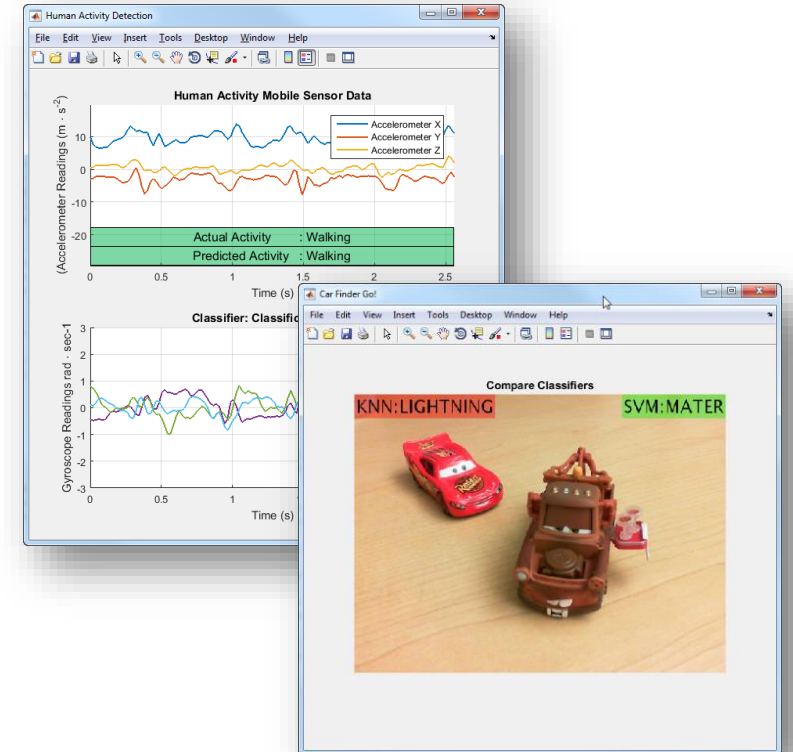


Machine Learning Made Easy

David Willingham
Senior Application Engineer



Agenda

- Machine Learning
 - What is Machine Learning and why do we need it?
 - Common challenges in Machine Learning

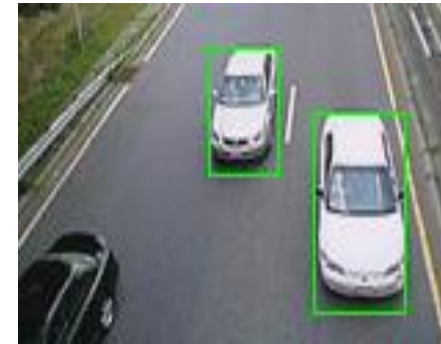
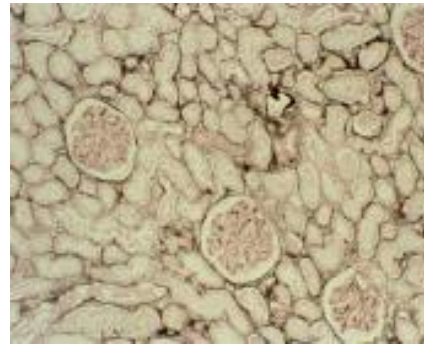
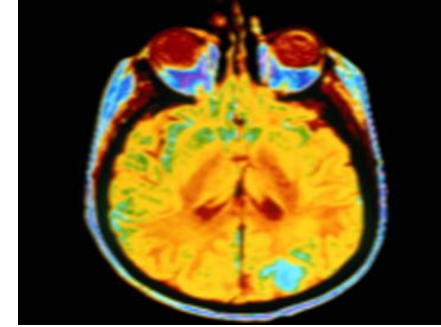
- Example 1: Human activity learning using mobile phone data
 - Learning from sensor data

- Example 2: Real-time car identification using images
 - Learning from images

- Summary & Key Takeaways

Machine Learning is Everywhere

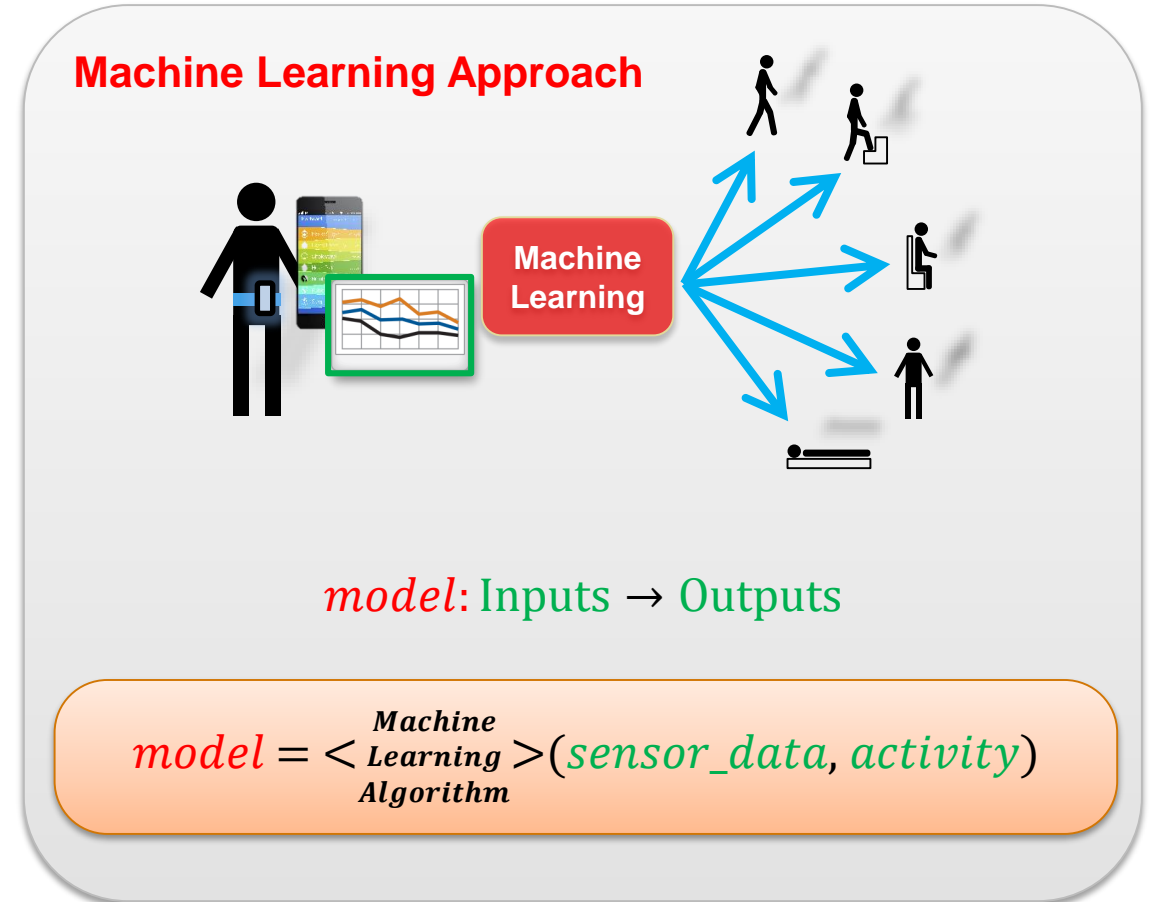
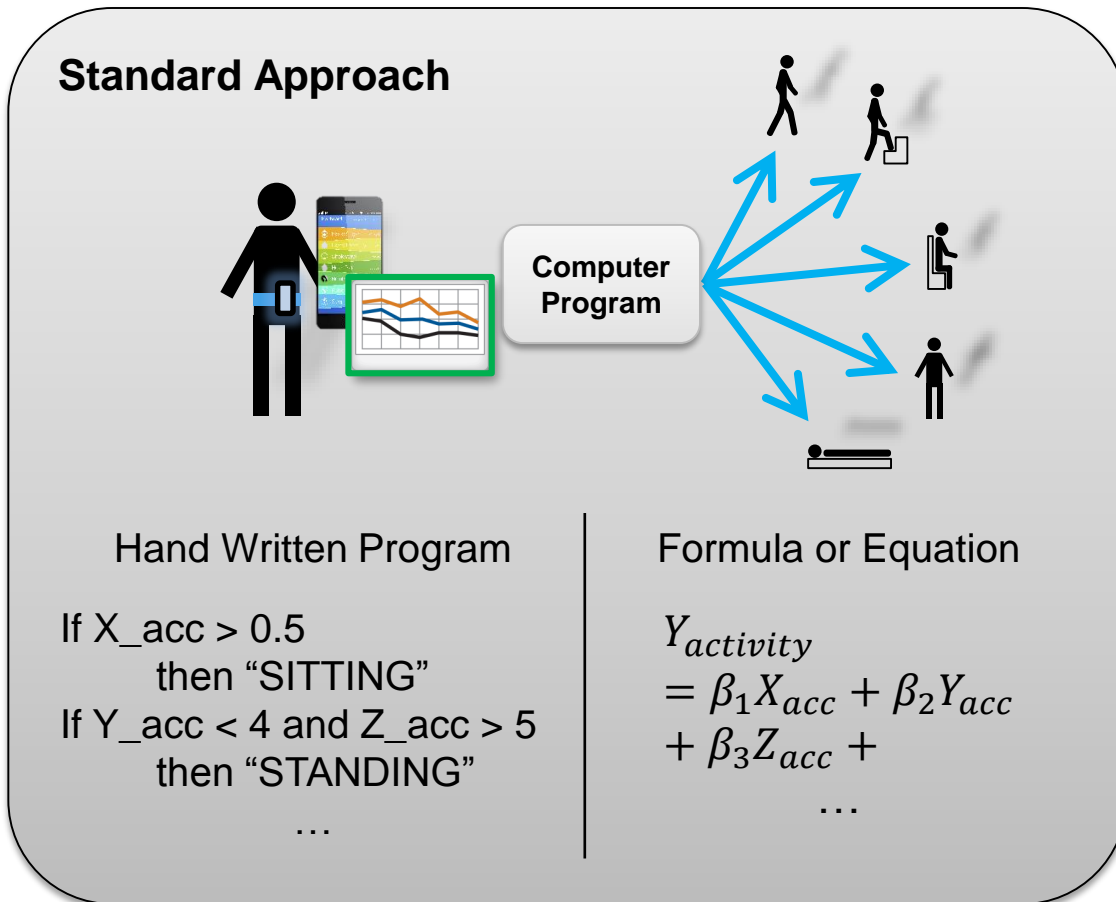
- Image Recognition
- Speech Recognition
- Stock Prediction
- Medical Diagnosis
- Data Analytics
- Robotics
- and more...



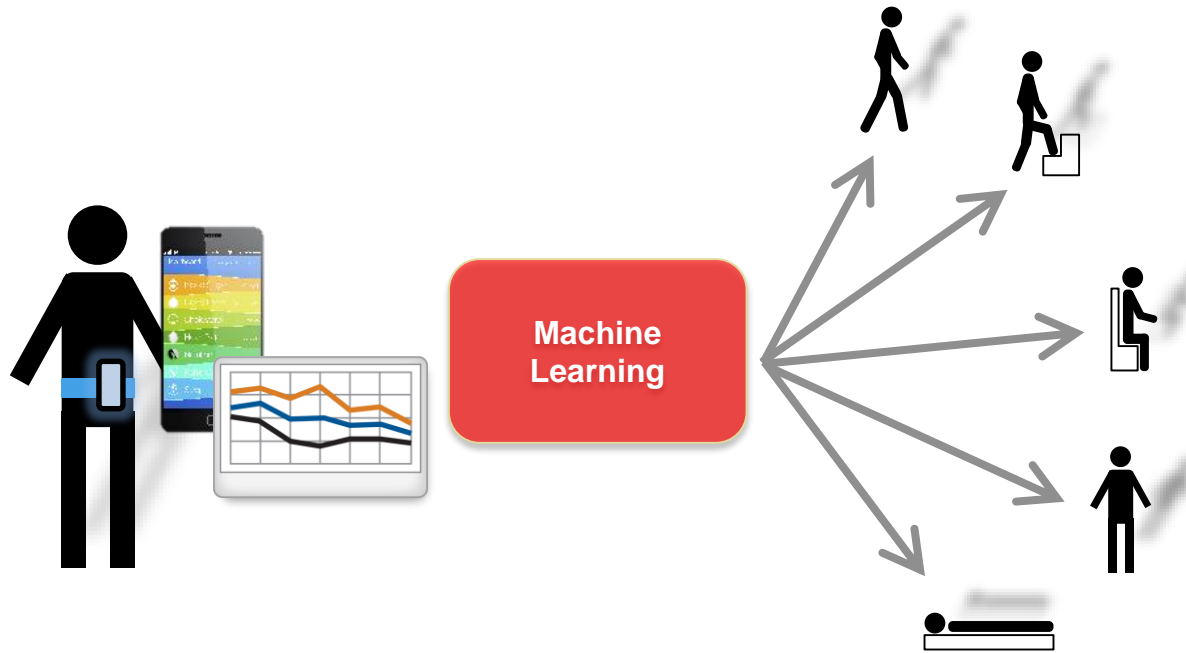
Machine Learning

Machine learning uses **data** and produces a **program** to perform a **task**

Task: Human Activity Detection

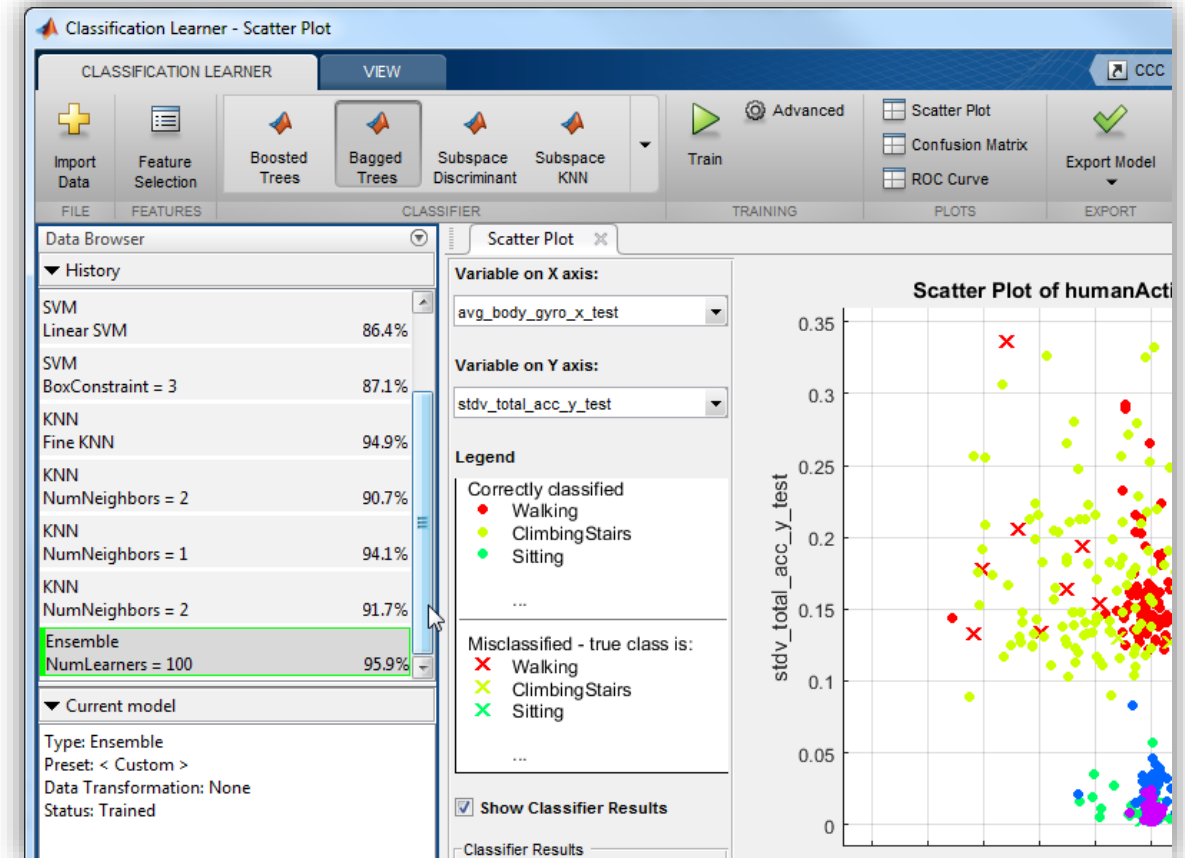


Example: Human Activity Learning Using Mobile Phone Data



Data:

- 3-axial Accelerometer data
- 3-axial Gyroscope data





**“essentially, all models are wrong,
but some are useful”
– George Box**

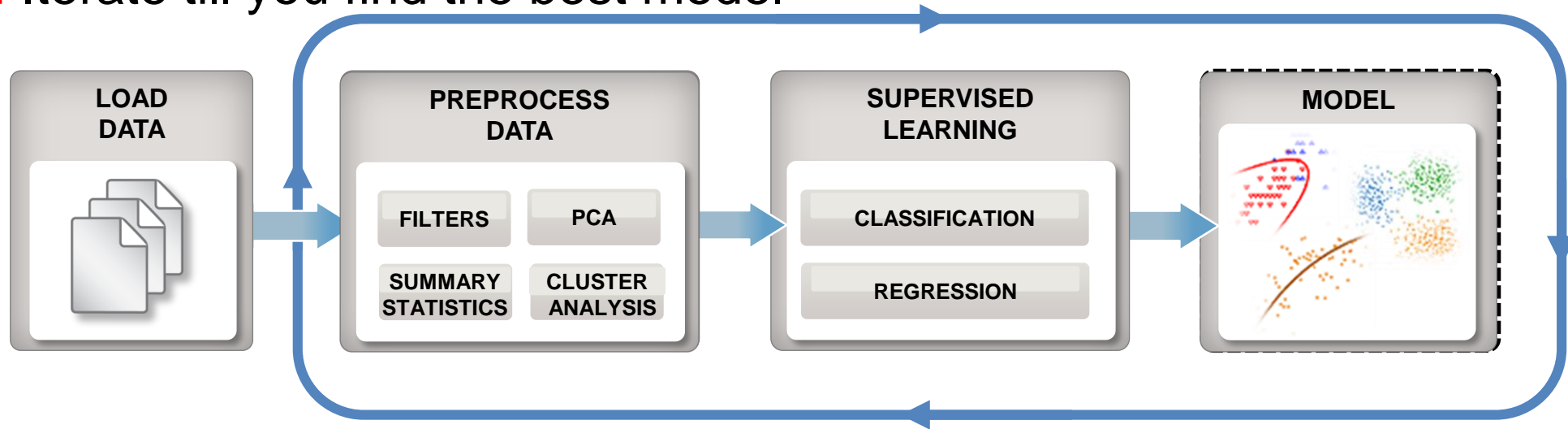
Challenges in Machine Learning

Hard to get started

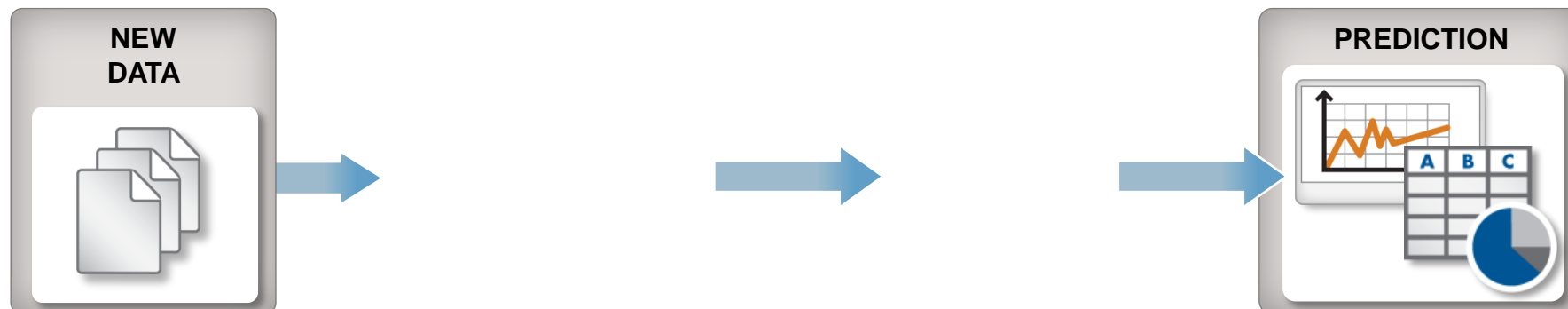
Steps	Challenge
Access, explore and analyze data	Data diversity Numeric, Images, Signals, Text – not always tabular

Machine Learning Workflow

Train: Iterate till you find the best model

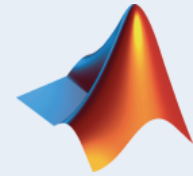


Predict: Integrate trained models into applications



Agenda






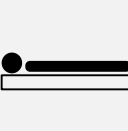
- Machine Learning
 - What is Machine Learning and why do we need it?
 - Common challenges in Machine Learning
- Example 1: Human activity learning using mobile phone data
 - Learning from sensor data
- Example 2: Real-time car identification using images
 - Learning from images
- Summary & Key Takeaways



Example 1: Human Activity Learning Using Mobile Phone Data

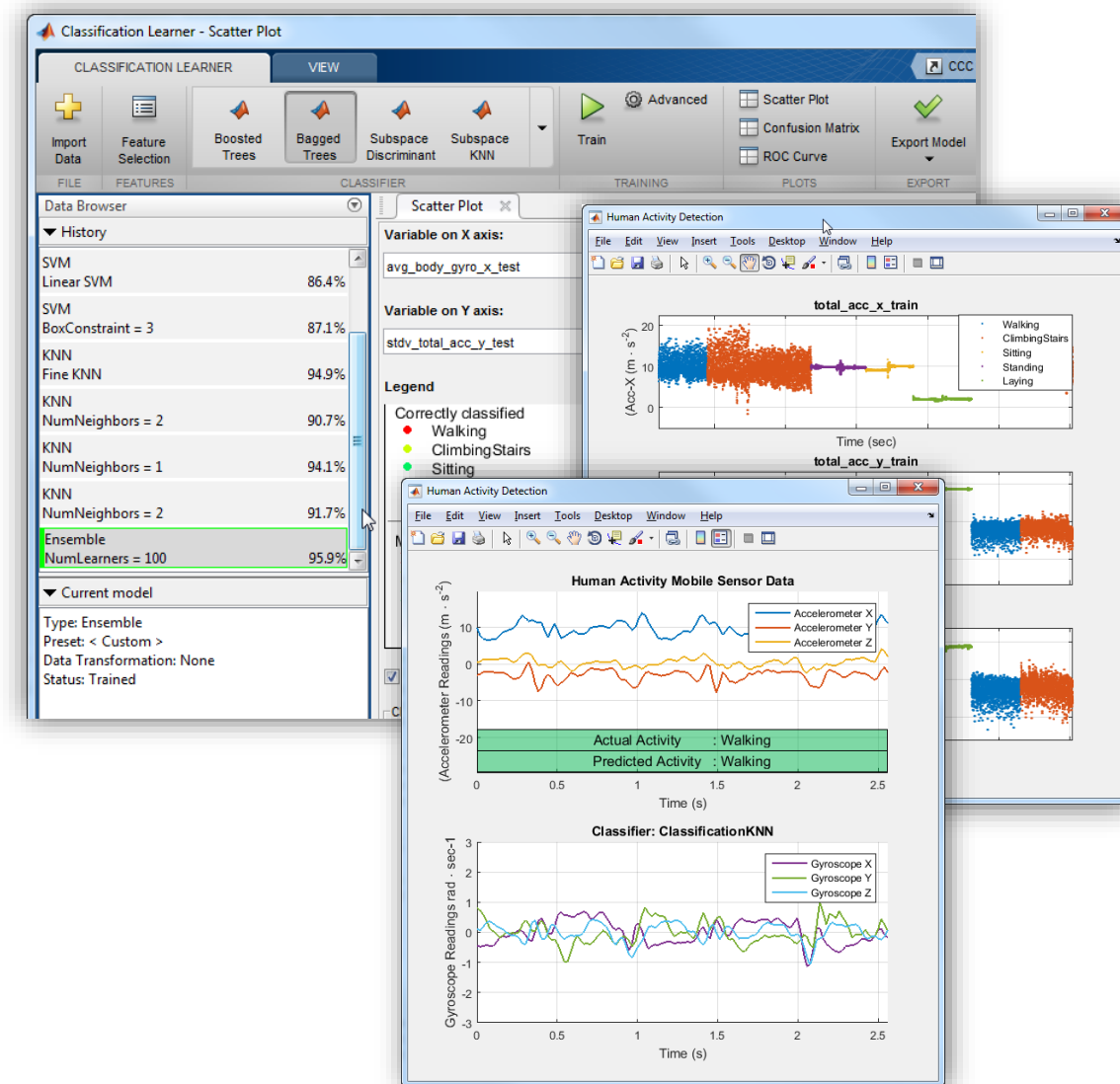
Objective: Train a classifier to classify human activity from sensor data

Data:

Predictors	3-axial Accelerometer and Gyroscope data	
Response	Activity:	    

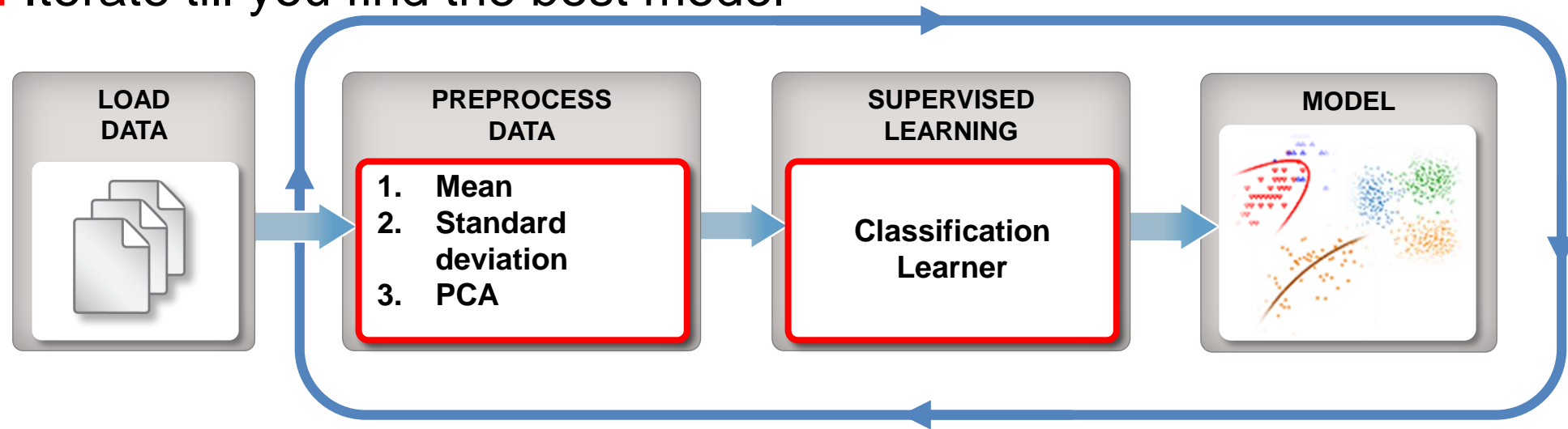
Approach:

- Extract features from raw sensor signals
- Train and compare classifiers
- Test results on new sensor data

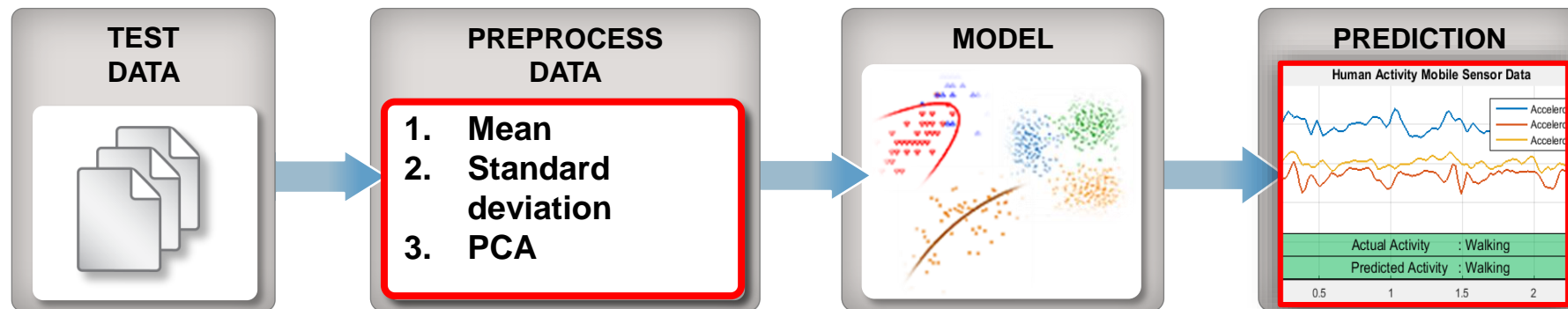


Machine Learning Workflow for Example 1

Train: Iterate till you find the best model

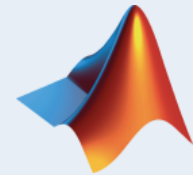


Predict: Integrate trained models into applications



Agenda


- Machine Learning
 - What is Machine Learning and why do we need it?
 - Common challenges in Machine Learning
- Example 1: Human activity learning using mobile phone data
 - Learning from sensor data
- Example 2: Real-time car identification using images
 - Learning from images
- Summary & Key Takeaways



Example 2: Real-time Car Identification Using Images

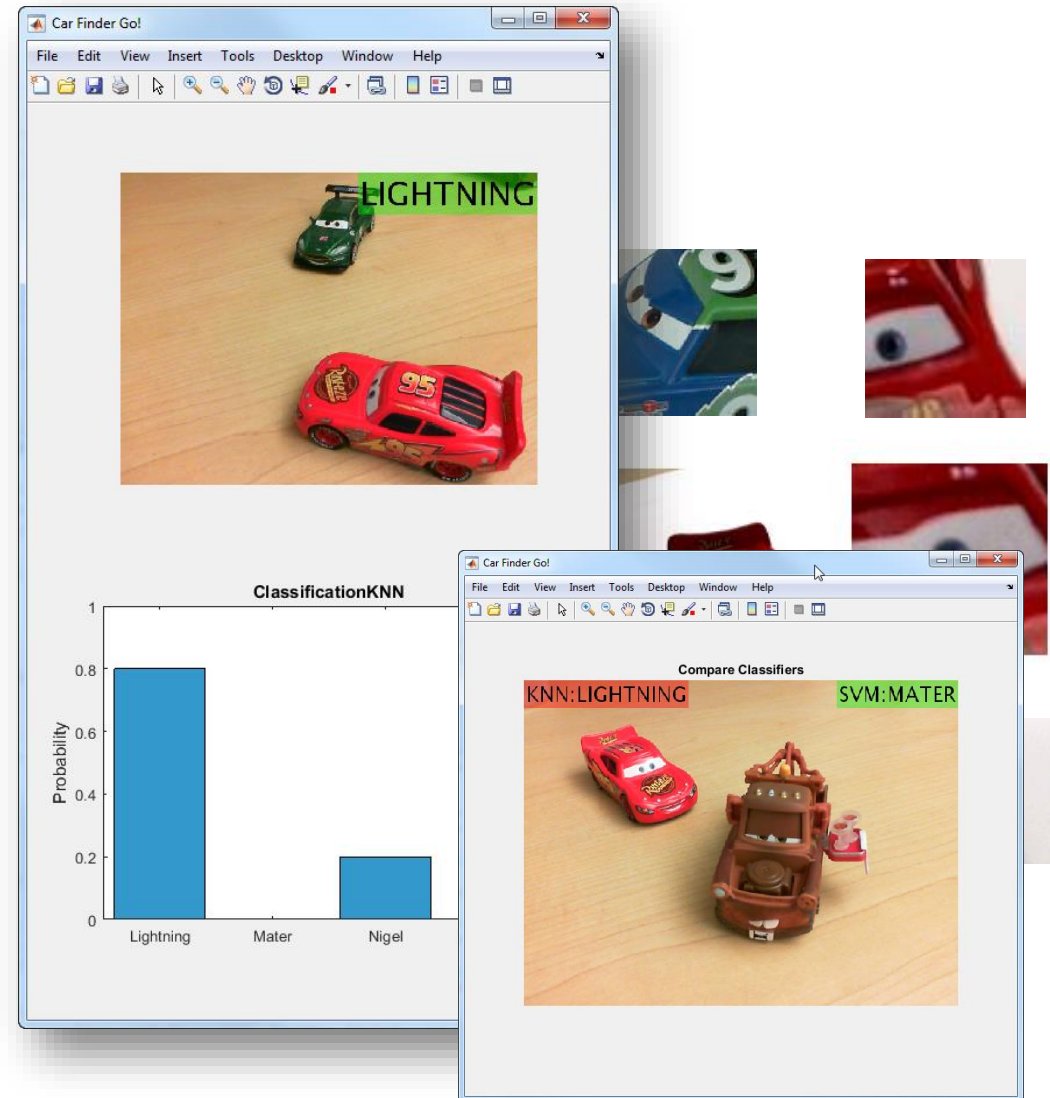
Objective: Train a classifier to identify car type from a webcam video

Data:

Predictors	Several images of cars: 
Response	NIGEL, LIGHTNING, SANDDUNE, MATER

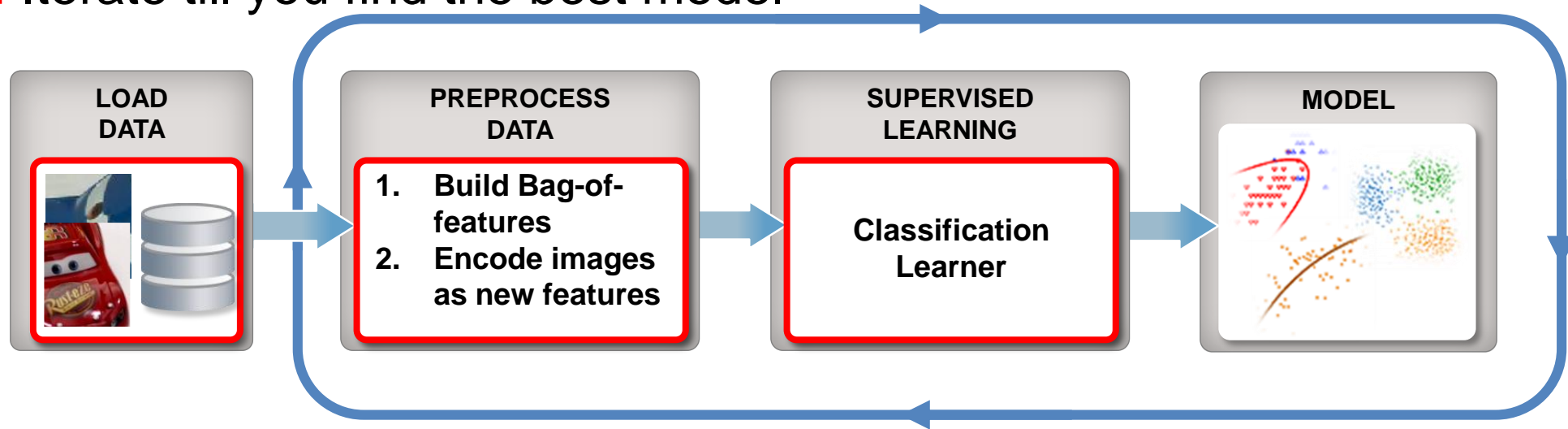
Approach:

- Extract features using Bag-of-words
- Train and compare classifiers
- Classify streaming video from a webcam

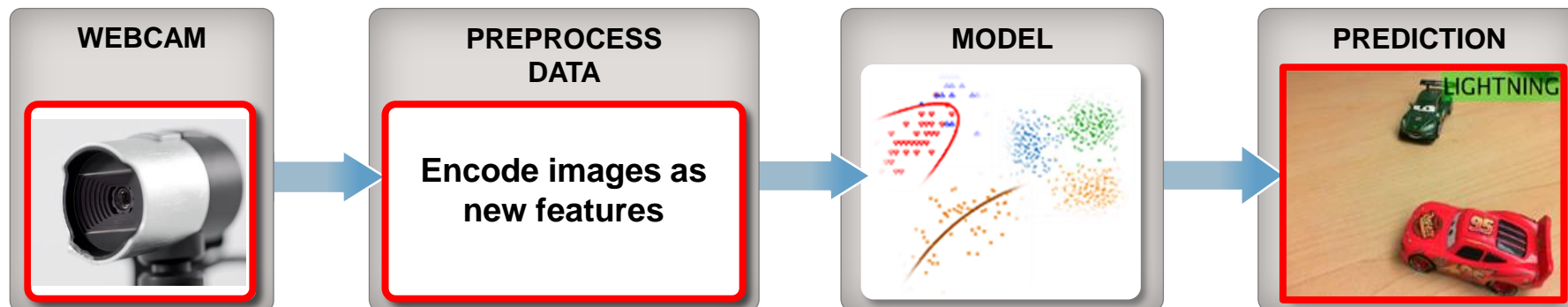


Machine Learning Workflow for Example 2

Train: Iterate till you find the best model

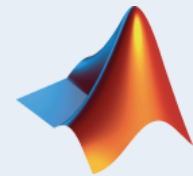


Predict: Integrate trained models into applications




Agenda

- Machine Learning
 - What is Machine Learning and why do we need it?
 - Common challenges in Machine Learning
- Example 1: Human activity learning using mobile phone data
 - Learning from sensor data
- Example 2: Real-time car identification using images
 - Learning from images
- Summary & Key Takeaways

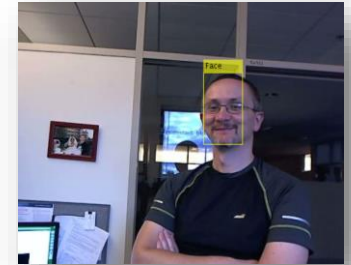


Challenges in Machine Learning

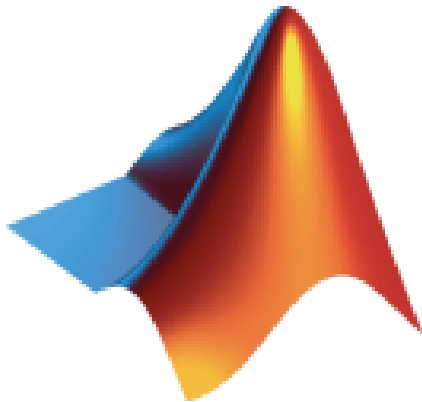
Steps	Challenge
Accessing, exploring and analyzing data	Data diversity
Preprocess data	Lack of domain tools
Train models	Time consuming
Assess model performance	Avoid pitfalls Over Fitting, Speed-Accuracy-Complexity
Iterate	

Key Takeaways

- Consider Machine Learning when:
 - Hand written rules and equations are too complex
 - *Face recognition, speech recognition, recognizing patterns*
 - Rules of a task are constantly changing
 - *Fraud detection from transactions, anomaly in sensor data*
 - Nature of the data changes and the program needs to adapt
 - *Automated trading, energy demand forecasting, predicting shopping trends*



- MATLAB for Machine Learning



Email me if you have further questions

Additional Resources

Documentation:

The screenshot shows the MathWorks documentation page for Machine Learning. The page title is "Machine Learning" and it is labeled as "R2015a". The main content area provides an overview of machine learning, defining it as building a model that makes decisions based on evidence in the presence of uncertainty. It then details supervised learning (classification and regression), unsupervised learning (clustering and dimensionality reduction), and ensemble learning (boosting, bagging, and random subspace). A "Machine Learning Basics" section lists several key topics with links: Steps in Supervised Learning, Characteristics of Classification Algorithms, What Are Classification Trees and Regression Trees?, What Are Linear Regression Models?, Introduction to Cluster Analysis, and Introduction to Feature Selection. A sidebar on the left contains a navigation menu with categories like "All Products", "Statistics and Machine Learning Toolbox", "Exploratory Data Analysis", "Probability Distributions", "Hypothesis Tests", "Regression and ANOVA", "Machine Learning", "Supervised Learning", "Unsupervised Learning", "Ensemble Learning", "Multivariate Data Analysis", "Industrial Statistics", and "Speed Up Statistical Computations". At the bottom right, there is a "Was this topic helpful?" survey with "Yes" and "No" buttons.

mathworks.com/machine-learning

The screenshot shows the "Machine Learning with MATLAB Webinar" page. The main heading is "Machine Learning with MATLAB Webinar" and the sub-heading is "Learn how to get started using machine learning tools to detect patterns and build predictive models from your data sets." A prominent "View webinar" button is visible. Below the main text, there are three paragraphs explaining machine learning: 1) Machine learning algorithms use computational methods to "learn" information directly from data without assuming a predetermined equation as a model. 2) Machine learning algorithms are used in applications such as computational finance (credit scoring and algorithmic trading), computational biology (tumor detection, drug discovery, and DNA sequencing), energy production (price and load forecasting), natural language processing, speech and image recognition, and advertising and recommendation systems. 3) Machine learning is often used in big data applications, which have large datasets with many predictors (features) and are too complex for a simple parametric model. Examples include forecasting electricity load with a neural network, or bond rating classification for credit risk using an ensemble of decision trees. At the bottom, there are three columns: "Classification" (Build models to classify data into different categories, with a small plot showing data points and decision boundaries), "Regression" (Build models to predict continuous data, with a small plot showing a curve fitting data points), and "Clustering" (Find natural groupings and patterns in data, with a small plot showing distinct clusters of data points). Each column also lists relevant algorithms: Classification (support vector machine (SVM), boosted and bagged decision trees), Regression (linear model, nonlinear model, regularization, stepwise regression, boosted), and Clustering (k-means, hierarchical clustering, Gaussian mixture models, hidden Markov models).

Q & A