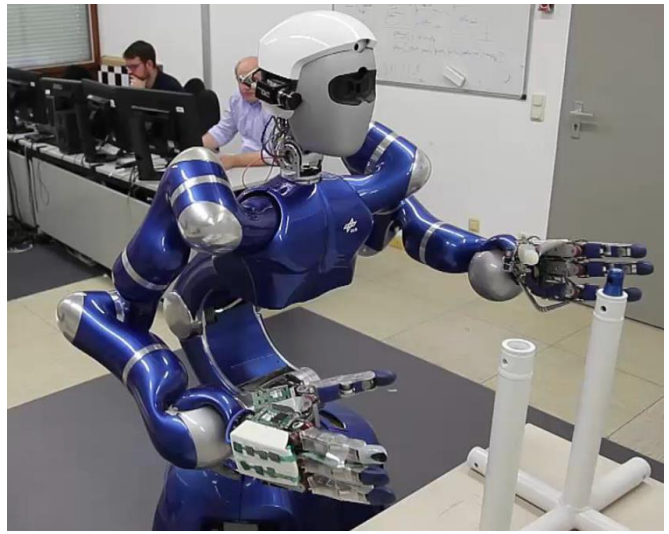

MATLAB EXPO 2018
KOREA

# MATLAB EXPO 2018

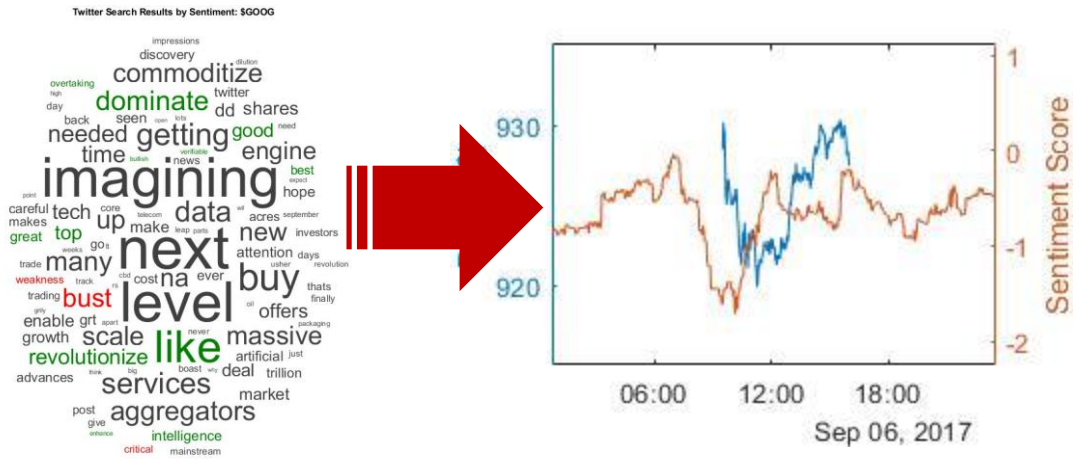
## 복잡한 문제를 단순하게 만드는 MATLAB 환경에서의 머신러닝(중급)

김종남
Application Engineer

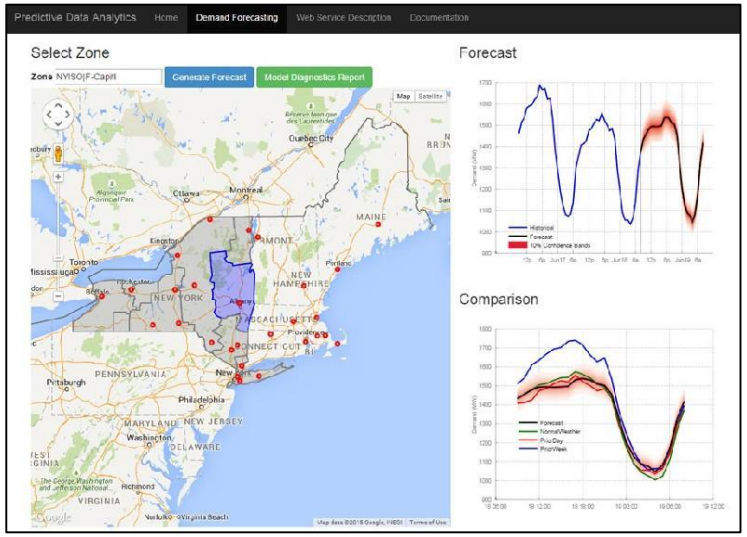
# Machine Learning has driven Innovation



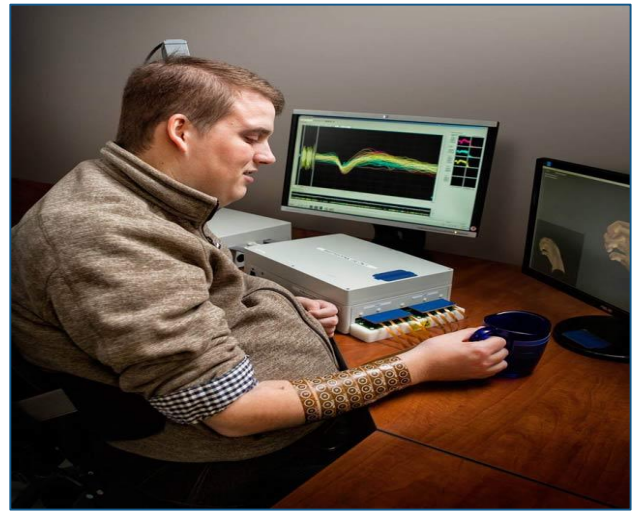
Robots mimic complex human behaviors




Sentiment Analysis in Finance




Electric Grid Load Forecasting



Restore Arm Control for Quadriplegic

# Outline

Machine Learning workflow and its challenges

Overview of Types of Machine Learning

Developing a Heart Sound Classifier

Applying Deep Learning

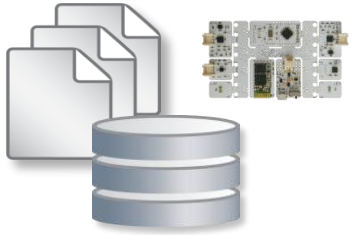
Key takeaways

- Cover complete workflow (exploration to deployment)
- Make machine learning easy
- Support for Deep Learning

# Challenges in Developing Machine Learning Applications

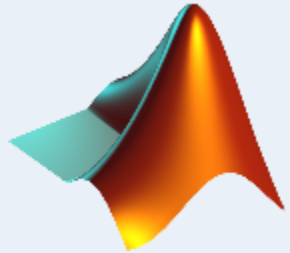
1. Access Data

*Sensors*
*Various Protocols*



2. Explore and Pre-Process

*Diverse data*
*Clean messy data*
*Discover patterns*



3. Feature Extraction

*Domain Knowledge*
*Select Features*

4. Build Models

*Many Algorithms*
*Tune Parameters*

5. Deploy

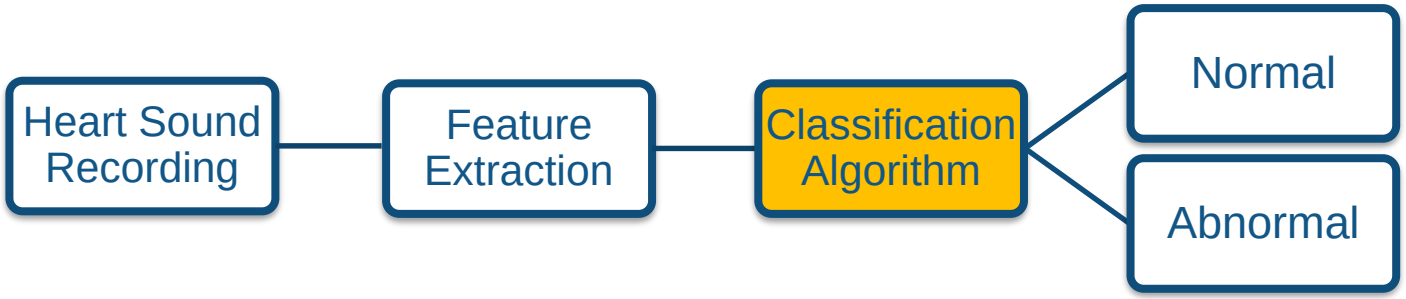
*Different platforms*
*Size/Speed*

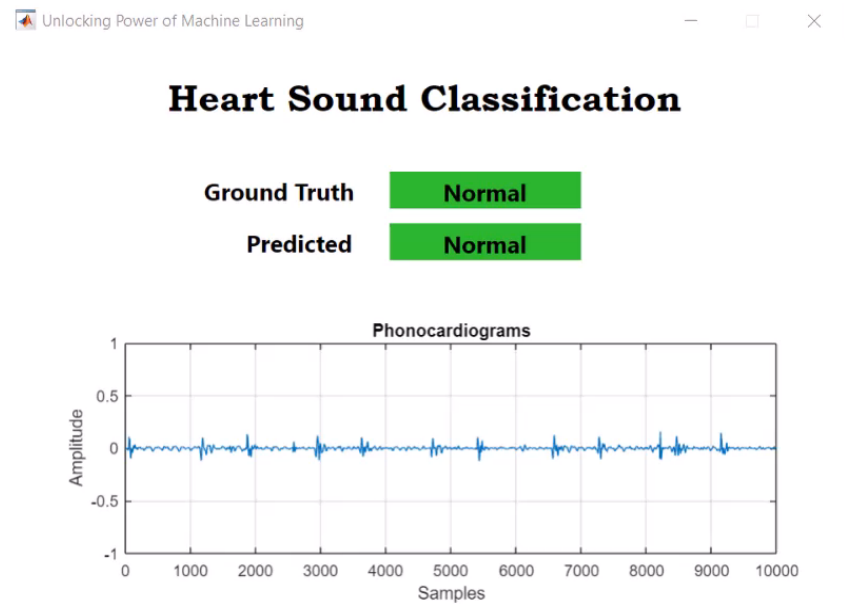
# Case Study: Heart Sound Classifier

## Motivation

- Heart sounds require trained clinicians for diagnosis

**Goal**: build a classifier and deploy in portable device

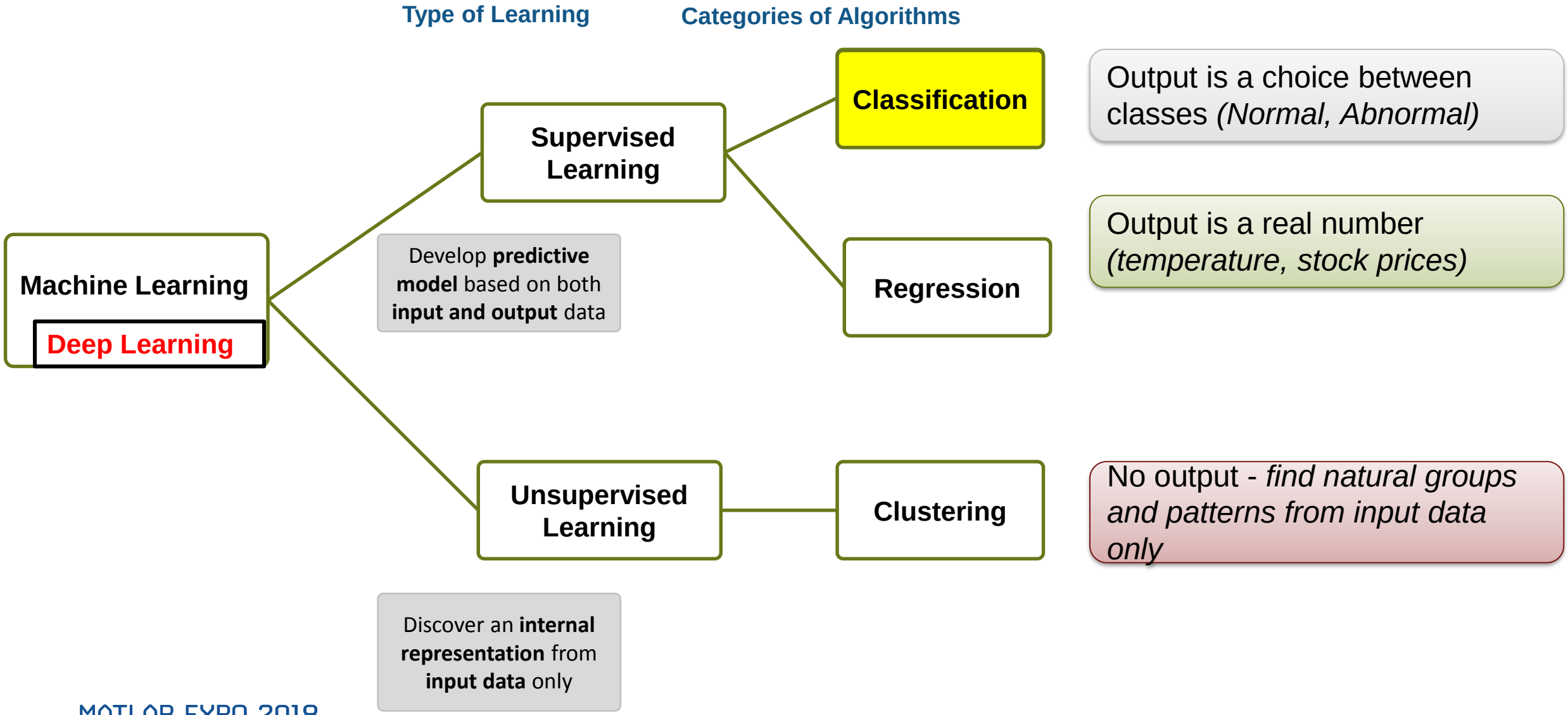



**Data:** Heart sound recordings (phonocardiogram):

- From PhysioNet Challenge 2016
- 5 to 120 seconds long audio recordings

# Different Types of Learning



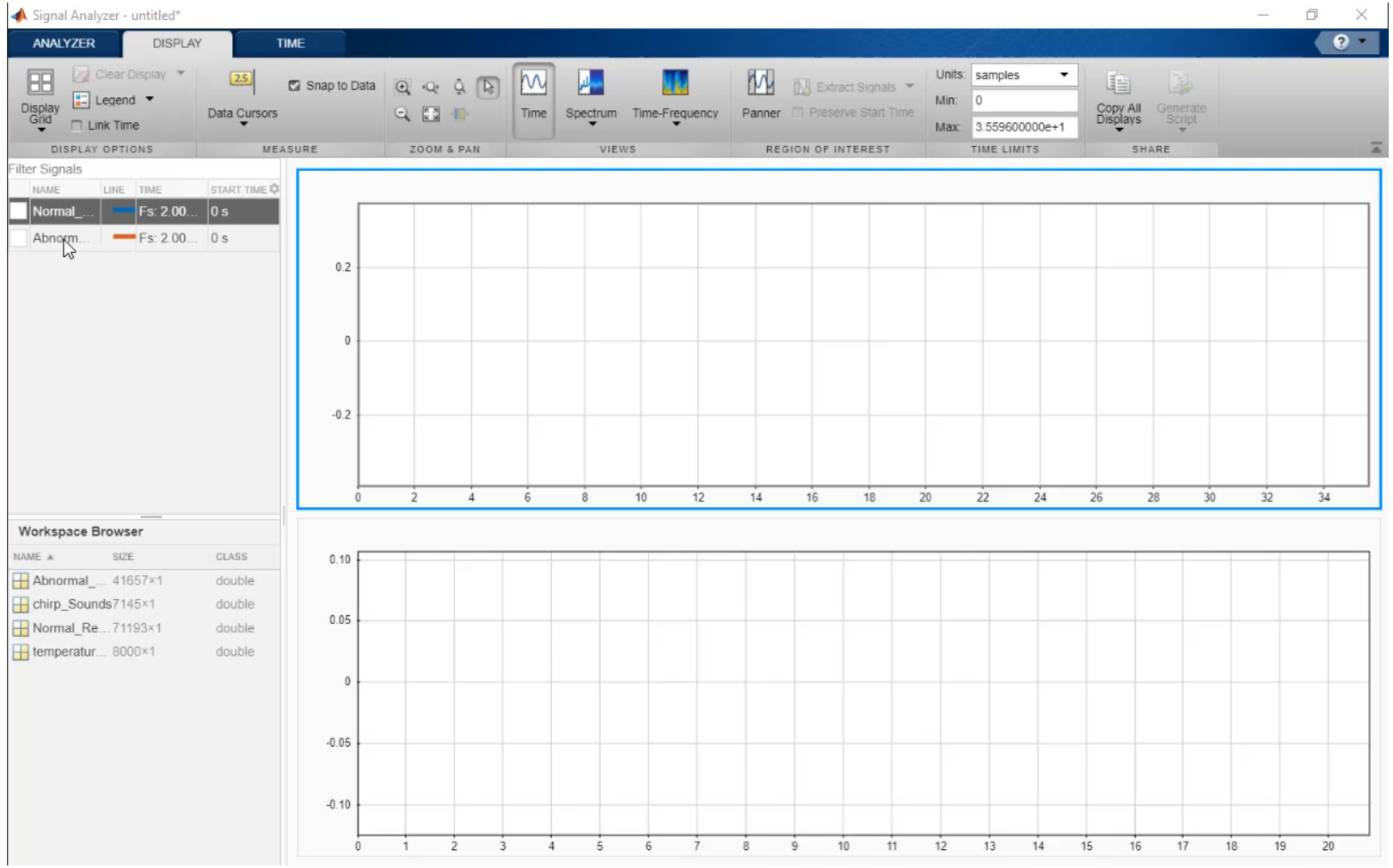
# Step 1: Access & Explore Data

Challenges:

- Different sampling rates
- Signal Management
- Large datasets (“big data”)

Easy Exploration of Data

- Time domain
- Frequency domain
- Time-Frequency domain




*Signal Analyzer: Visual Data Exploration*

R2018a

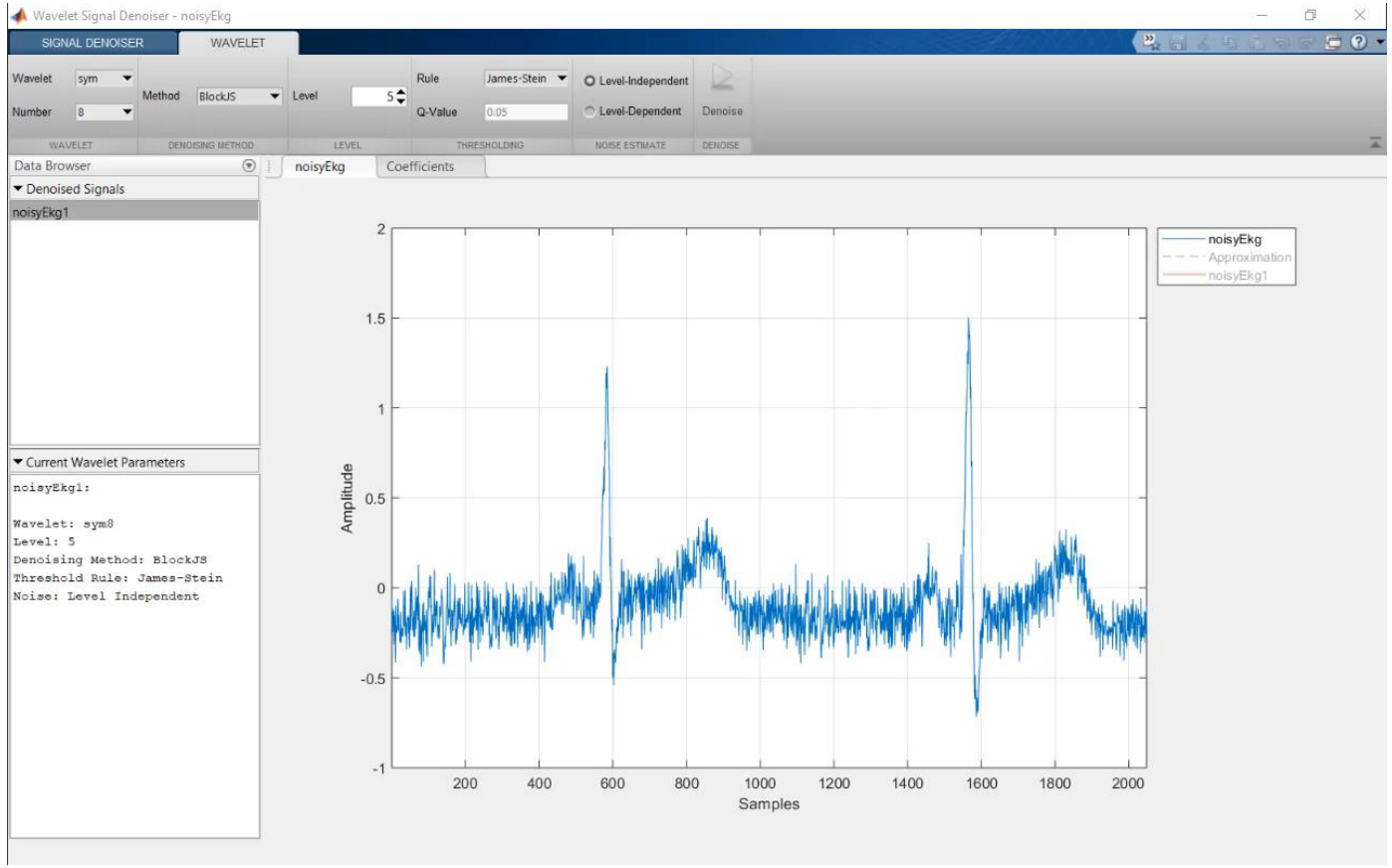
# Step 2: Pre-process Signals

Challenges

- Preserving sharp features
- Overlap of signal and noise spectra

Automatic Denoising

Generate MATLAB code




*Signal Pre-processing without writing any code*

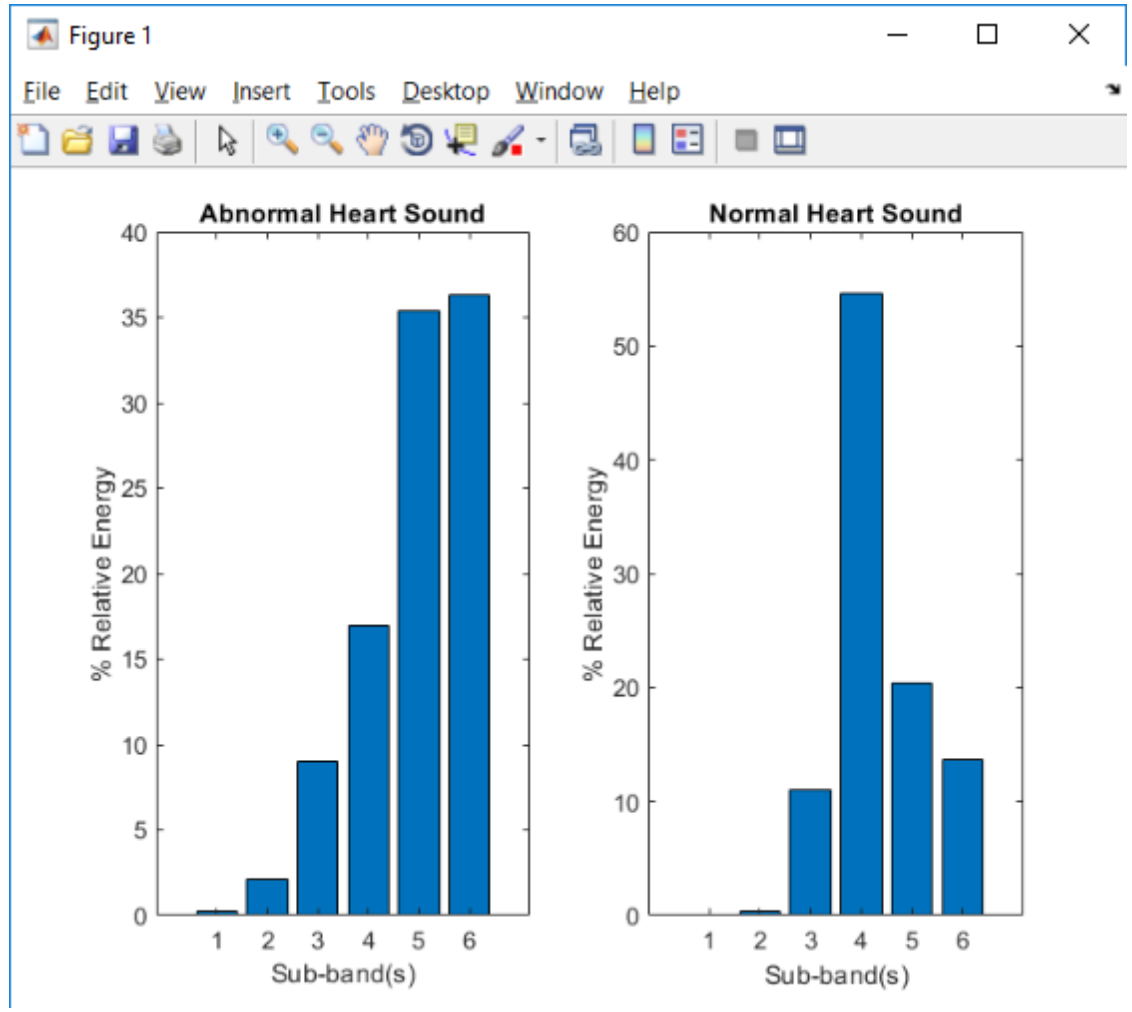
# Step 3: Extract Features

## Challenges

- Find features for non-stationary signals
- Features occurring at different scales
- Feature selection

## Spectral features:

- Mel-Frequency Cepstral Coefficients
- Octave band decomposition with Wavelets



# Step 4: Train Models

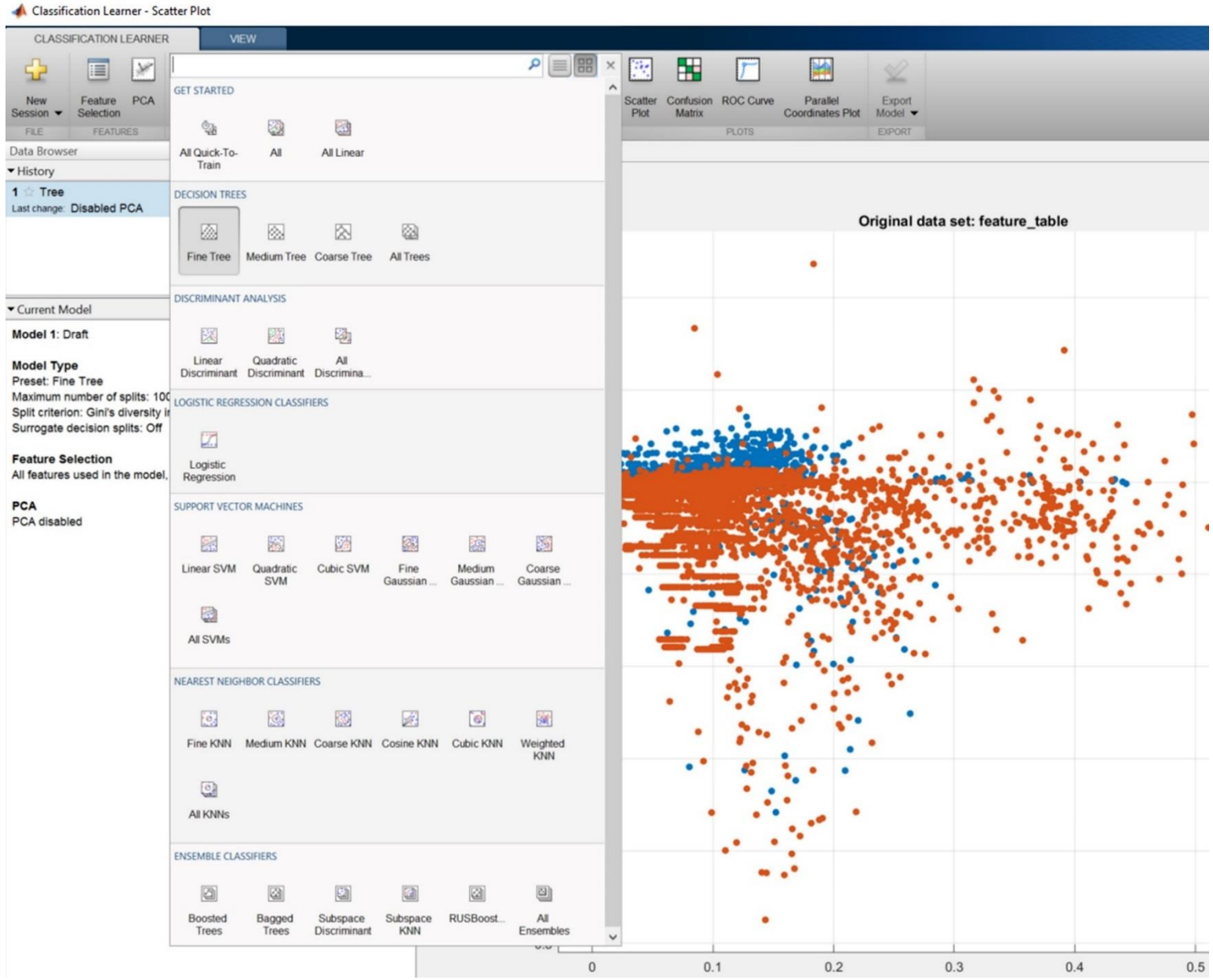
Challenges:

- Knowledge of machine learning algorithms
- Scale to large data sets

Quickly train model in App

- Define crossvalidation
- Try all popular algorithms
- Analyze performance: 93% on test data

Scale to large data sets without recoding: “Tall” arrays




*Model Training with Classification Learner*

# Step 4 Cont'd: Optimize Model

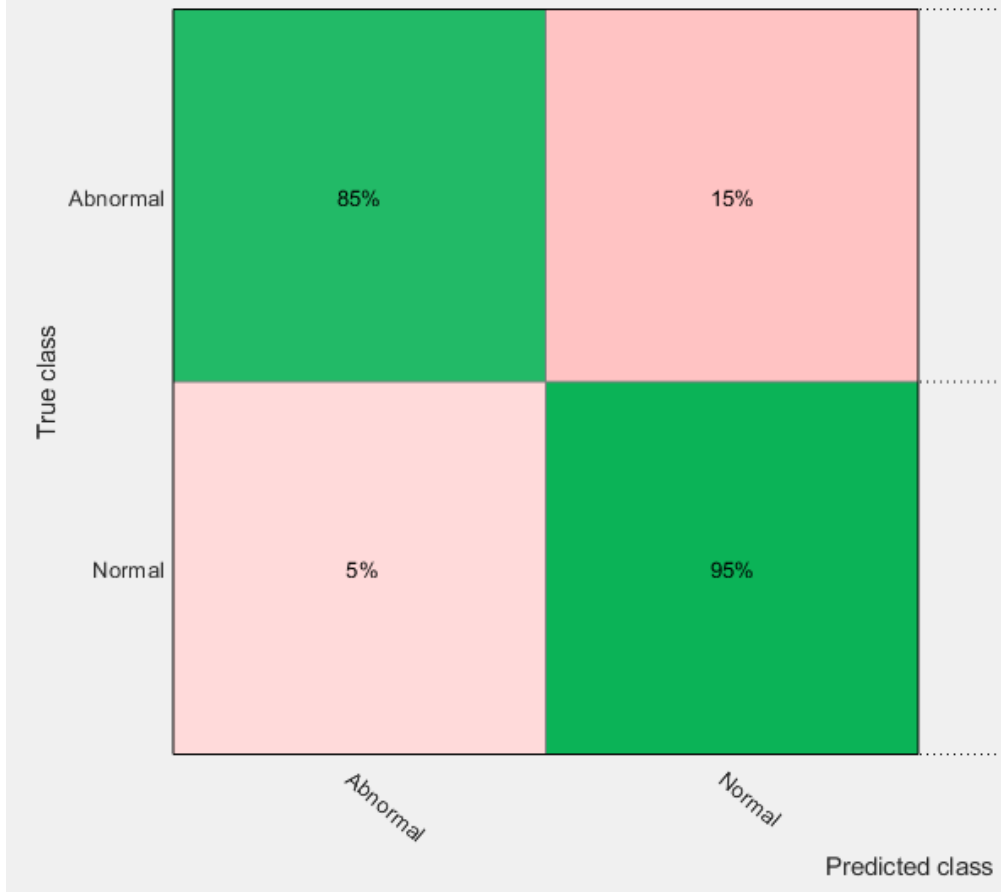
Challenges:

- Manual parameter tuning tedious
- Identify additional improvements

Iterative Model Optimization

- Bayesian Optimization of parameters
- Visually analyze performance
- Adjust for imbalances (data or severity of misclassifications)

| Class | Distribution |
|---|---|
| Normal | 75% |
| Abnormal | 25% |



# Step 5: Deploy

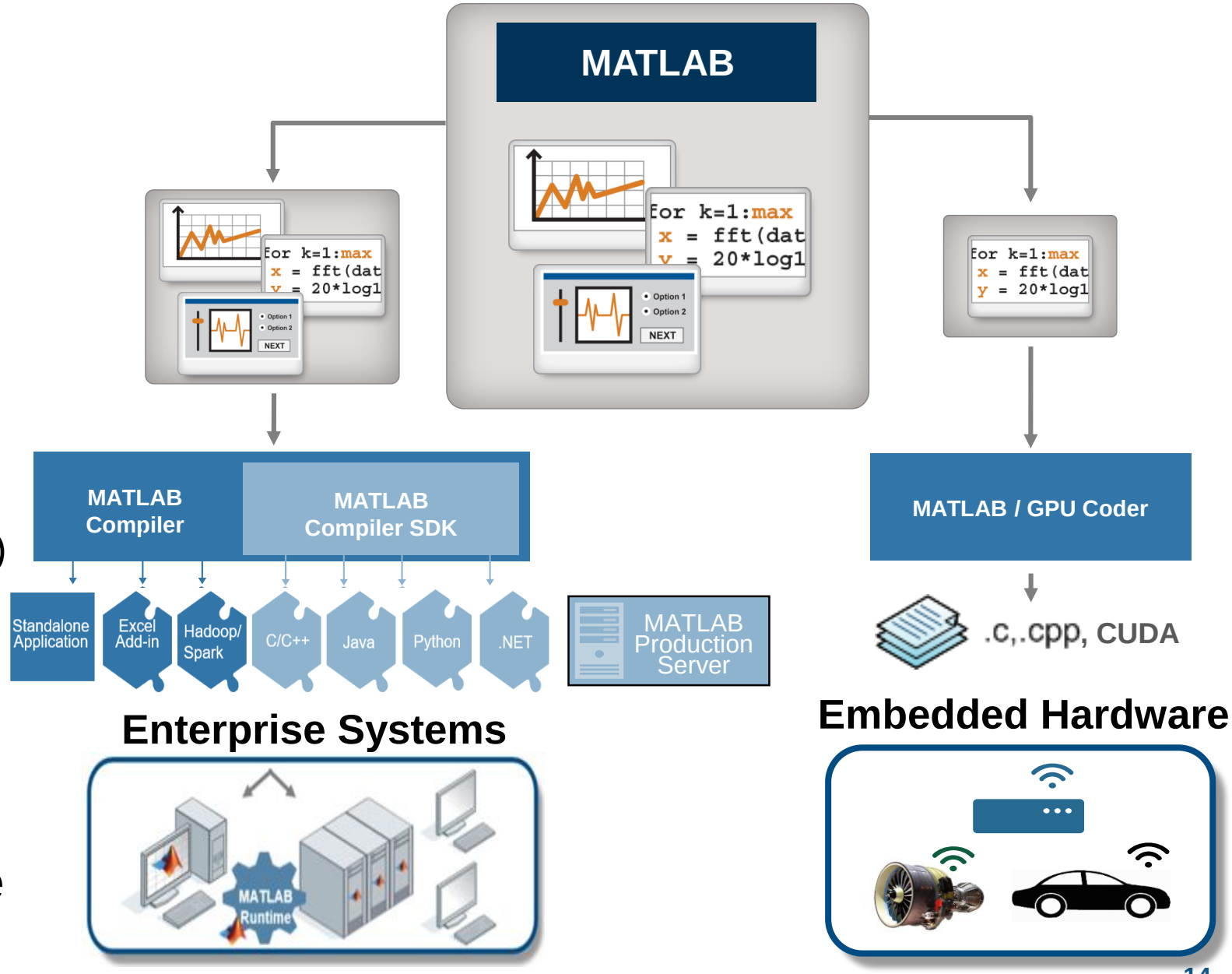
Challenges:

- Different target platforms
- Hardware requirements (Size, Speed, Fixed point, etc)

Deployment options:

- Generate Code (C, HDL, PLC) for Embedded System
- Compile MATLAB, scale using MPS for Enterprise systems

Apply automated feature selection to reduce model size

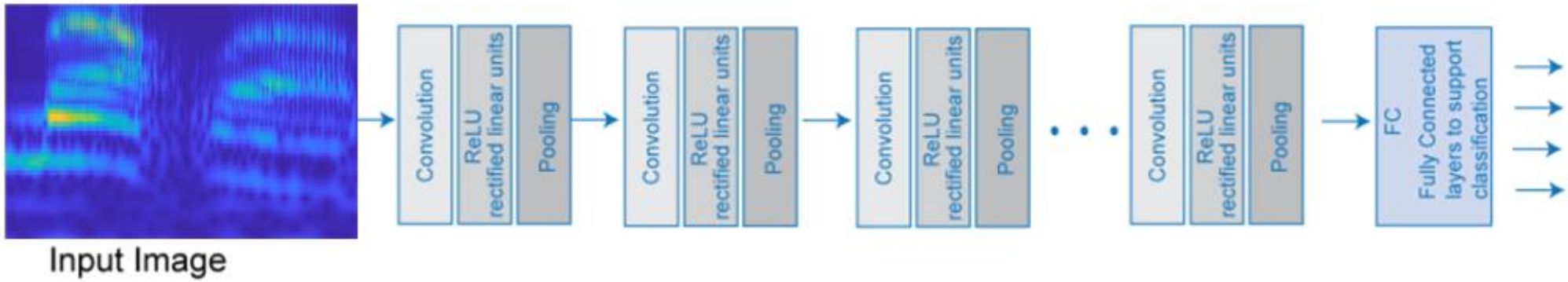


# Deep Learning on Signals

## Supervised Classification using Neural Nets with many layers

## 1. Convolutional Neural Networks (CNN)

- A versatile and flexible approach for Deep Learning
- Apply to signals by converting to time-frequency representation:




## 2. Long short-term memory networks (LSTM)

# Apply Deep Learning to Heart Sound Classifier

## Steps

- Signal ➔ Time-Frequency
- Continuous Wavelet Transform
- Transfer Learning with GoogleNet

## Results

- Achieves 90% accuracy
- Just 10 lines of code

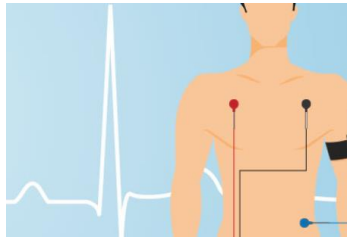

*Deep Learning Training*

R2017b

# Recap: Making Machine Learning Easier

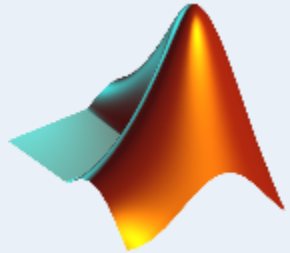
1. Access Data

*Support for industrial sensors, phones, etc.*



2. Explore and Pre-Process

*Visual Exploration*



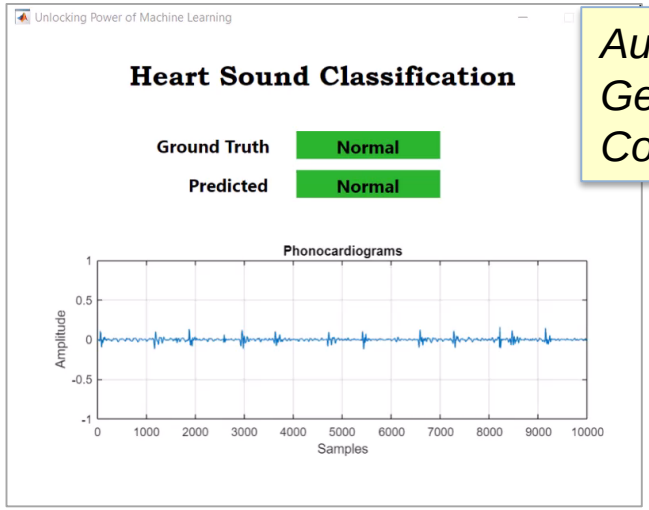
3. Feature Extraction

*Wavelets*
*Feature Selection*

4. Build Models

*Quickly compare models in App*
*Automatically tune parameters*
*Explore Deep Learning*

5. Deploy




*Automatically Generate C/CUDA Code*

# Key takeaways

Empower engineers to be productive in data science!

- Cover complete workflow (exploration to deployment)
- Make machine learning easy
- Support for Deep Learning

# Learn More

Complete user story for Battelle's "NeuroLife" system

Download Heart Sounds Classification application from File Exchange

Watch "Machine Learning Using Heart Sound Classification"

Read:

- Machine Learning with MATLAB
- What is Deep Learning?