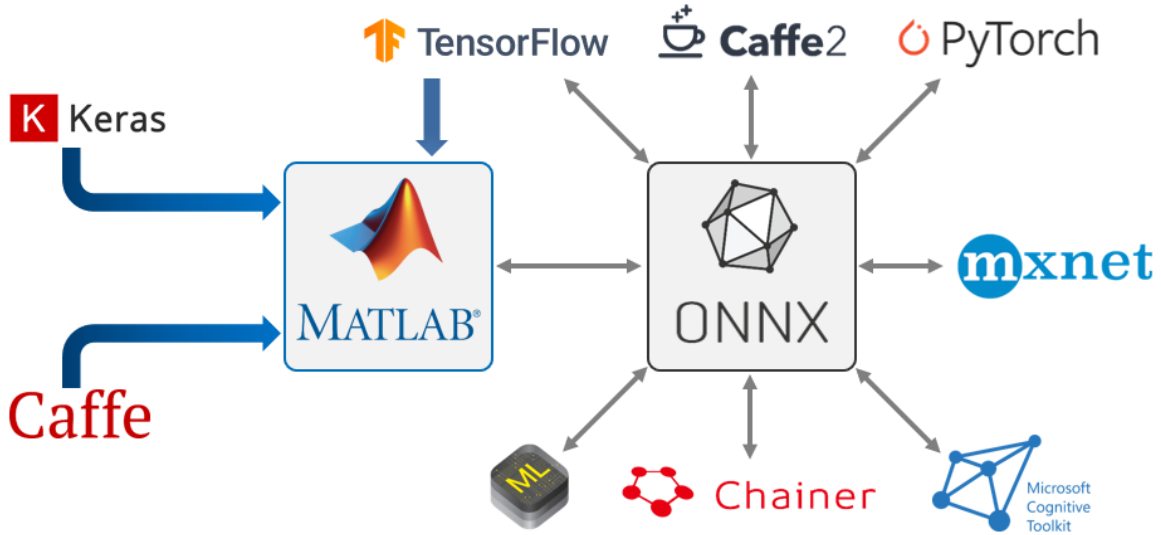
寻找用于迁移学习的预训练深度学习网络

- Find one directly in MATLAB



https://github.com/matlab-deep-learning/MATLAB-Deep-Learning-Model-Hub

- Import it from a known non-MATLAB repository



MATLAB R2022a

HOME PLOTS APPS LIVE EDITOR INSERT VIEW

Level A Update Cleanup Search Documentation Gabriele

New Open Save Compare Print Export FILE | Go To Find Bookmark NAVIGATE | Text Normal B I U M TEXT | Code Control Task Refactor CODE | Run Section Section Break Run and Advance Run to End SECTION | Run Step Stop RUN

C: ▸ Users ▸ gbunkhei ▸ OneDrive - MathWorks ▸ Documents ▸ MATLAB ▸ Examples ▸ R2022a ▸ deeplearning_shared ▸ TransferLearningWithAudioNetworkInDeepNetworkDesignerExample

Current Folder | Command History

Name	Size	Date Modified
Live Script		
Transf...	425 KB	07/04/2022 ...

Details

Workspace

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adsTest	*1x1 audioData*
adsTrain	*1x1 audioData*
adsValidation	*1x1 audioData*
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downloadFolder	'C:\Users\gbun
tdsTrain	*1x1 Transform*
tdsValidation	*1x1 Transform*
url	'https://www.m

Live Editor - C:\Users\gbunkhei\OneDrive - MathWorks\Documents\MATLAB\Examples\R2022a\deeplearning_shared\TransferLearningWithAudioNetworkInDeepNetworkDesignerExample\TransferLearningWithAudioNetworkInDeepNetw...

TransferLearningWithAudioNetworkInDeepNetworkDesignerExample.mlx

Transfer Learning with Pretrained Audio Networks in Deep Network Designer

This example shows how to interactively fine-tune a pretrained network to classify new audio signals using Deep Network Designer.

Transfer learning is commonly used in deep learning applications. You can take a pretrained network and use it as a starting point to learn a new task. Fine-tuning a network with transfer learning is usually much faster and easier than training a network with randomly initialized weights from scratch. You can quickly transfer learned features to a new task using a smaller number of training signals.

This example retrains YAMNet, a pretrained convolutional neural network, to classify a new set of audio signals. This example requires Audio Toolbox™ and Deep Learning Toolbox™.

Load Data

Download and unzip the air compressor data set [1]. This data set consists of recordings from air compressors in a healthy state or one of 7 faulty states.

```
url = 'https://www.mathworks.com/supportfiles/audio/AirCompressorDataset/AirCompressorDataset.zip';
downloadFolder = fullfile(tempdir,'aircompressordataset');
datasetLocation = tempdir;

if ~exist(fullfile(tempdir,'AirCompressorDataSet'),'dir')
    loc = websave(downloadFolder,url);
    unzip(loc,fullfile(tempdir,'AirCompressorDataSet'))
end
```

Create an `audioDatastore` object to manage the data and split it into training, validation, and test sets.

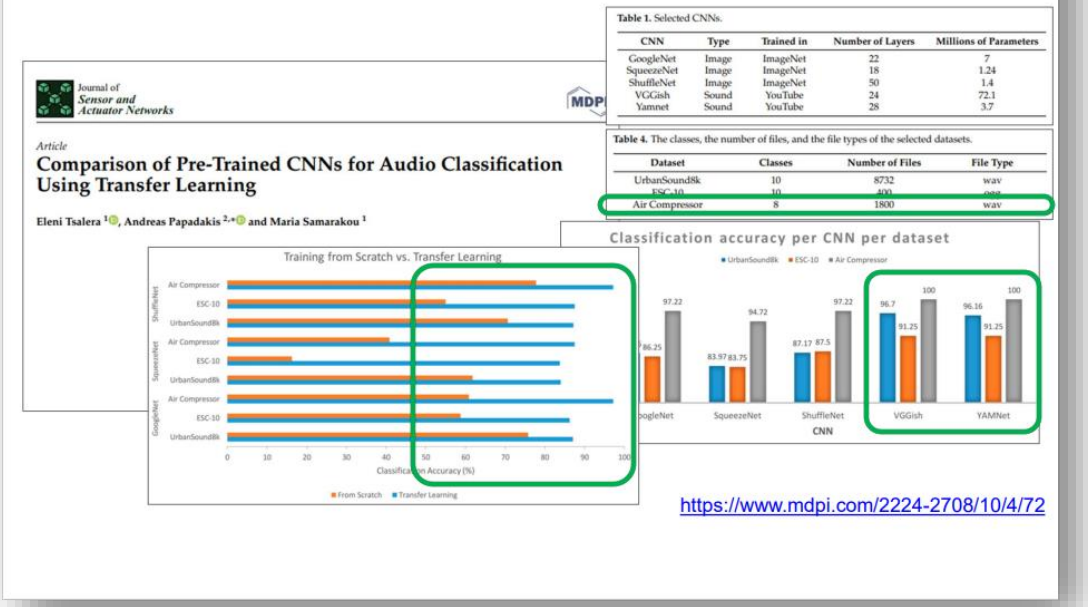
Command Window

fx >>

Zoom: 100% UTF-8 LF script

迁移学习 — 参考资料

Choosing the right model for transfer learning

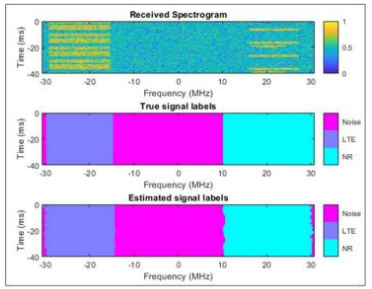


https://www.mdpi.com/2224-2708/10/4/72

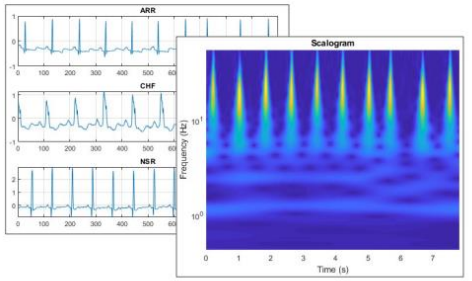
Download @ Journal of Sensors and Actuator Networks

Transfer Learning with models pre-trained on different types of data

- Spectrum Sensing with Deep Learning to Identify 5G and LTE Signals
- Network: ResNet-50 (Image segmentation)
- Input: 256-by-256-by-3 images
- Features: `spectrogram` of baseband waveforms



- Classify Time Series Using Wavelet Analysis and Deep Learning
- Network: GoogLeNet (Image object classification)
- Input: 224-by-224-by-3 images
- Features: `cwt` (scalogram) of ECG signals



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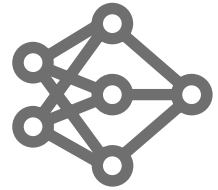

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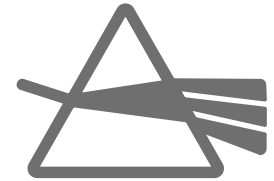
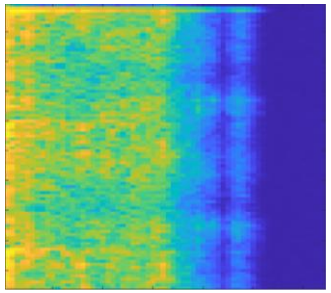
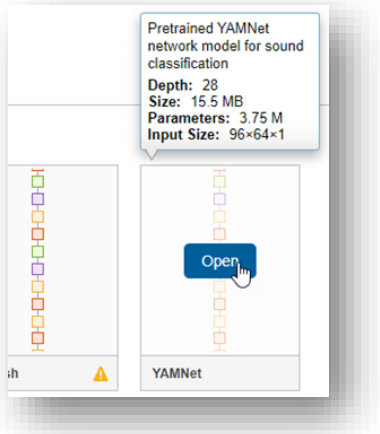
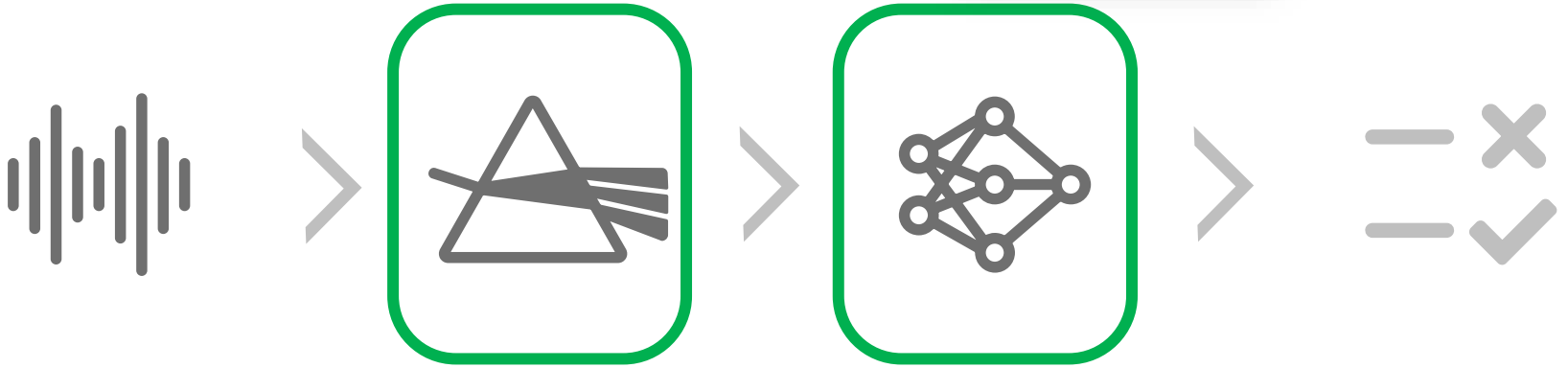


3. 更优的信号数据集，真实或生成的

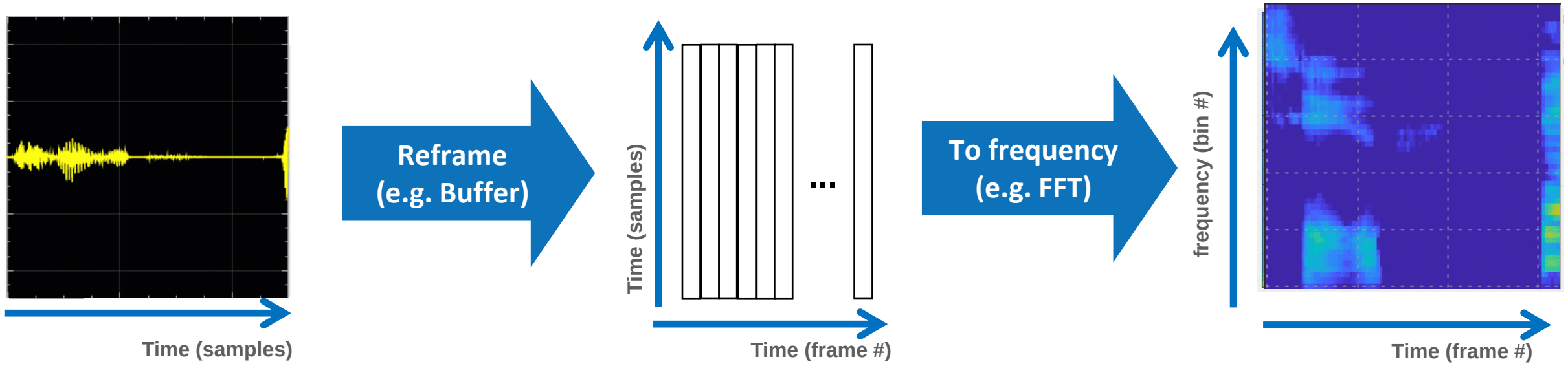
深度学习通常不直接从原始信号中学习





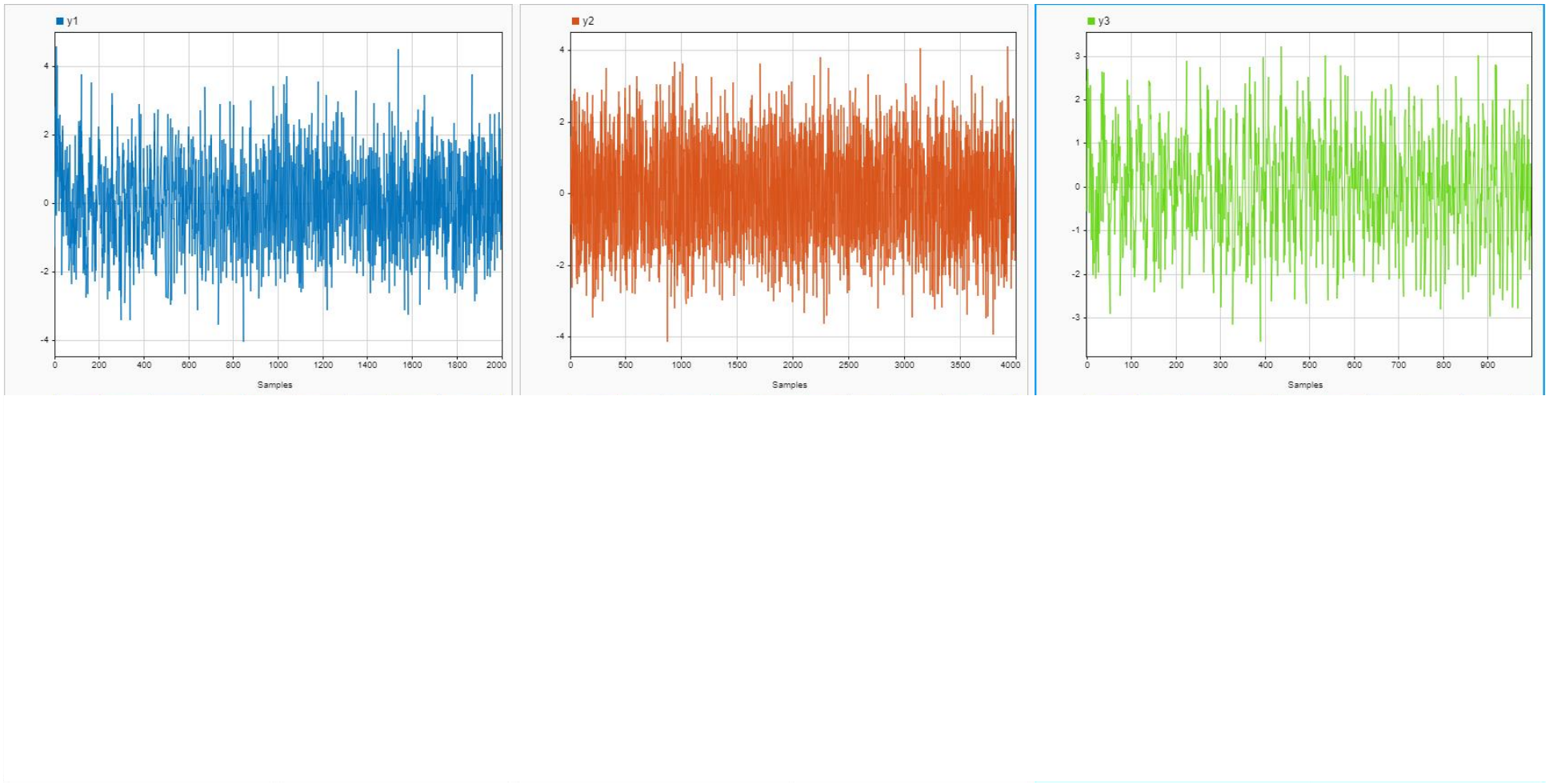


时频变换是非常受欢迎的特征提取方法



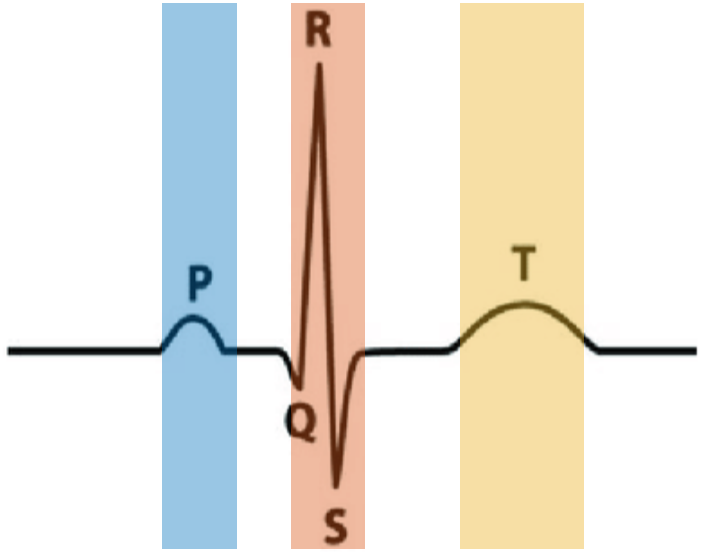
时频变换使信号特征更显著

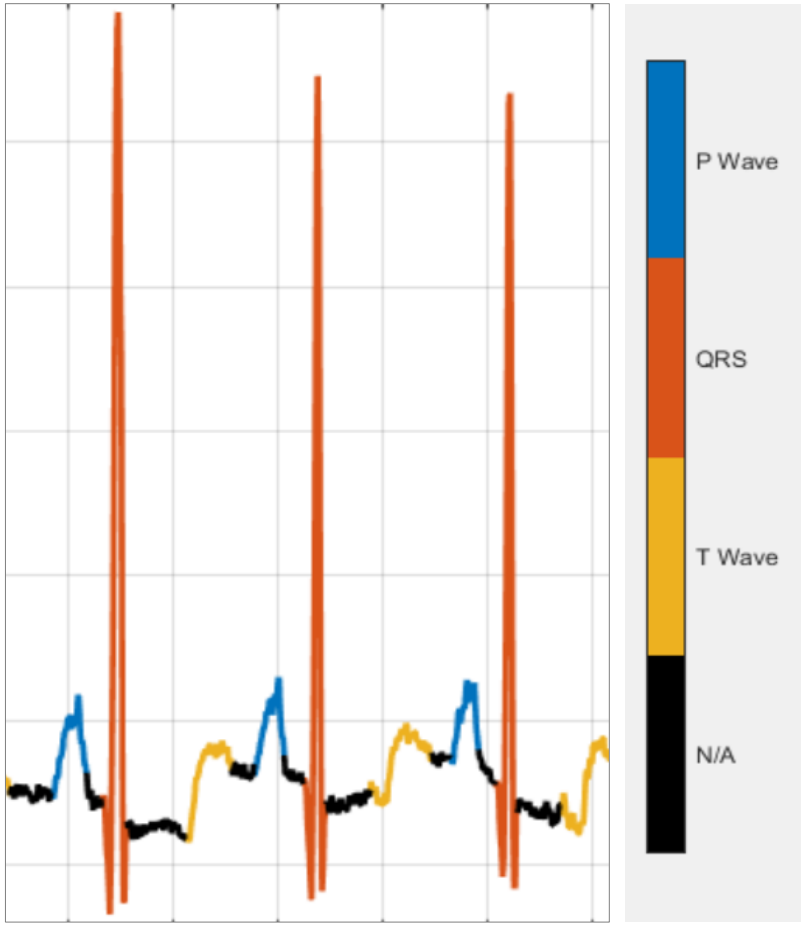
Time-frequency transform



如何使用特征提取实现ECG信号分割?

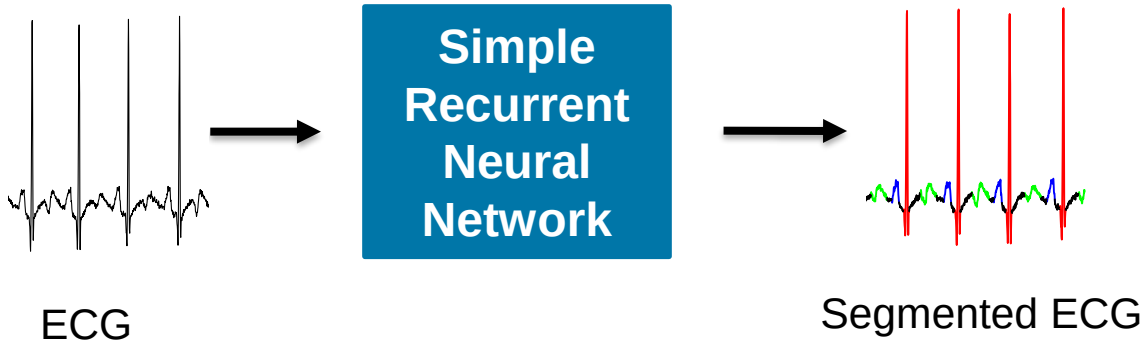
- Have dataset with signals labeled by cardiologists
- 3 types of wave events
- 210 ECG recordings (total ~15 minutes)

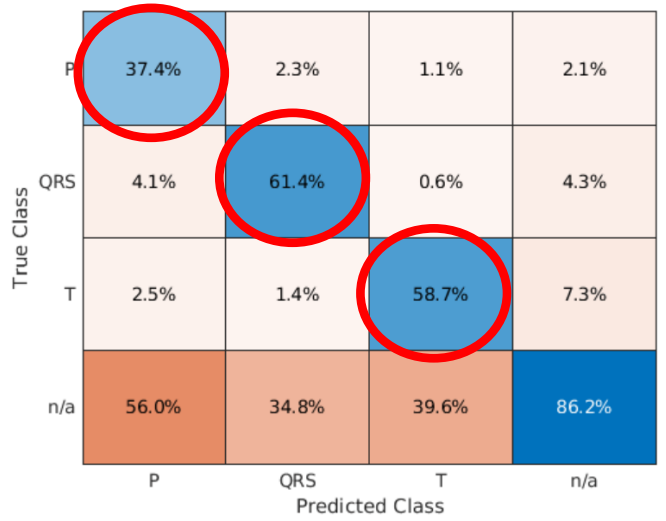


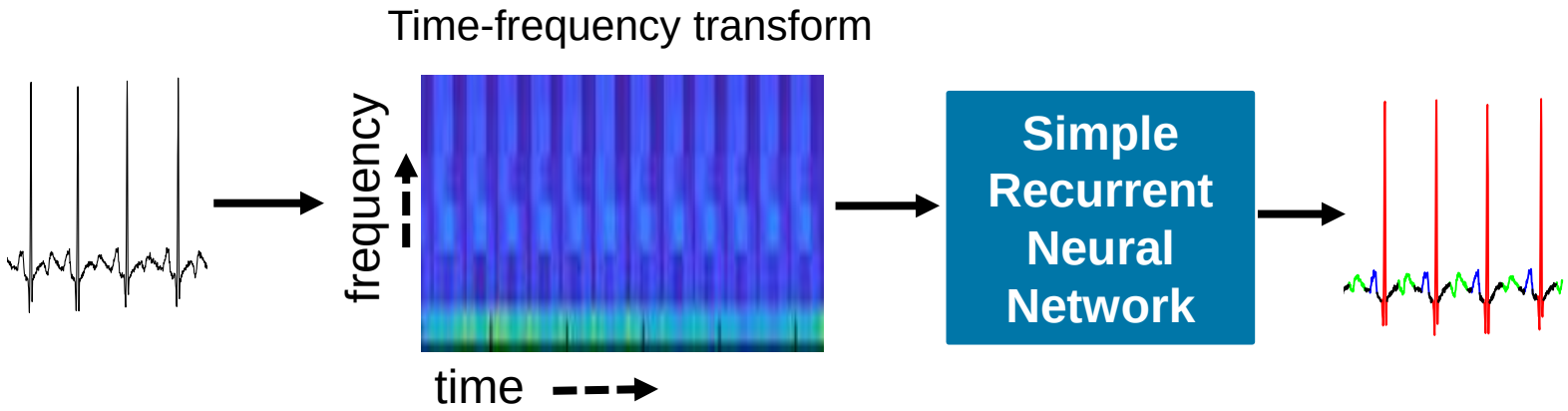


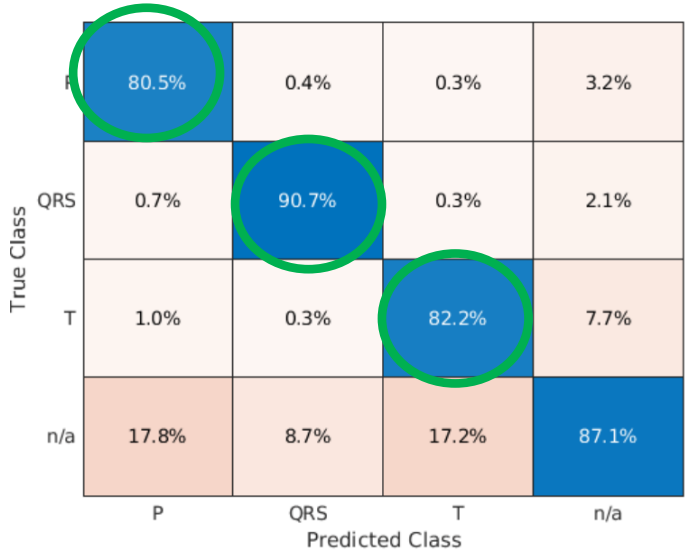
Example: Waveform Segmentation Using Deep Learning

特征提取使得我们可以从简单AI模型中获取高准确率

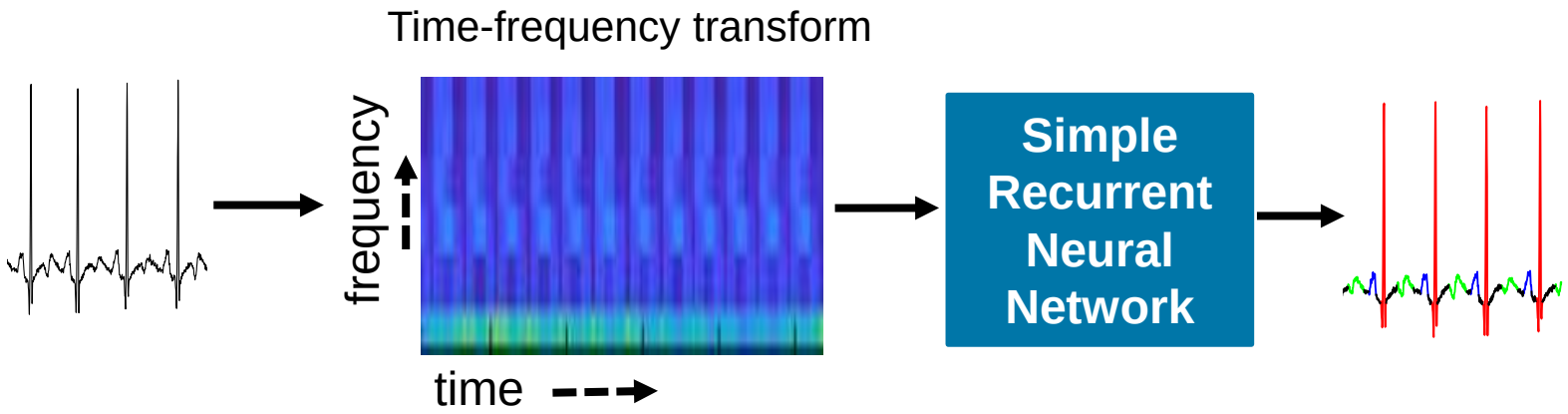


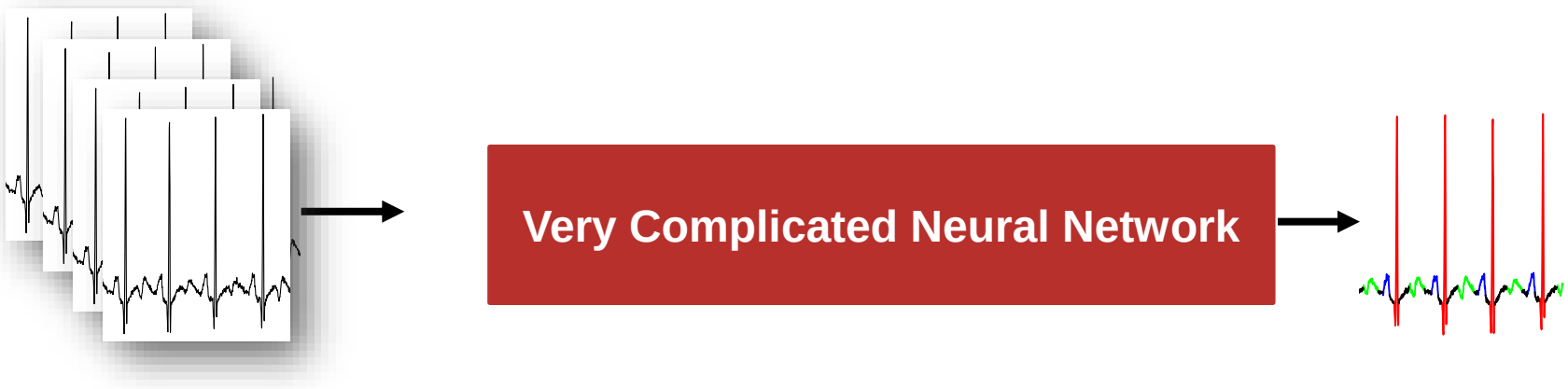


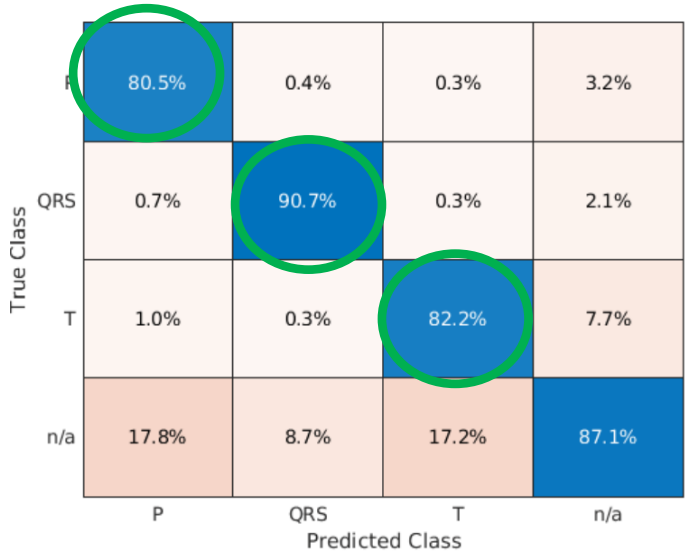




特征提取降低模型和数据复杂度

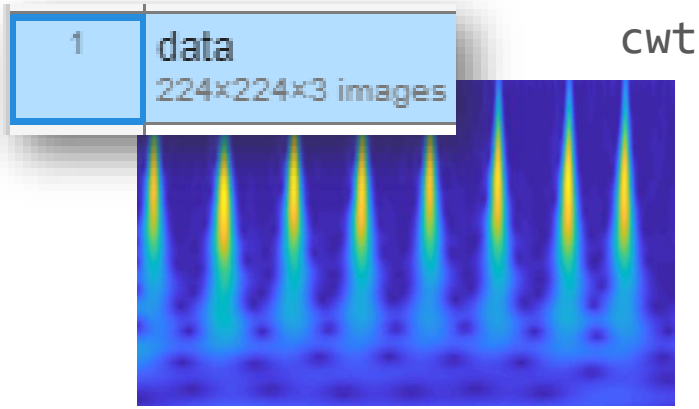






由领域专家选择特征提取算法

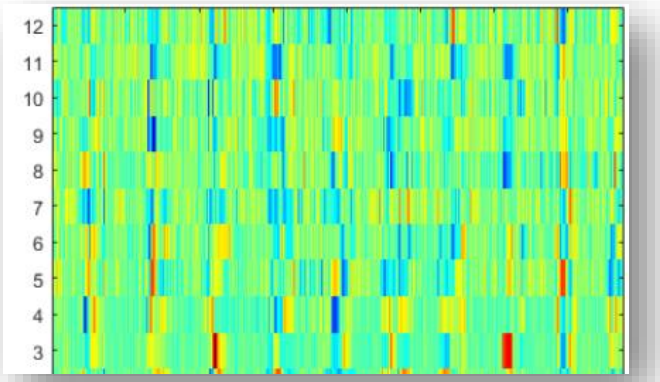
Model size, signal patterns



cwt

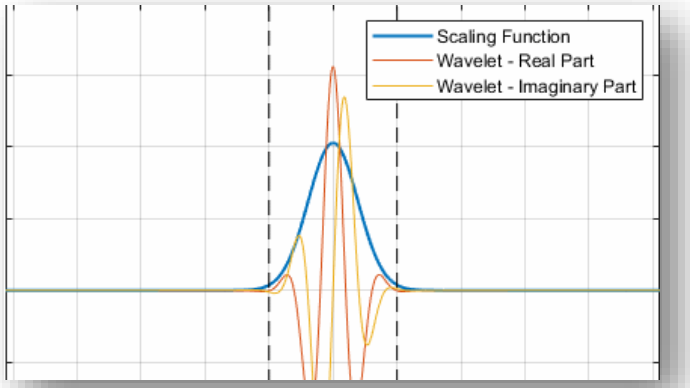
Application and signal type

mfcc



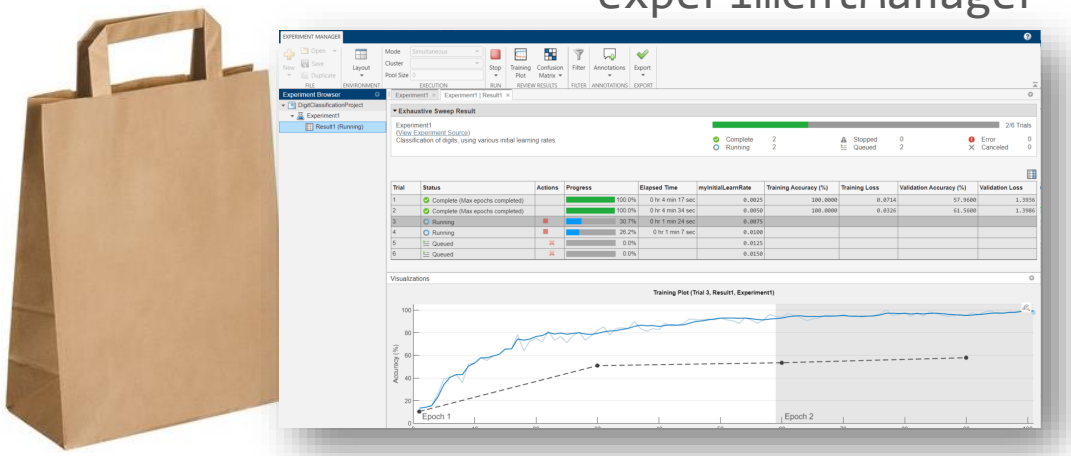
Automated methodology

waveletScattering



Test-based experiments

experimentManager



signalFrequencyFeatureExtractor

特征提取 – 参考资料

MathWorks Wins Geoscience AI GPU Hackathon

The following post is from Akhilesh Mishra, Mil Shastri and Samvith V. Rao from MathWorks here to talk about their participation and in a Geoscience hackathon. Akhilesh and Mil are Applications Engineers and Samvith is the Industry Marketing Manager supporting the Oil and Gas industry.

Background

SEAM (SEG Advanced Modeling Corp.) is a petroleum geoscience industry body that fosters collaborations among industry, government, and academia to address major Geological challenges. Their latest event was a hackathon (SEAM AI Applied Geoscience GPU Hackathon) that sought to explore the use of AI to improve both qualitative and quantitative interpretation of geophysical images of Earth's interior, and speed up the applications using NVIDIA GPUs.

A total of 7 teams participated from all over the world, including commercial companies (Chevron, Total, Petrobras) and a mix of industry and university students. Each team was assigned a mentor who is an expert geoscientist working for a top oil and gas company.

The Challenge

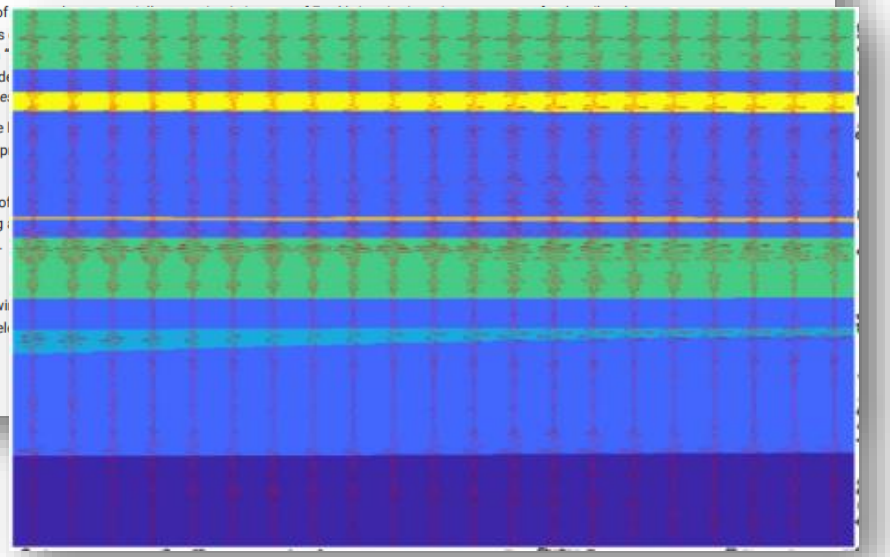
Geologic interpretation of
industry. Seismic images
summarized by the term "
and abandonment of und
often called *seismic facie*

This process is still done
display. Successful interp
features.

The problem statement o
automatically, producing
up human interpretation.

The Data

We were given the followi
public and has been label



[MathWorks Deep Learning Blog Post]

Daihatsu Uses AI to Classify Engine Sounds

Challenge

Develop an AI solution that can judge the level of engine knocking sound, which only skilled workers could judge

Solution

Create classification models and easy-to-use interface with MATLAB, making it possible to examine features multiple times

Key Outcomes

- Performed knocking sound analysis with the same accuracy as skilled workers
- Increased AI expertise through MATLAB training
- Promoted visualization of AI and increased awareness of AI

Daihatsu used AI to identify knocking sounds from its engines.

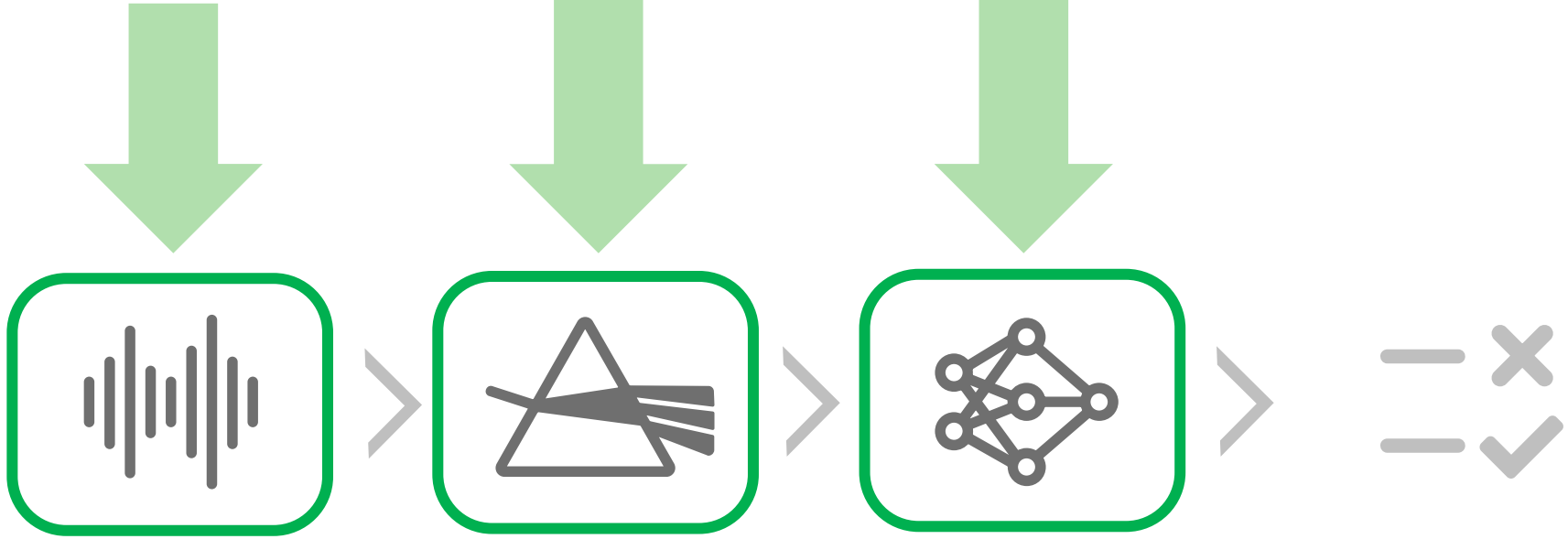
"Although we tried other programming languages, it was hard to implement. We decided to use MATLAB, which allows us to easily import the necessary data by dragging and dropping, and we could easily see the result by ourselves."
- Takuya Kumagae, Daihatsu Motor Co., Ltd.

Link to case study

[Daihatsu User Story]

需要使用更小的数据集会成倍增加数据工程的影响

- Using **transfer learning**…
- …or **feature extraction** with simple models…
- …leads to requiring **much smaller labeled datasets** for model training



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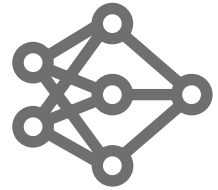

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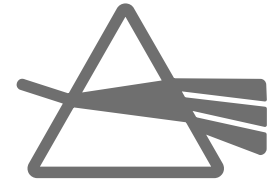
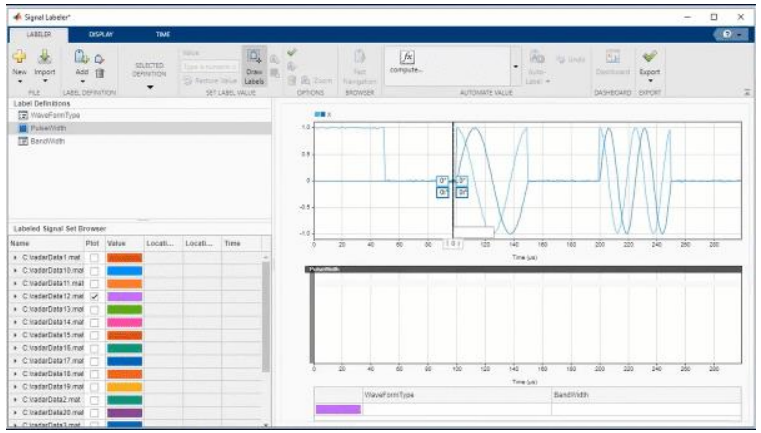


3. 更优的信号数据集，真实或生成的

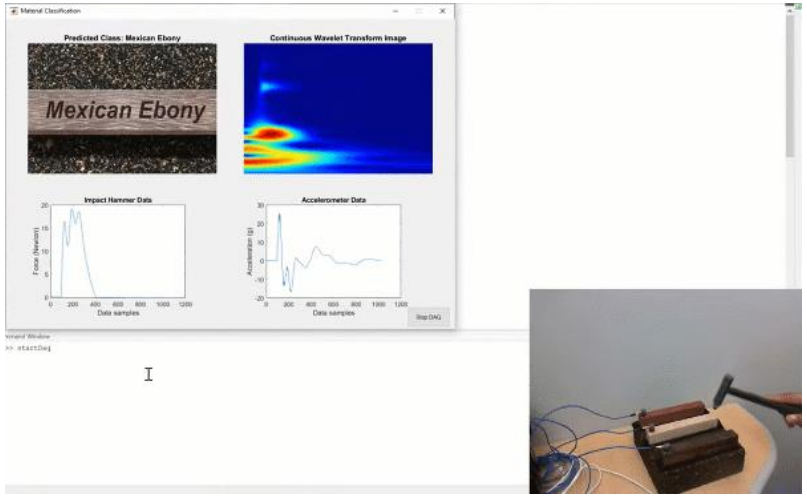
怎样提高训练信号数据的质量？

Define accurate data labels



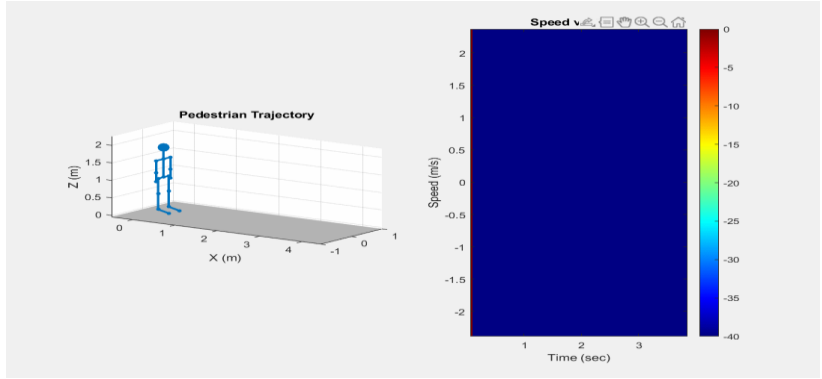
`signalLabeler`

Record and label new data via Apps and Hardware

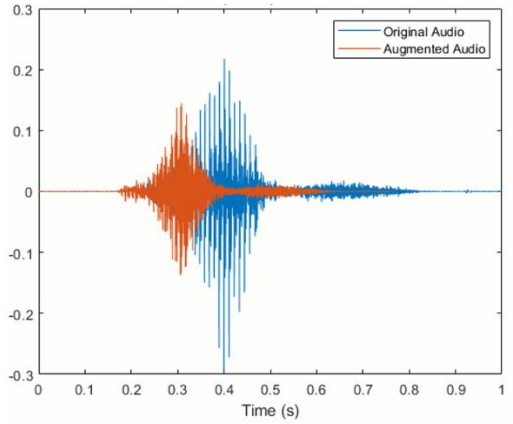


`App Designer`

Synthesize data via simulation



Augment data via signal processing



`audioDataAugmenter`

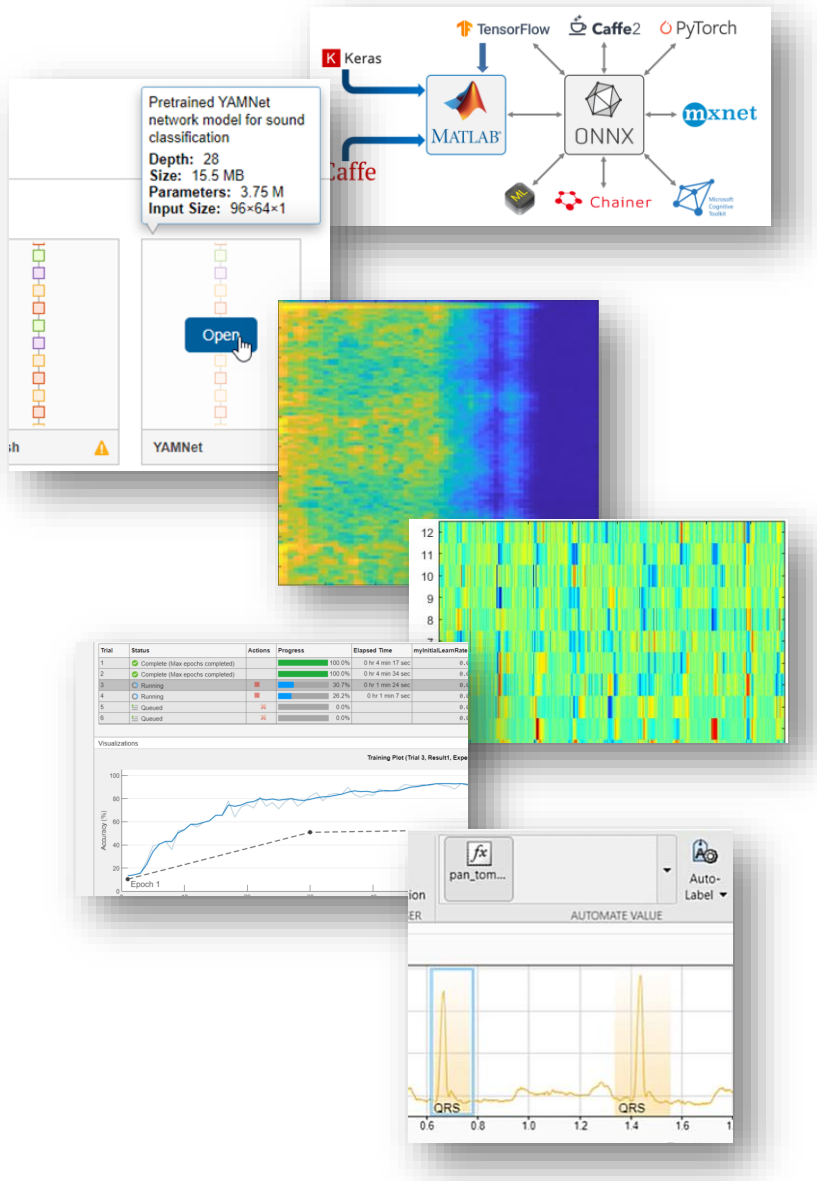
MATLAB EXPO 2022 Talk – Honeywell Technology Solutions

Automating Audio Labeling Workflow Using Pre-Trained Deep Learning Models for Voice Activity Detection

Track: **AI in Engineering**

以数据为中心的AI加速领域专家应用AI
“unbiggen AI” 效应

- ~~Model Complexity~~ » MATLAB
- ~~Data Complexity~~ » Signal Processing
- ~~AI Expertise~~ » Domain Expertise



AI ~~vs.~~ Signal Processing

MATLAB EXPO

谢谢