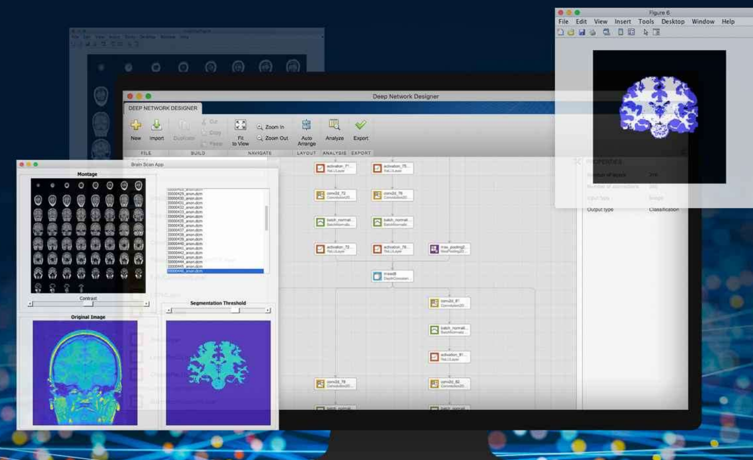


Lowering Barriers to AI Adoption with AutoML and Interpretability

Bernhard Suhm
Product Marketing – Machine Learning

AI adoption is hitting barriers

Not explainable like traditional models

BlackRock shelves unexplainable AI liquidity models

Risk USA: Neural nets beat other models in tests, but results could not be explained

Unexpected bias

Card Investigated After Gender Discrimination Complaints

A prominent software developer said on Twitter that the credit card was "sexist" against women applying for credit.

Pushback against Automation

INSIGHTS | January 10, 2020

4 Barriers to Adopting Artificial Intelligence in Healthcare

Outline

Introduction

Optimized models with AutoML

Overcoming Blackbox with Interpretability

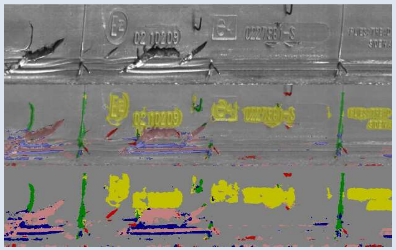
Examples:

- Human Activity Recognition
- ECG Classification

AutoML and Interpretability in Deep Learning

Addressing other Barriers

AI is used in many Industries

Automobile	Manufacturing	Communication & Operations	Energy & Finance
 Tire Wear BRIDGESTONE	 Overlay metrology improvement ASML	 Telecom customer churn prediction Cognizant	 Forecasting & Risk Analysis HORIZON WIND POWER
 Detect Oversteer BMW	 Monitor Deployed Compressors using Digital Twin Atlas Copco	 Building energy use optimization BuildingIQ	 Portfolio Allocation Aberdeen Asset management

What is AI?

Artificial Intelligence

The ability of a

Machine Learning

Apply statistical methods
explicit

Deep Learning

A type of machine learning that uses **Neural networks** with **many layers**

Deep Learning more accurate than humans on image classification

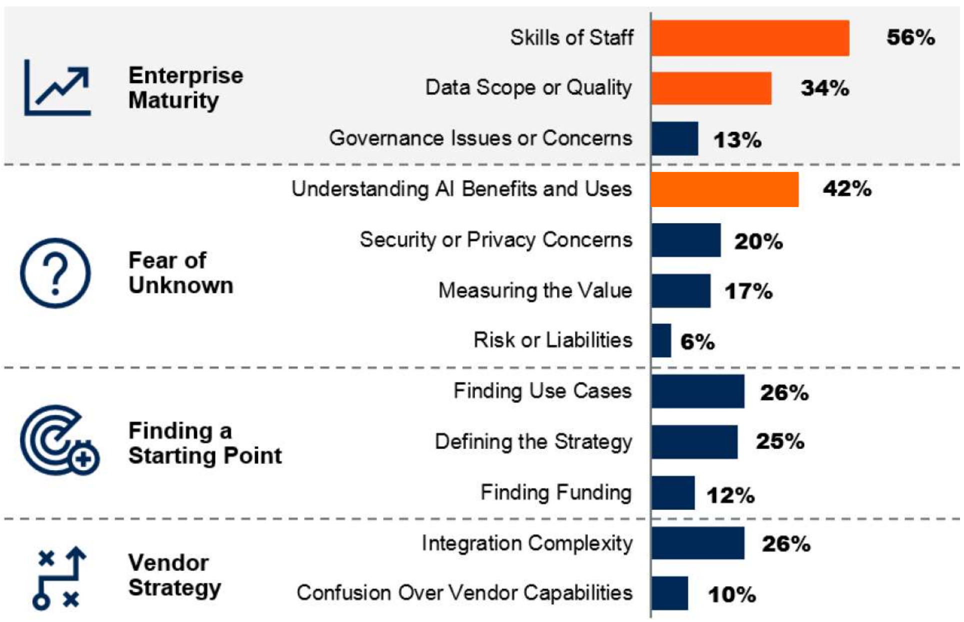
1950s

1980s

2015

Barriers to broader Adoption of AI

Top Challenges to adoption of AI and ML (Gartner Research)

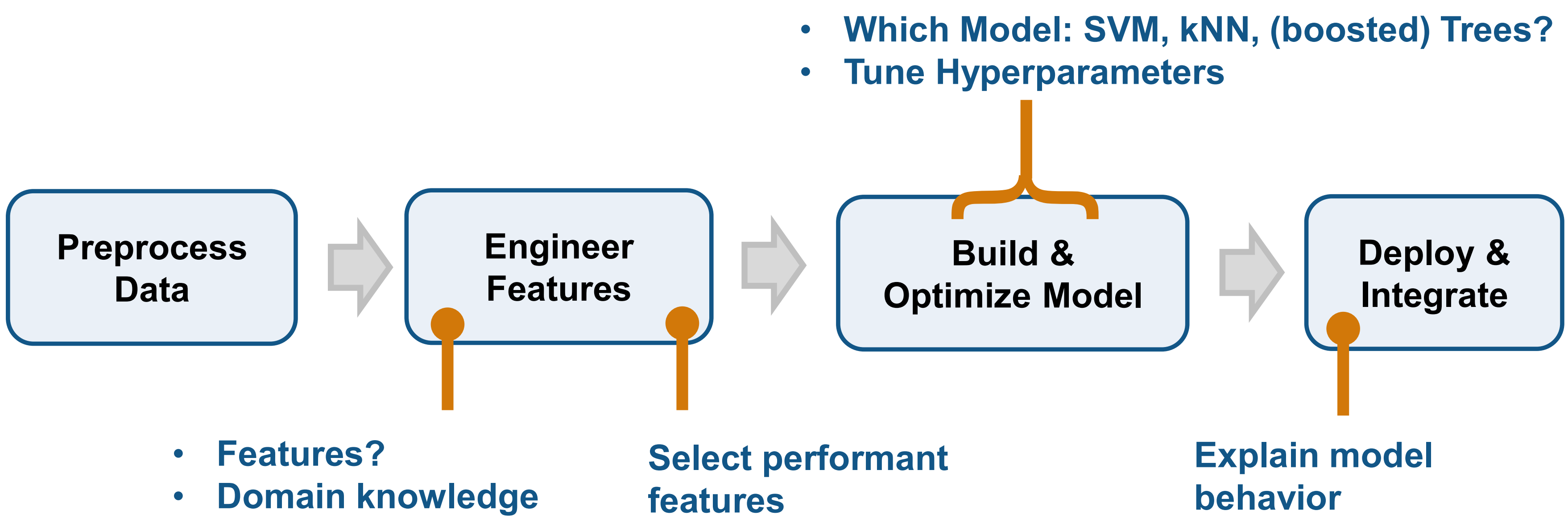


n = 106
Gartner Research Circle members, excluding “unsure”
Source: Gartner AI and ML Development Strategies Survey
Q: What are the top three challenges or barriers to the adoption of AI and ML within your organization?
Rank up to three.
ID: 390794
published 19 June 2019

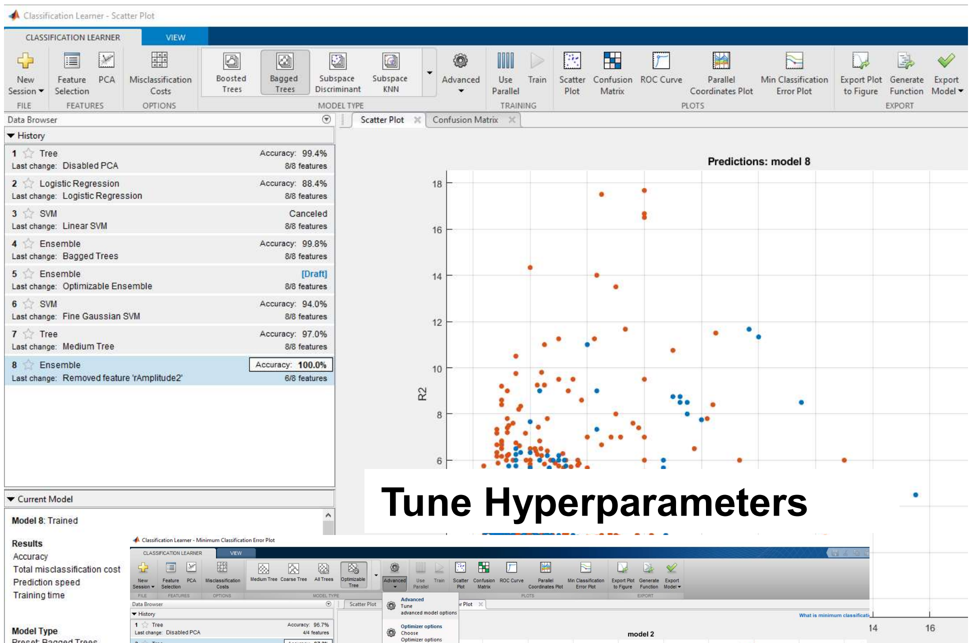
Top barriers to successful adoption of AI

1. Lack of AI skills
2. Black-box nature
3. Data

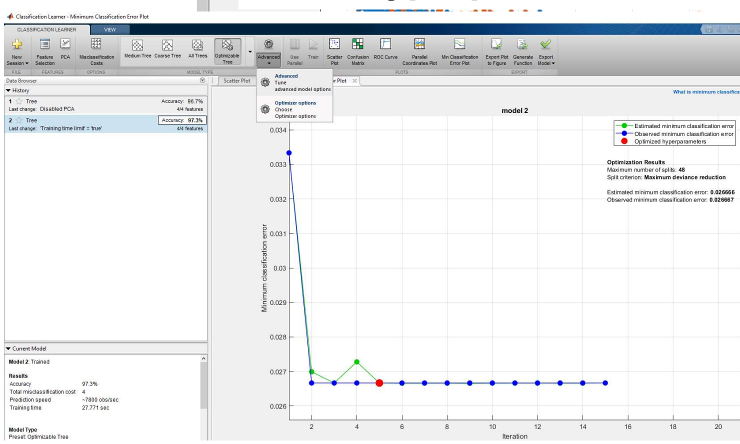
Challenges in the Machine Learning Workflow



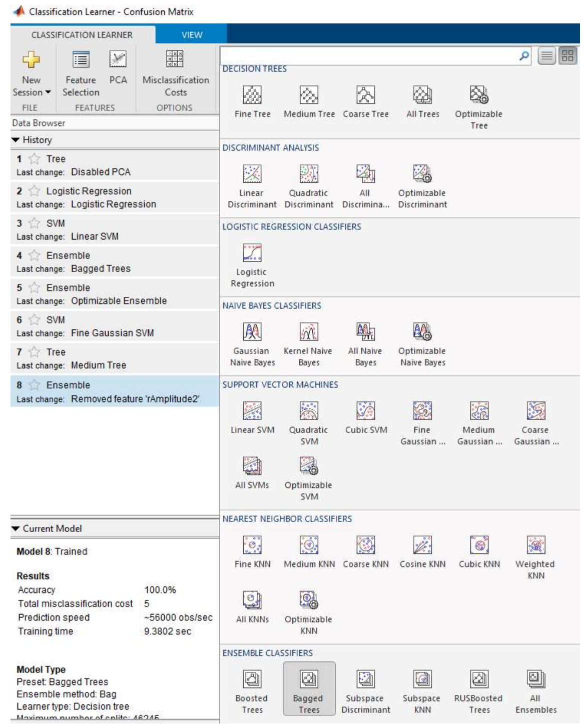
Build Models interactively

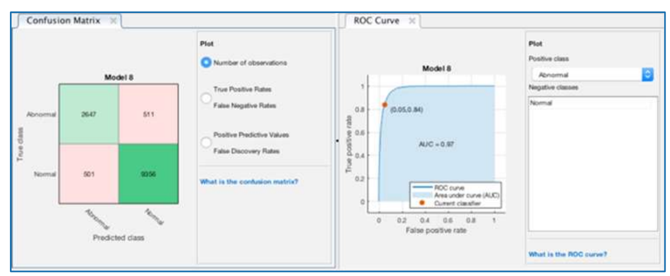


Tune Hyperparameters



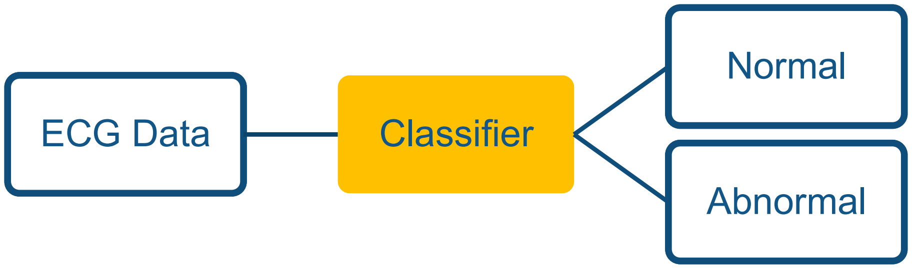
Chose among many popular models



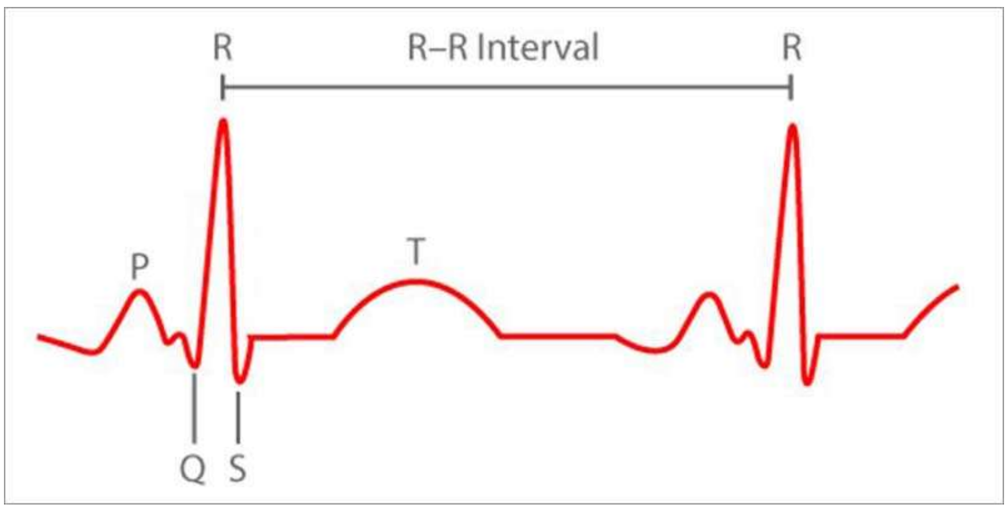


Evaluate Models using Confusion Matrix and ROC curve

Example: Classify Heart Condition from ECG data

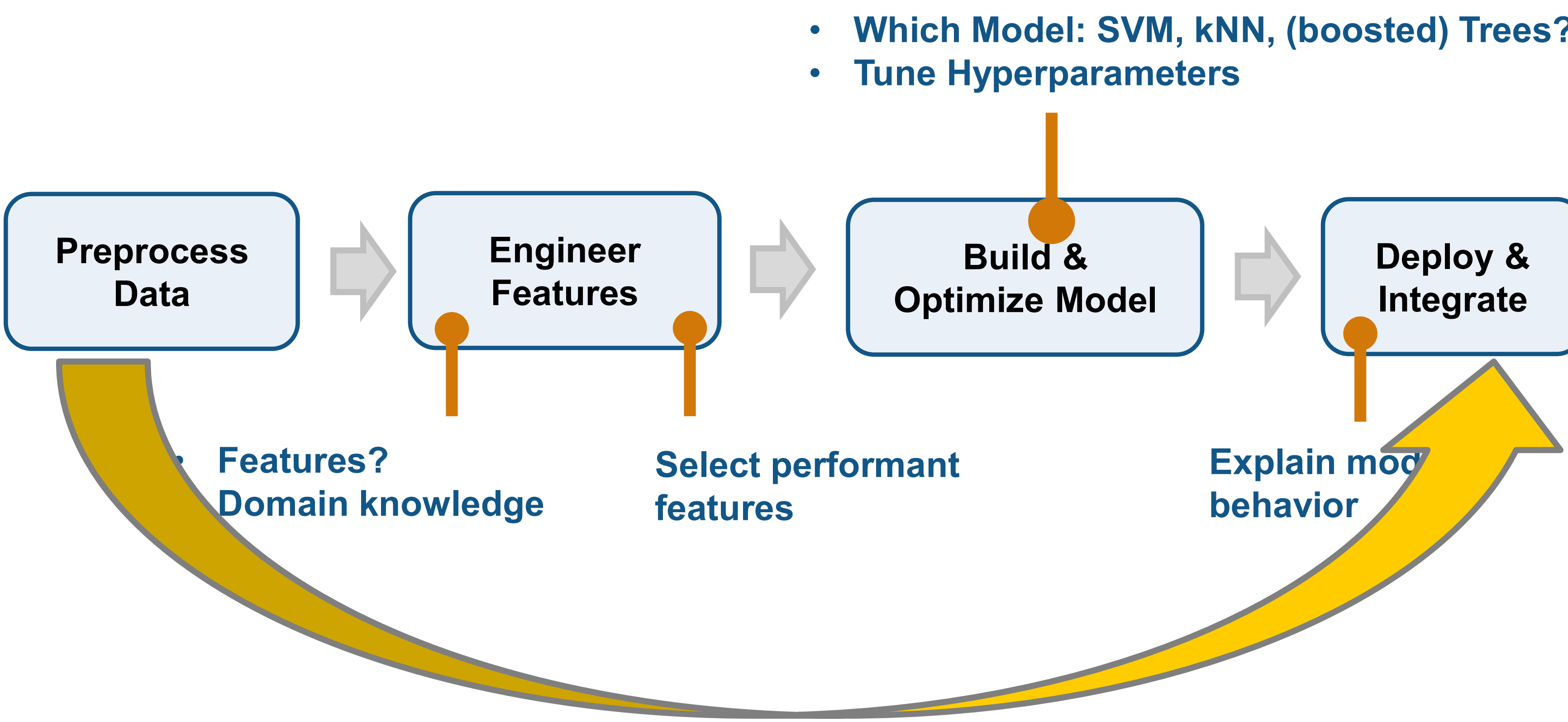


How ECG is characterized:



Dataset was curated for 2017 PhysioNet challenge: "normal" ECG data was obtained from the MIT-BIH Normal Sinus Rhythm database available at https://physionet.org/content/nsrdb/1.0.0/, and "abnormal" from MIT-BIH Arrythmia database at https://www.physionet.org/content/mitdb/1.0.0/

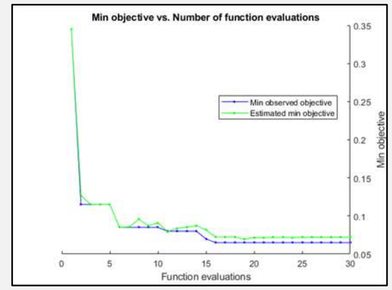
What is AutoML?



AutoML for Engineering Applications

3

Model Selection with Hyperparameter Optimization

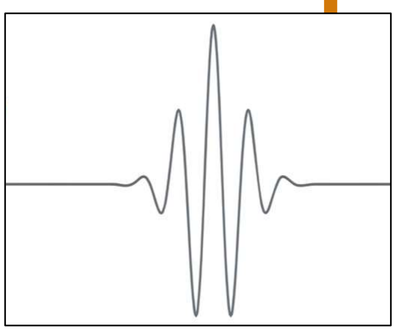


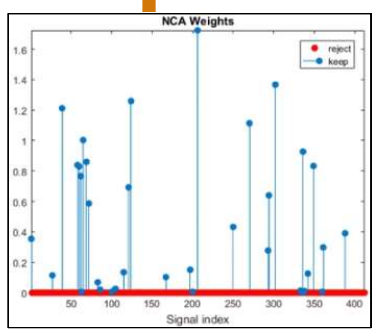
Decision Tree?
SVM?
KNN?
Ensemble?
…?

Preprocess Data → **Engineer Features** → **Build & Optimize Model** → **Deploy & Integrate**

1

Wavelet Scattering

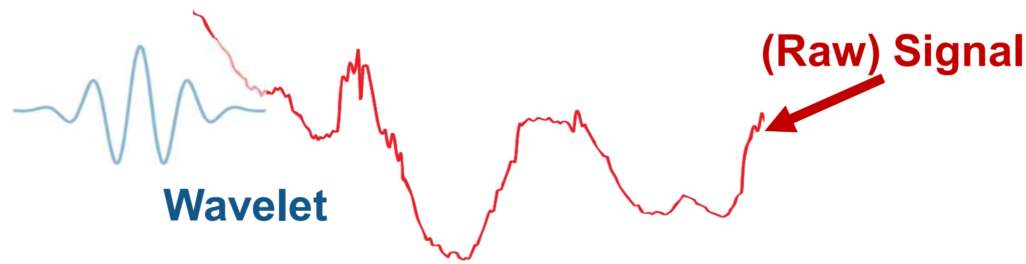




2

Feature Selection

Feature Generation with Wavelet Scattering



What are Wavelets?

Decompose signal into “wavelets”

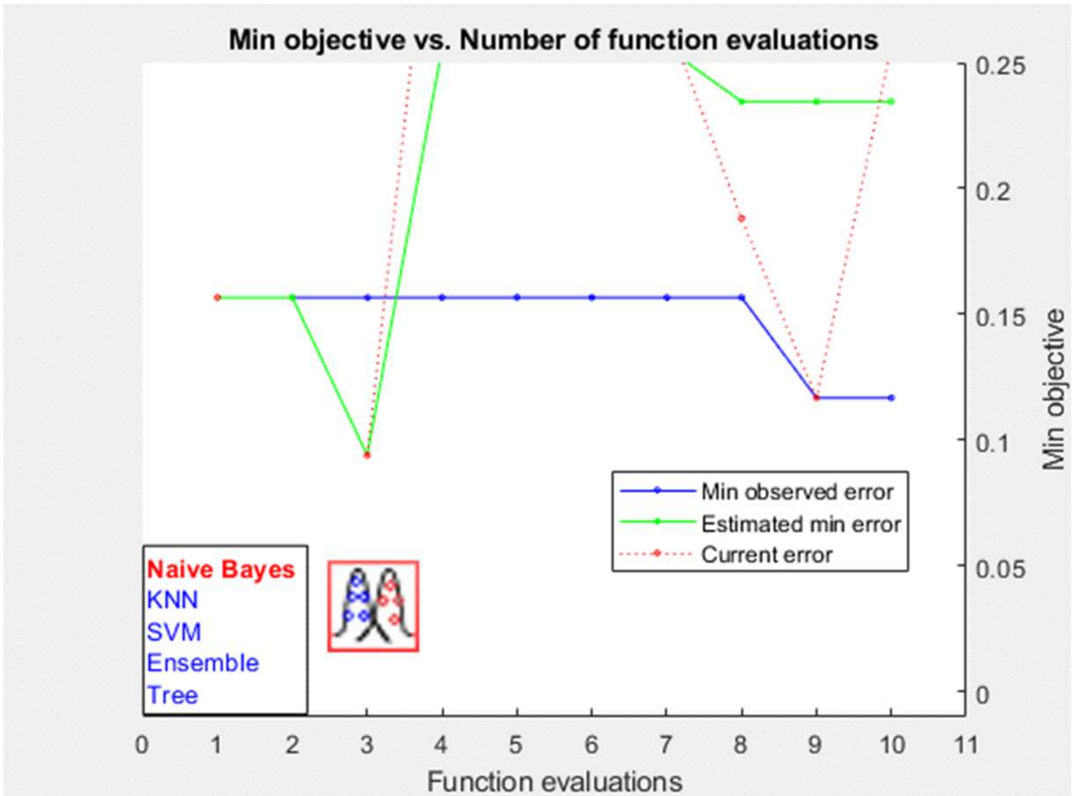
Wavelet Scattering Framework [Bruna and Mallat 2013]

– Reduces data dimensionality and provides compact features
– For Signal and Image data
– Great starting point if you don’t have a lot of data

Many Feature Selection methods are available.

Function	Predictors	Machine Learning	Training Speed	Types of Models	Accuracy	Caveats
NCA	Continuous	Classification Regression	Medium	KNN SVM (can use for others)	Strong	Needs manual tuning of regularization lambda (doc page)
MRMR R2019b	Continuous Categorical Mix of both	Classification	Fast	Model Independent	Strong	
ReliefF	Continuous Categorical	Classification Regression	Medium	KNN SVM (can still use for others)	Moderate	Unable to differentiate correlated predictors
Sequentialfs	Continuous Categorical	Classification Regression	Very Slow	Model Independent (define custom loss function)	Strong	Doesn't rank all features
F Test R2020a	Continuous Categorical Mix of both	Regression	Very Fast	Model Independent	Weak	Unable to differentiate correlated predictors
Chi Squared R2020a	Continuous Categorical Mix of both	Classification	Very Fast	Model Independent	Weak	Unable to differentiate correlated predictors

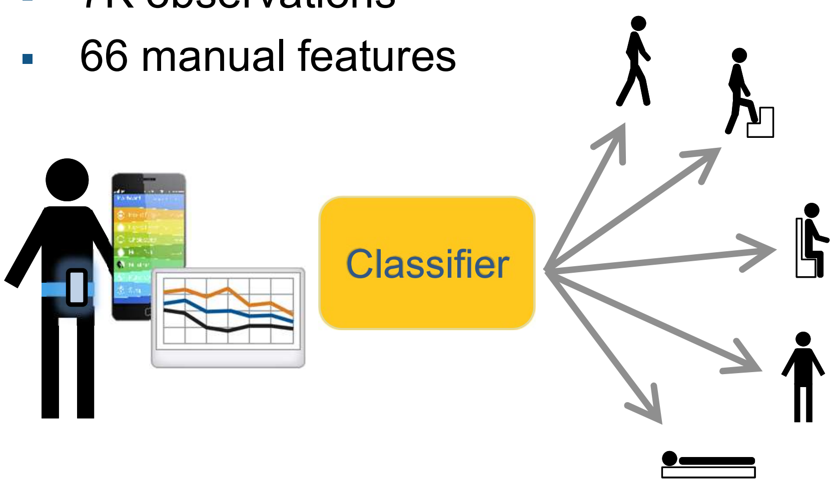
Simultaneous Optimization of Model and Hyperparameters



AutoML matches Manual Optimization in performance.

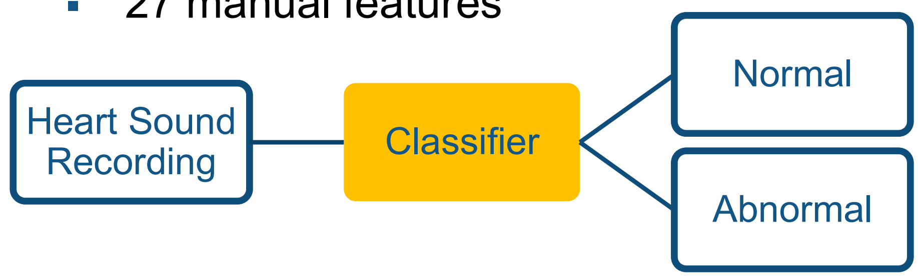
Human Activity Recognition

- Accelerometer from mobile
- 7K observations
- 66 manual features



Heart Sound Classification

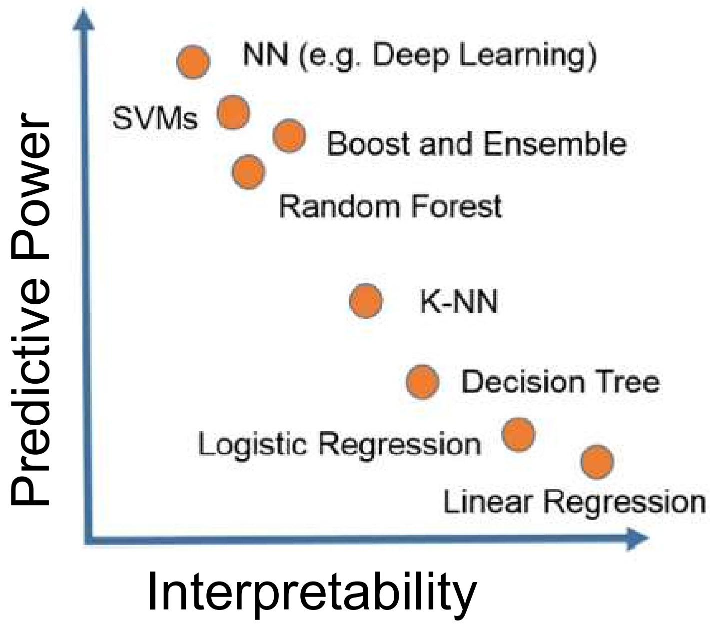
- Phonograms
- 10K observations
- 27 manual features



Results:

	Human Activity	Heart Sound
Manual	95%	98%
AutoML	98%	97%

Interpretability and Explainability



Use Cases

1. Overcome black-box model
2. Regulatory requirements
3. Debug models

Interpretability: causality of (mostly machine learning) model decisions

Explainable AI: visualize activations in various layers (deep learning)

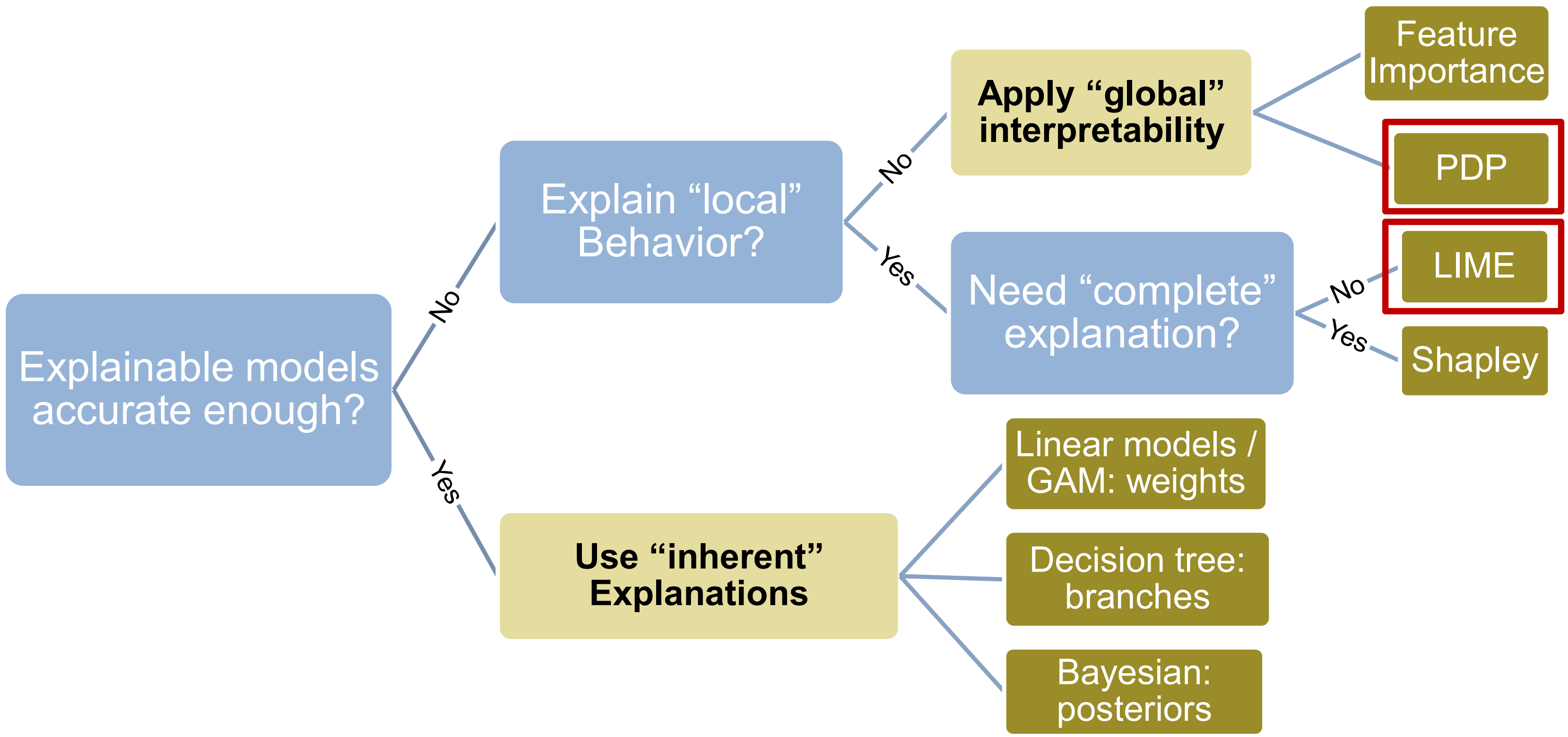
Where is Interpretability most needed?

	Finance	Auto & Aero
Why Interpretability	Credit / Market risk models	Safety certification
	Traditional models explainable	
Popular complex models	Gradient-boosted trees Random forests	Deep neural networks
	Neural networks	Reinforcement learning
Popular Interpretability	Shapley values	Network visualizations

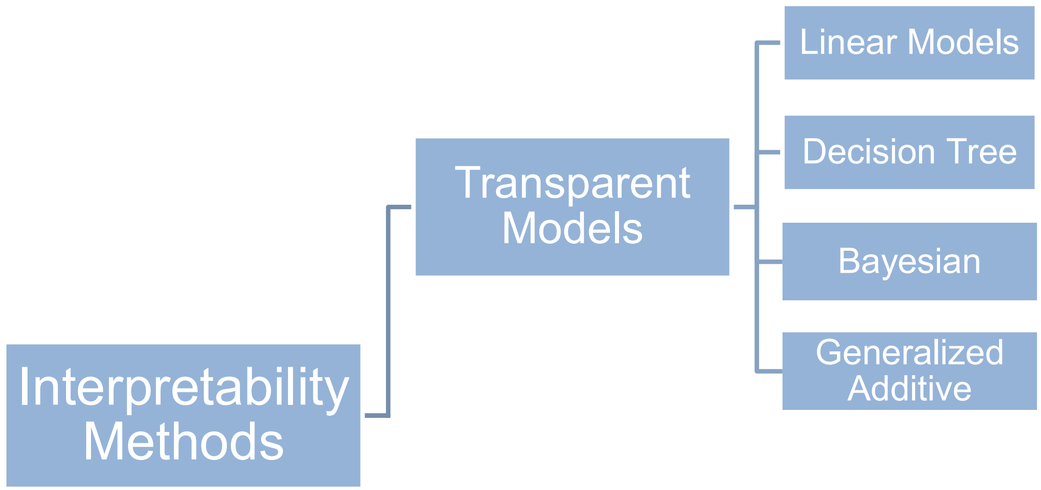
EUROCAE WG-114 "Artificial Intelligence"

SAE G-34 "Artificial Intelligence in Aviation"

Which Interpretability method?



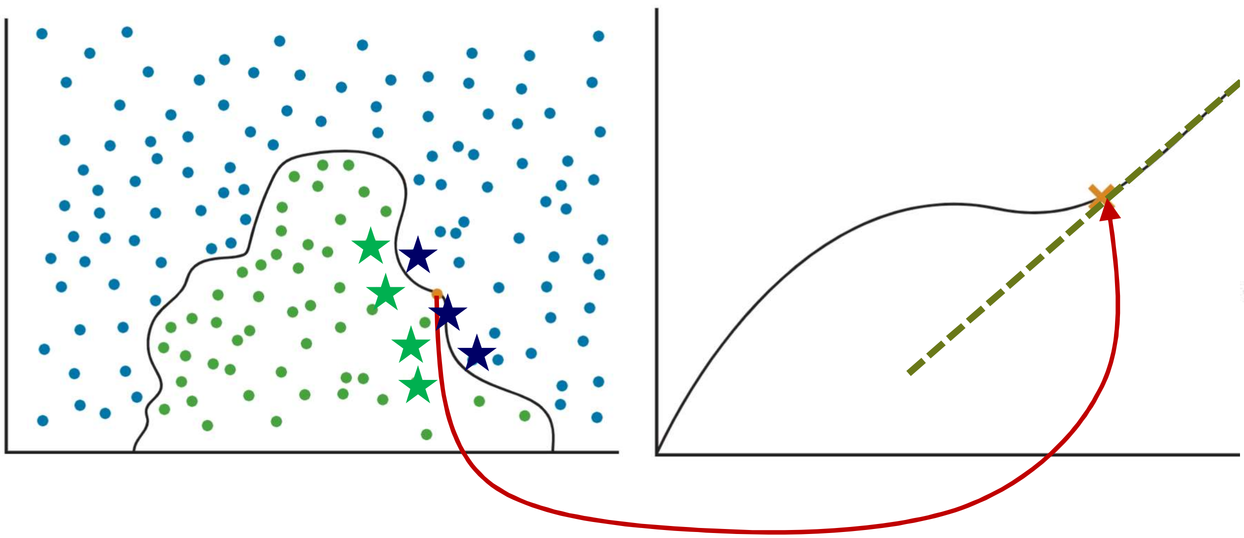
Which Interpretability methods are available?

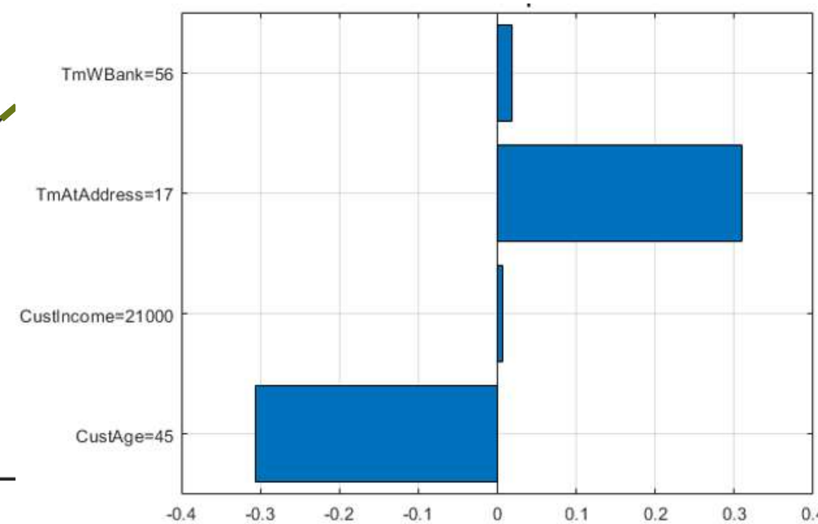


LIME = Local Interpretable Model-Agnostic Explanations

1 Approximate complex model near Point of Interest with simple model

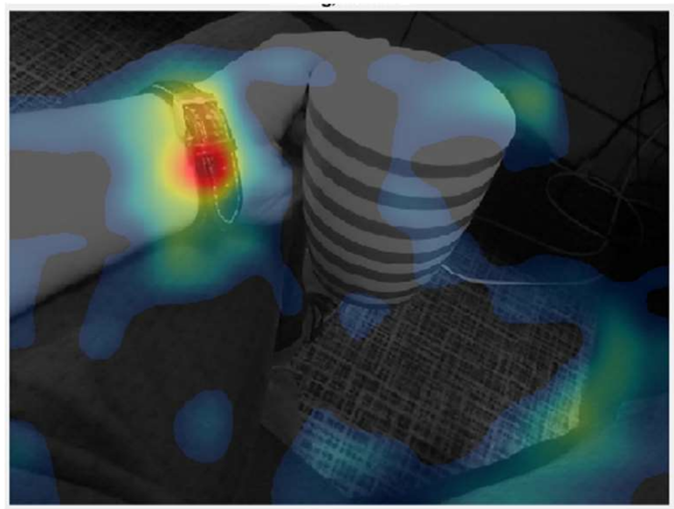
2 “Explain” using weights of simple model





Deep Learning Explainability: “why” behind deep net’s decisions

Truth:	Coffee mug
AI:	Buckle (15%) ✗



AI classifies incorrectly as “buckle” due to the watch

Three techniques:

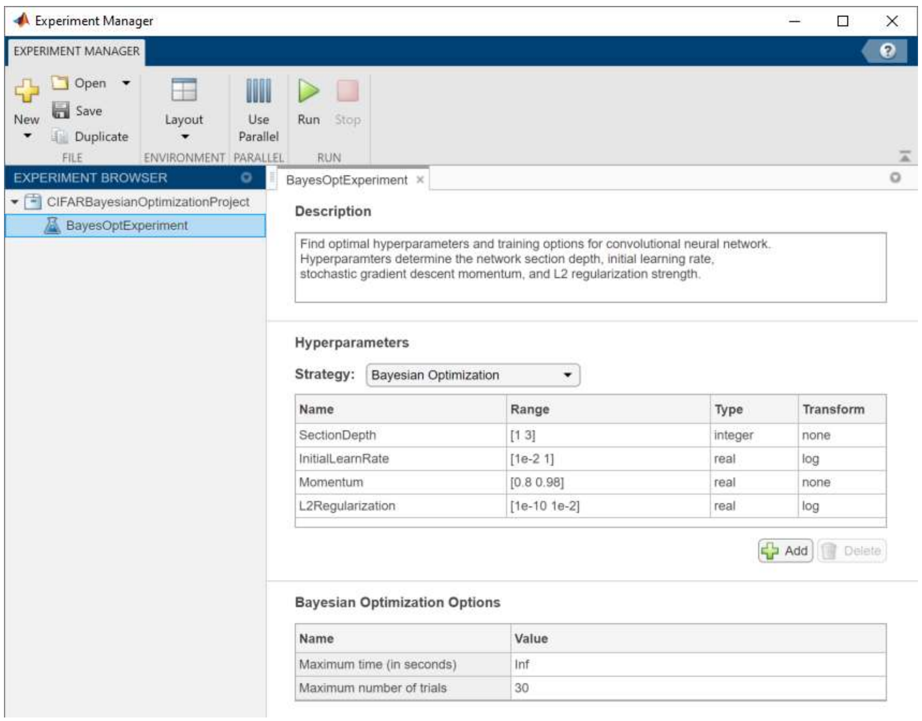
Occlusion Sensitivity

GradCAM

Image LIME

AutoML in Deep Learning

Neural Net Hyperparameters

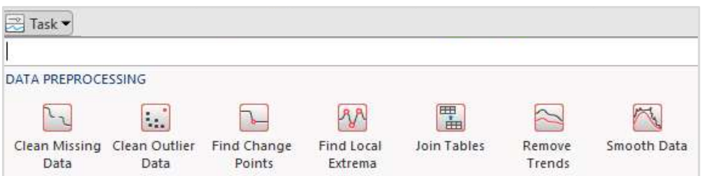


Neural Architecture Search

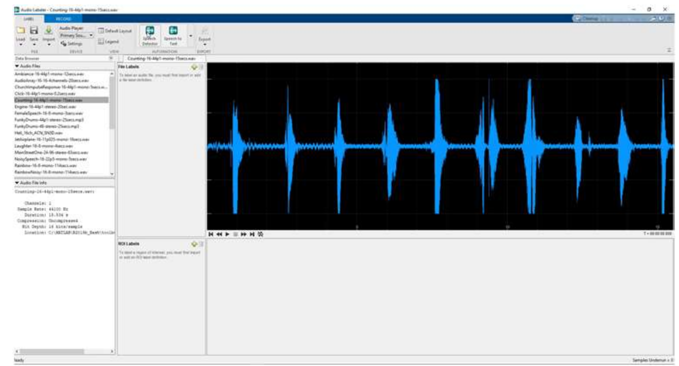
- Identify “optimal” neural net
- Computationally extremely challenging
- Currently: exploring variants of established networks

Addressing other Challenges

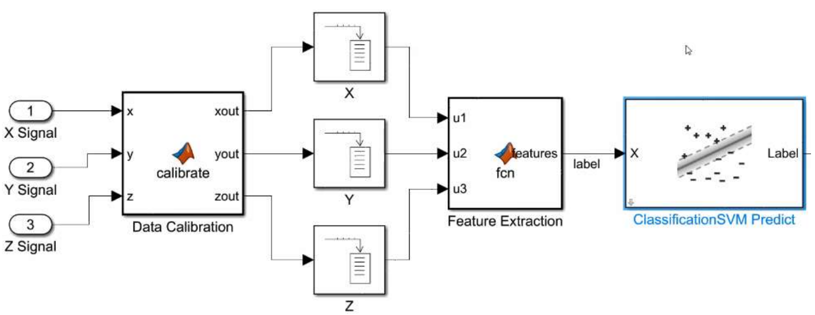
Preprocess with Live Tasks



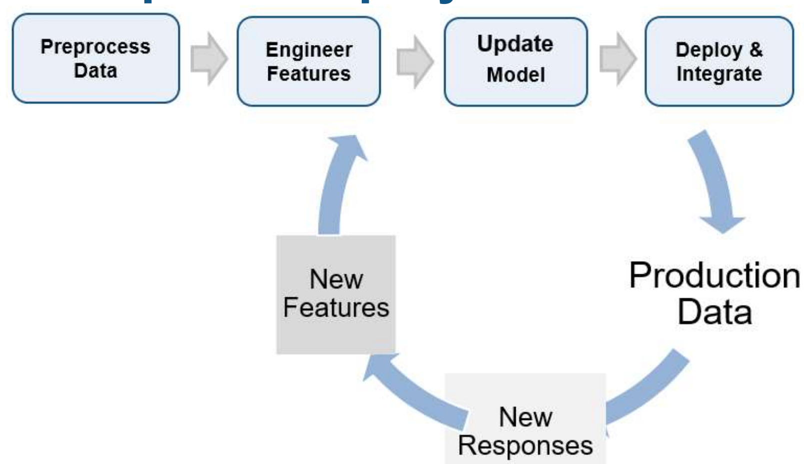
Reduce Labeling Effort



Integrate in Complex Systems



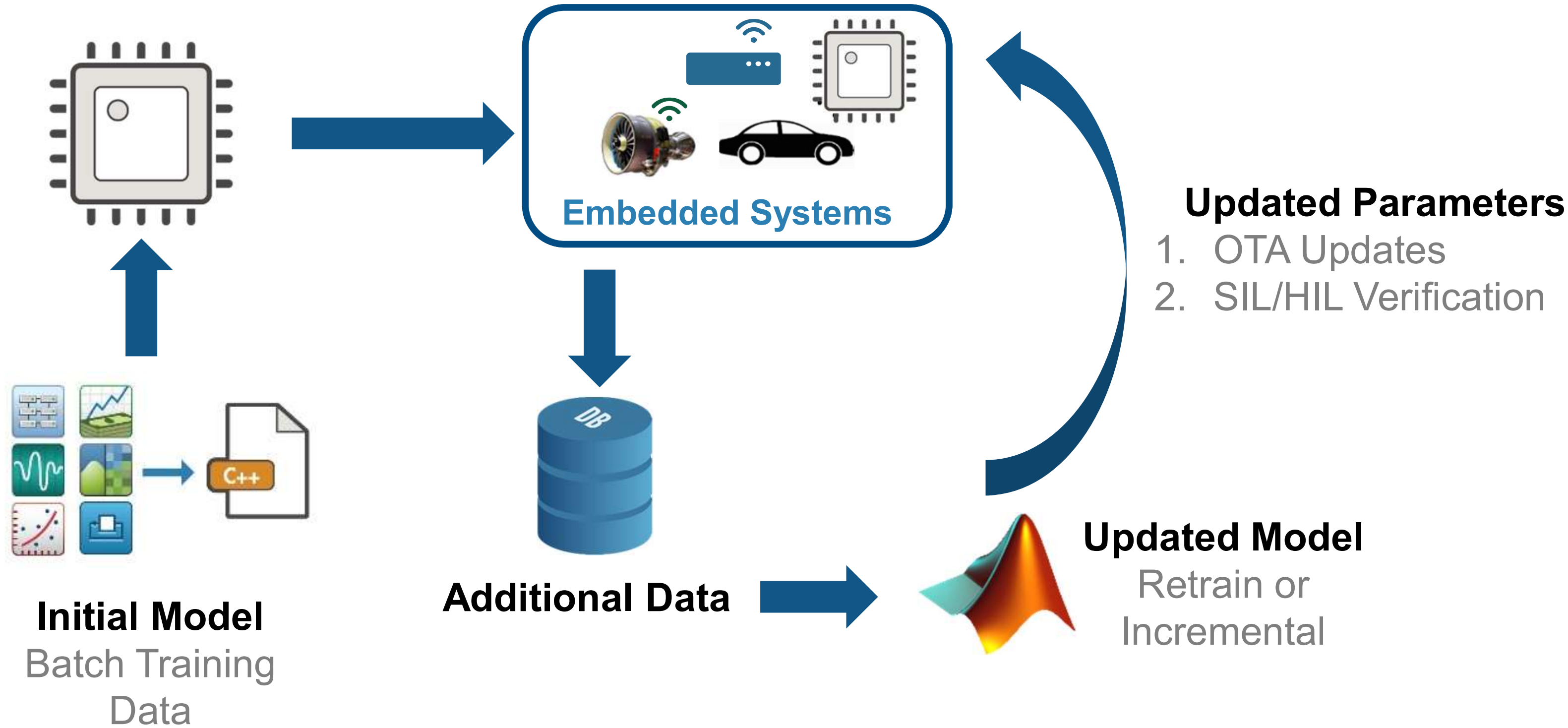
Update deployed models



Updating deployed models

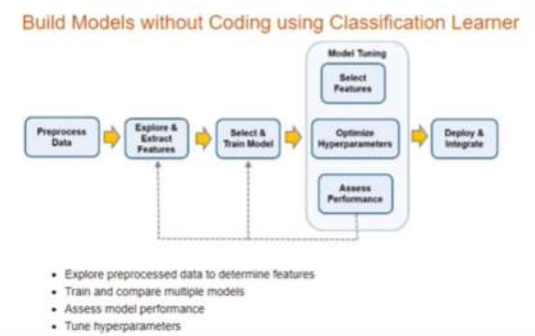
R2019b

SVM
Linear Models
Decision Trees

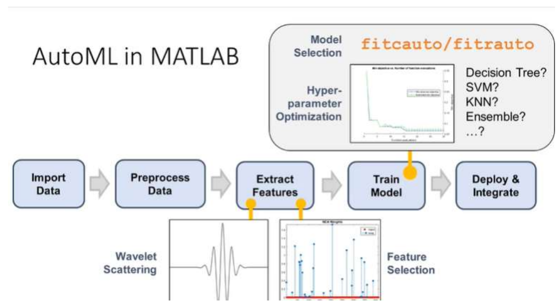


Learn more: Tools that facilitate Adoption of Machine Learning

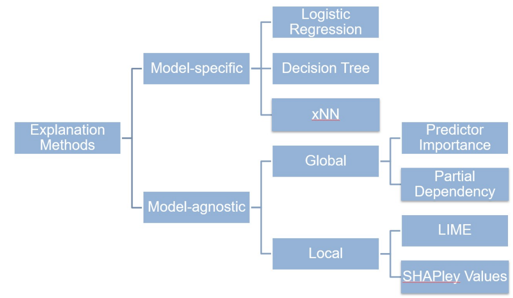
Videos: *Classification Learner*



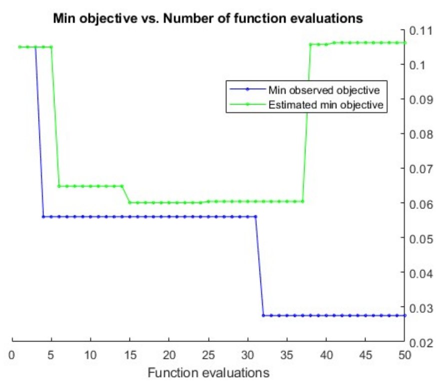
AutoML in MATLAB



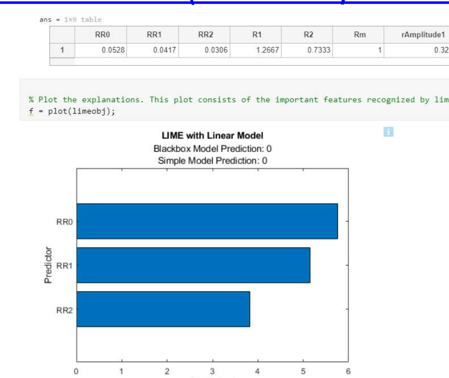
Applying Model Interpretability



Demo: *Apply AutoML to Human Activity (Blog)*



Demo: *Machine Learning for ECG Classification (with Interpretability)*



How MATLAB lowers barriers to adopting Machine Learning

Build models interactively & AutoML

- Empower Engineers & Domain experts with limited expertise
- Make experienced practitioners more productive

Code Generation for Embedded Deployment

- Fixed point for popular Classification and Regression models
- Quantization and C / CUDA code generation for deep learning

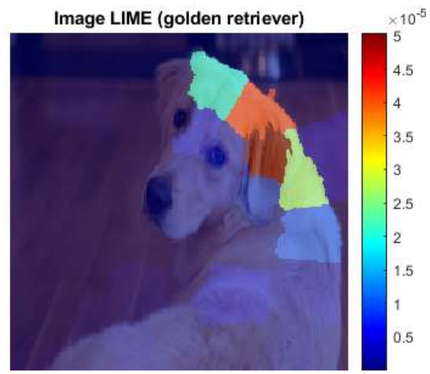
Integration with Simulink

- Native blocks for Machine Learning facilitate Model-Based Design
- Deep Learning blocks for prediction and image classification

Learn more: Deep Learning with MATLAB

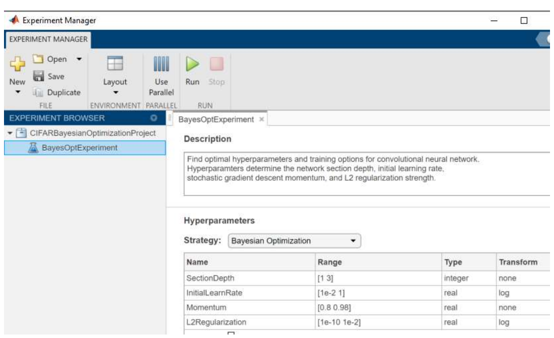
Video: *[Get Started with Deep Learning in MATLAB]*

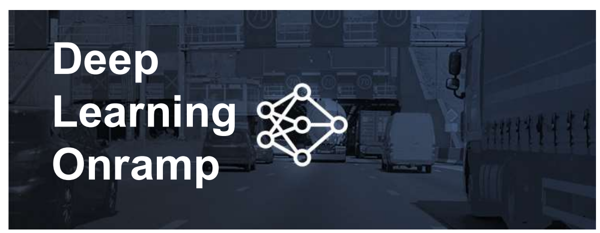
Example: [Understand Network Predictions using (image) LIME]



Example: [Grad-CAM] and [Occlusion Sensitivity]

Example: [Tuning Hyperparameters in Experiment Manager]





mathworks.com/solutions/deep-learning.html
mathworks.com/solutions/machine-learning.html