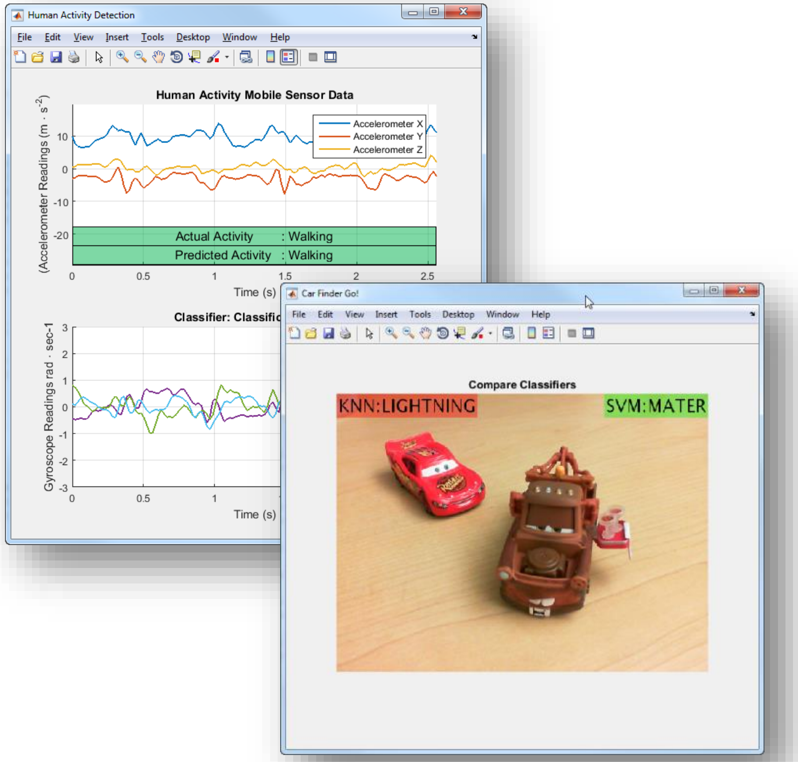
Machine Learning Made Easy



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Statistics and Machine Learning

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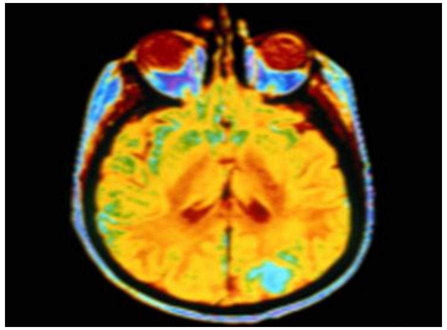
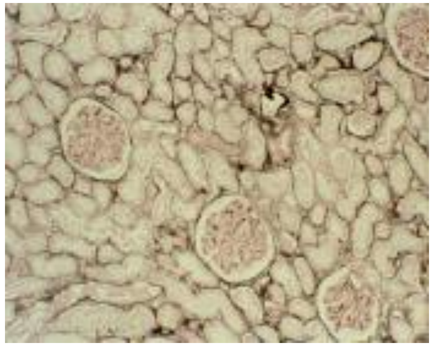
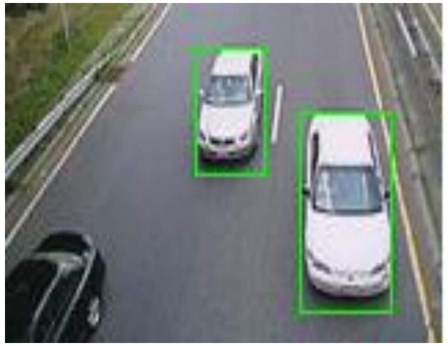
Agenda

- 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…

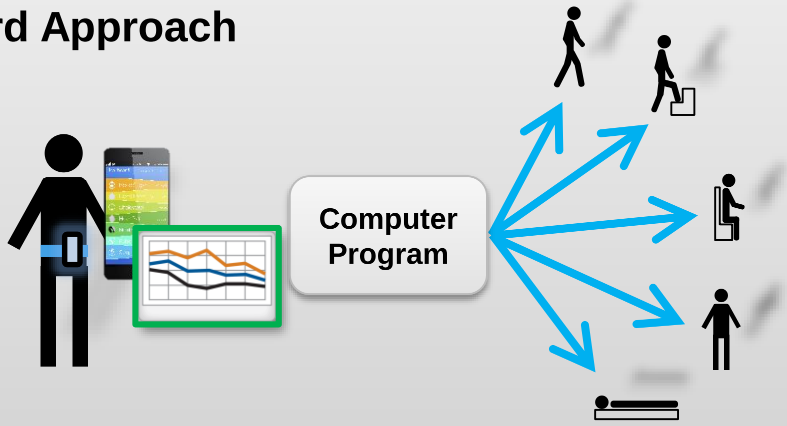


Machine Learning

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

Task: Human Activity Detection

Standard Approach



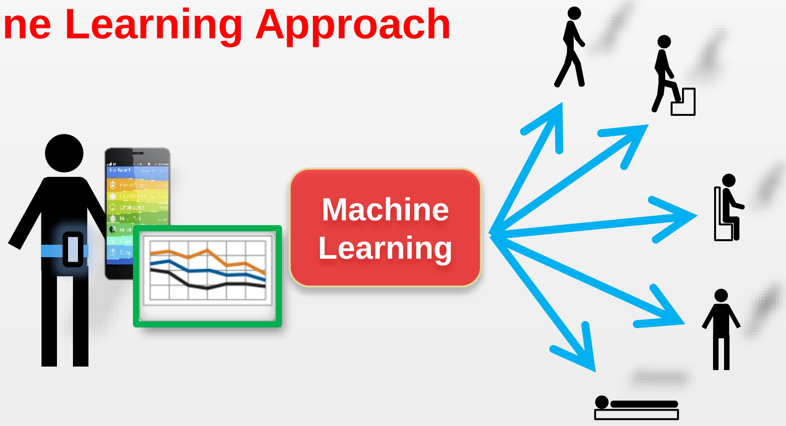
Hand Written Program

If X_acc > 0.5
then "SITTING"
If Y_acc < 4 and Z_acc > 5
then "STANDING"
…

Formula or Equation

$$Y_{activity} = \beta_1 X_{acc} + \beta_2 Y_{acc} + \beta_3 Z_{acc} + \dots$$

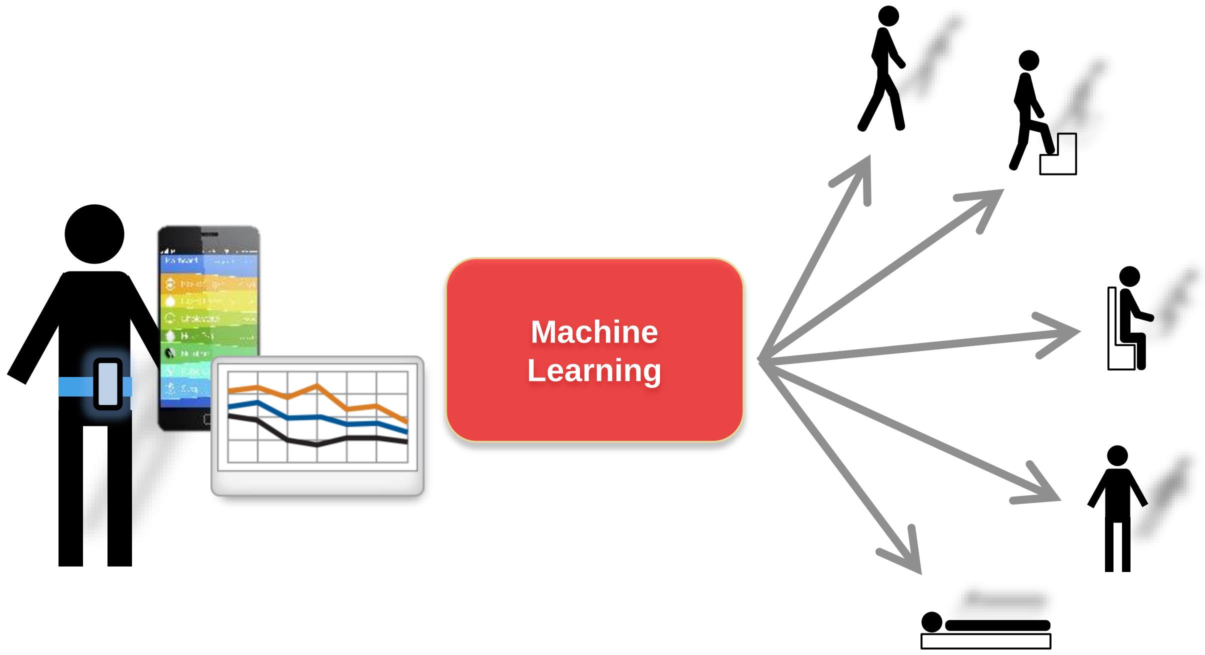
Machine Learning Approach

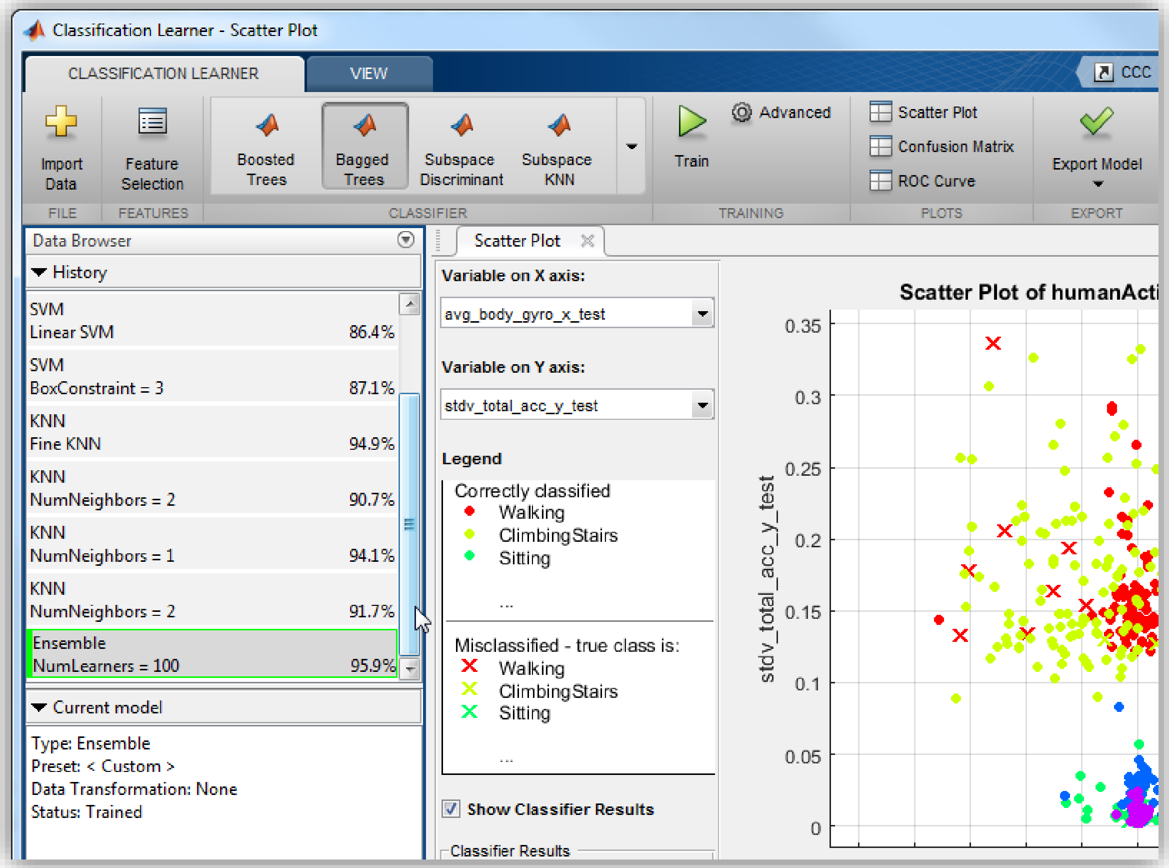


$model$: Inputs → Outputs

$$model = <\text{Machine Learning Algorithm}>(sensor\_data, activity)$$

Example: Human Activity Learning Using Mobile Phone Data





Data:

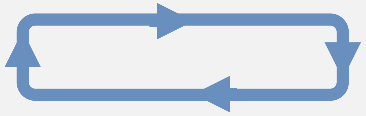
- ➢ 3-axial Accelerometer data
- ➢ 3-axial Gyroscope data

“essentially, all models are wrong, but some are useful”

– George Box

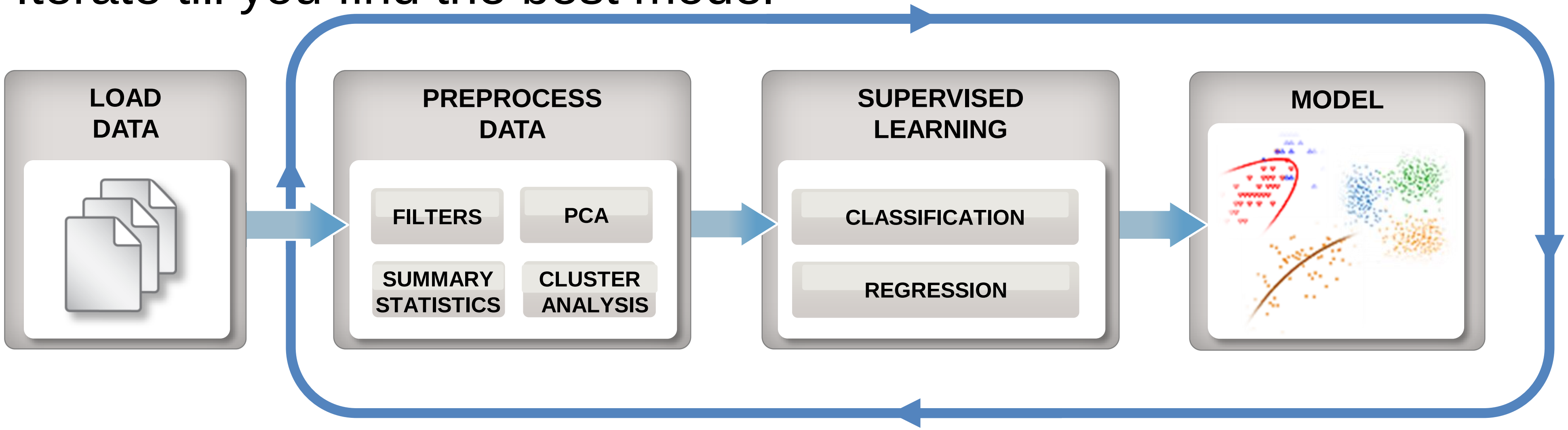
Challenges in Machine Learning

Hard to get started

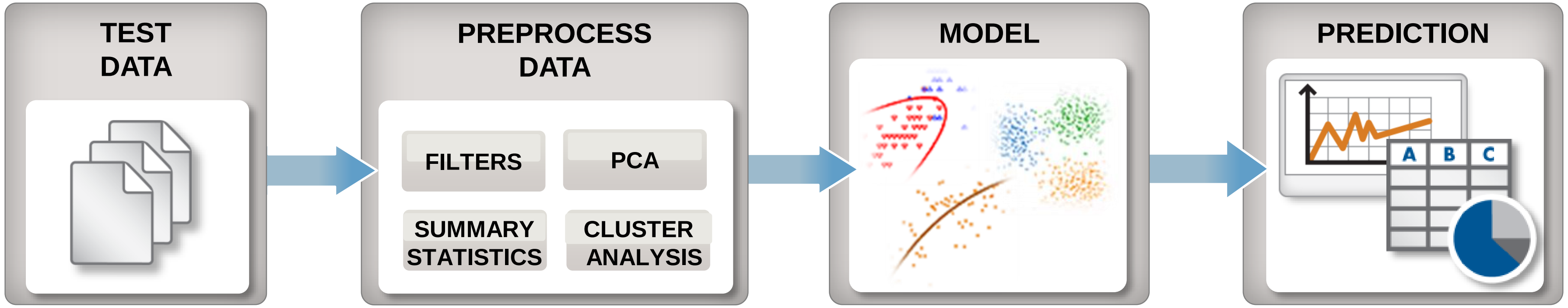
Steps	Challenge
Access, explore and analyze data	**Data diversity** Numeric, Images, Signals, Text – not always tabular
Preprocess data	**Lack of domain tools** Filtering and feature extraction Feature selection and transformation
Train models	**Time consuming** Train several models to find the “best”
Assess model performance	**Avoid pitfalls** Over Fitting Speed-Accuracy-Complexity tradeoffs
Iterate	

Machine Learning Workflow for Example 1

Train: Iterate till you find the best model



Predict: Integrate trained models into applications



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Example 1: Human Activity Learning Using Mobile Phone Data

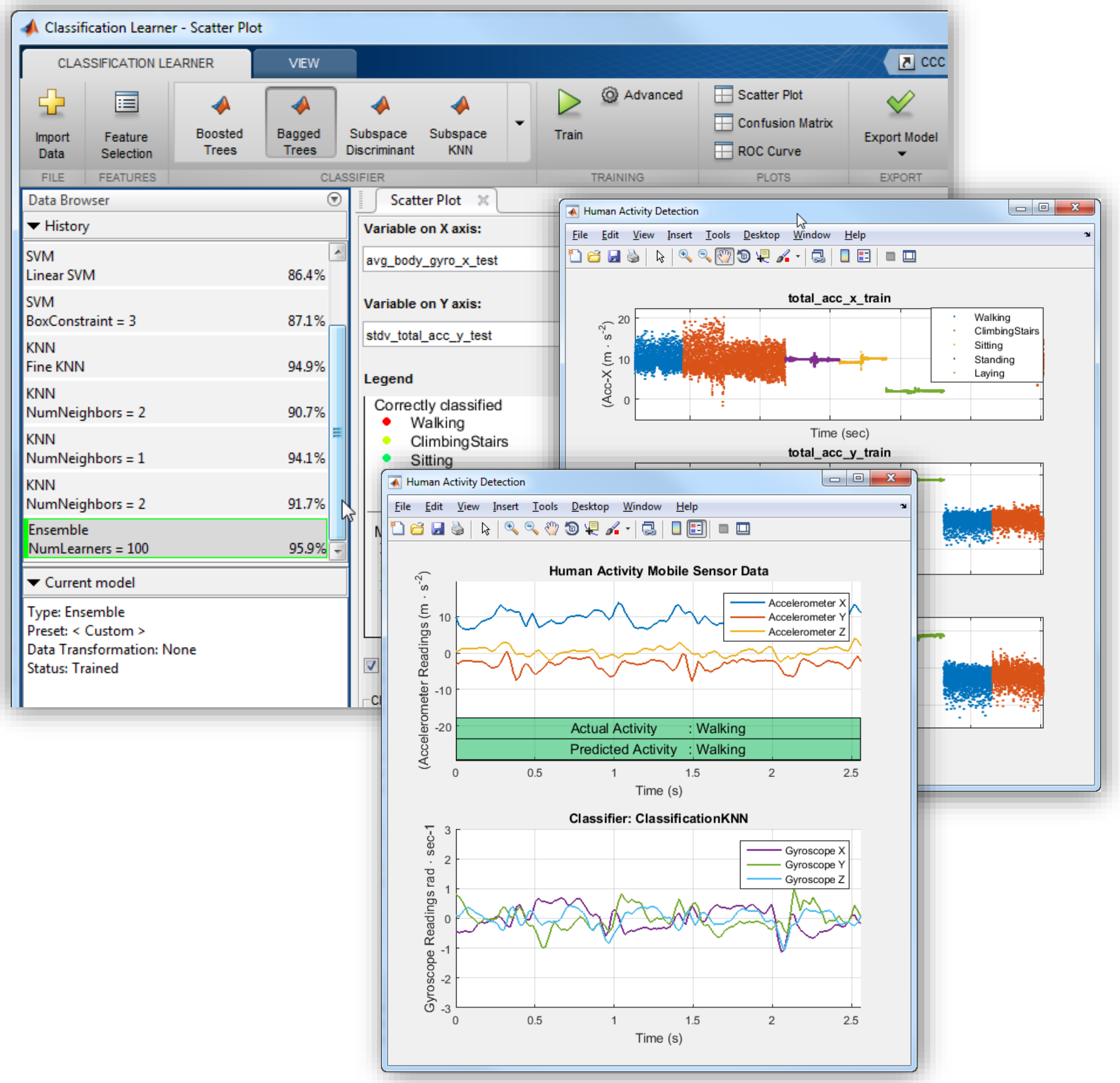
Objective: Train a classifier to classify human activity from sensor data

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



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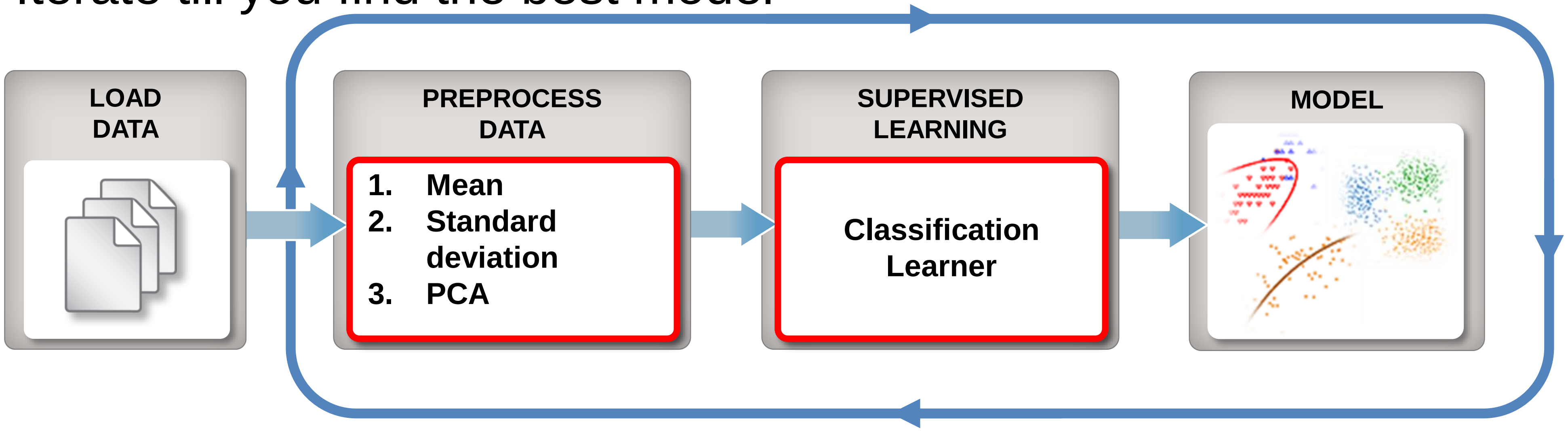

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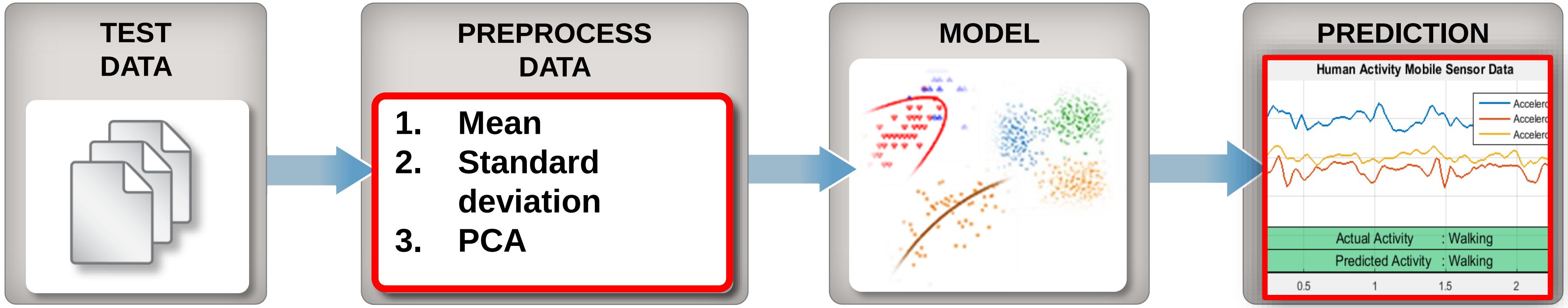

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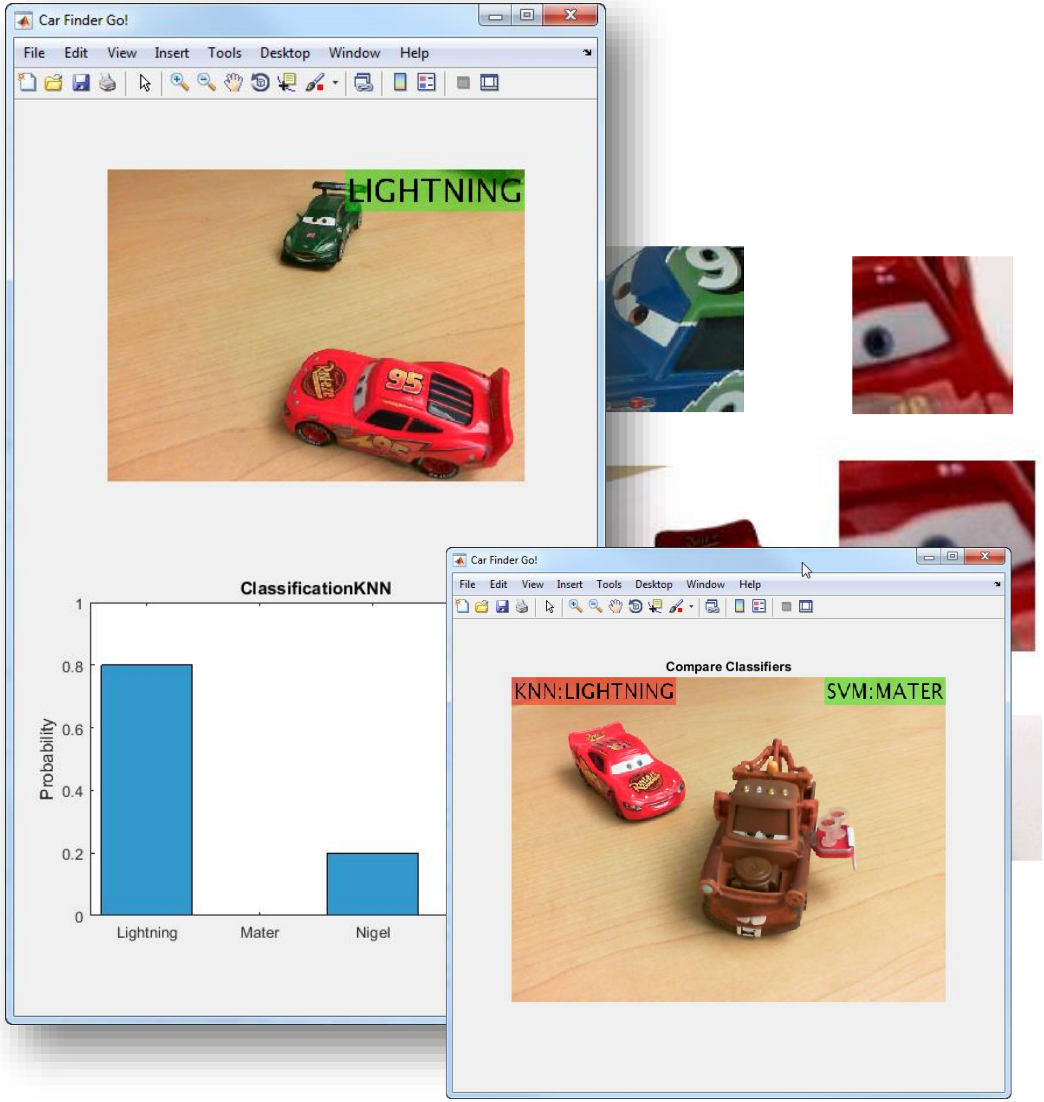
Example 2: Real-time Car Identification Using Images

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

LOAD DATA

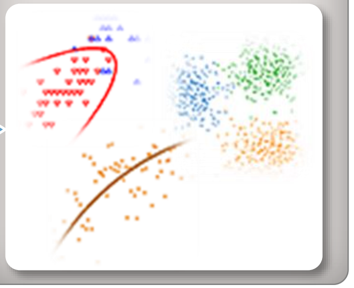
PREPROCESS DATA

1. Build Bag-of-features
2. Encode images as new features

SUPERVISED LEARNING

Classification Learner

MODEL



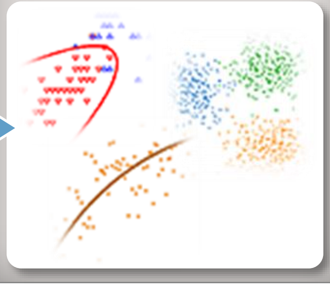
Predict: Integrate trained models into applications

WEBCAM

PREPROCESS DATA

Encode images as new features

MODEL



PREDICTION

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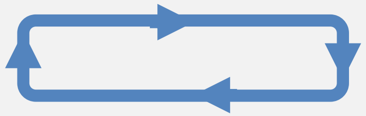
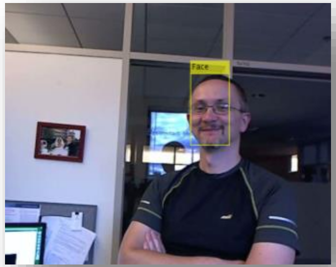
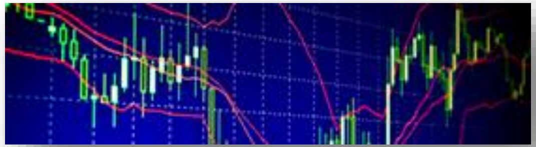
MATLAB Strengths for Machine Learning

Challenge	Solution
Data diversity	**Extensive data support** Import and work with signal, images, financial, Textual, geospatial, and several others formats
Lack of domain tools	**High-quality libraries** Industry-standard algorithms for Finance, Statistics, Signal, Image processing & more
Time consuming	**Interactive, app-driven workflows** Focus on machine learning, not programing
Avoid pitfalls Over Fitting, Speed-Accuracy-Complexity	**Integrated best practices** Model validation tools built into app Rich documentation with step by step guidance
	**Flexible architecture for customized workflows** Complete machine learning platform

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

What's New

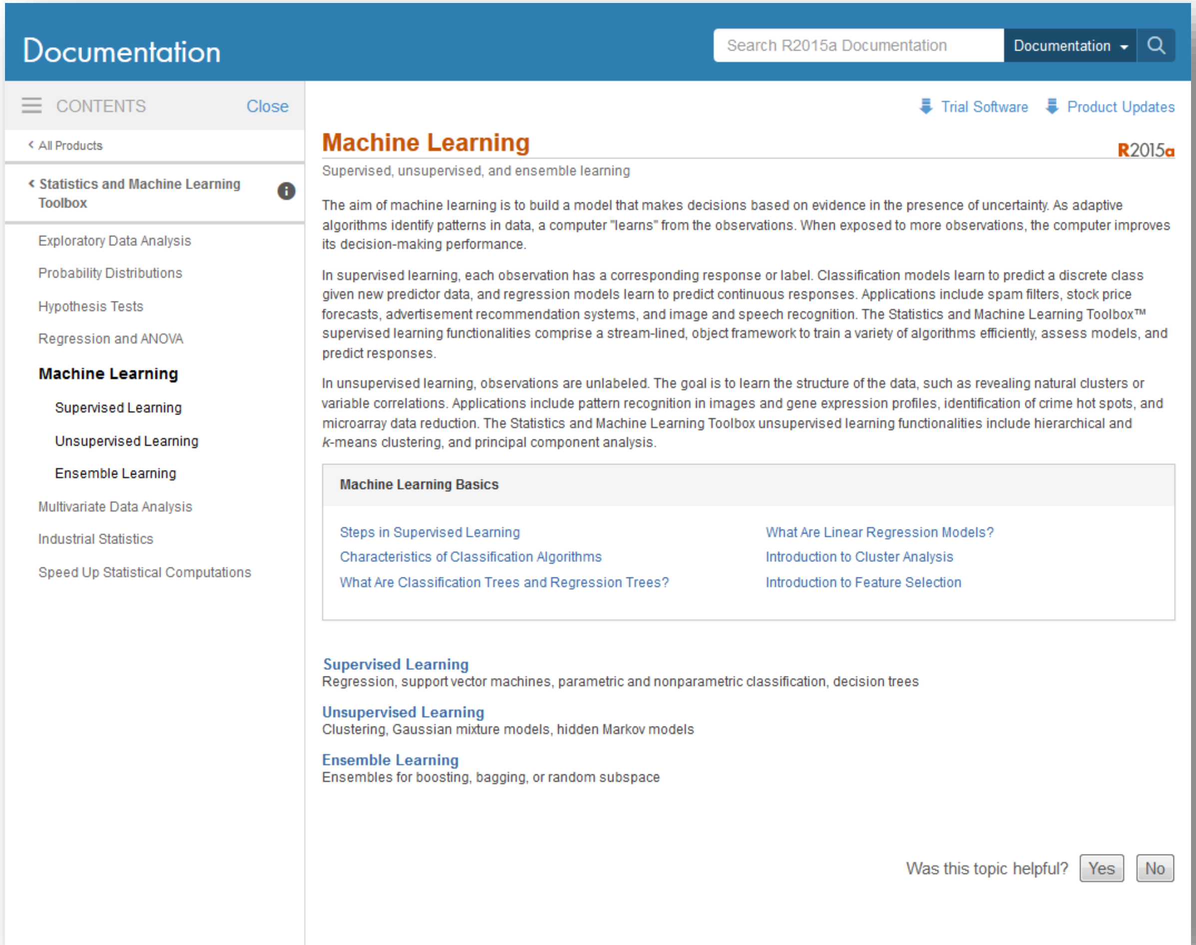
From Shashank Prasanna, Statistics and Machine Learning Toolbox Technical Expert

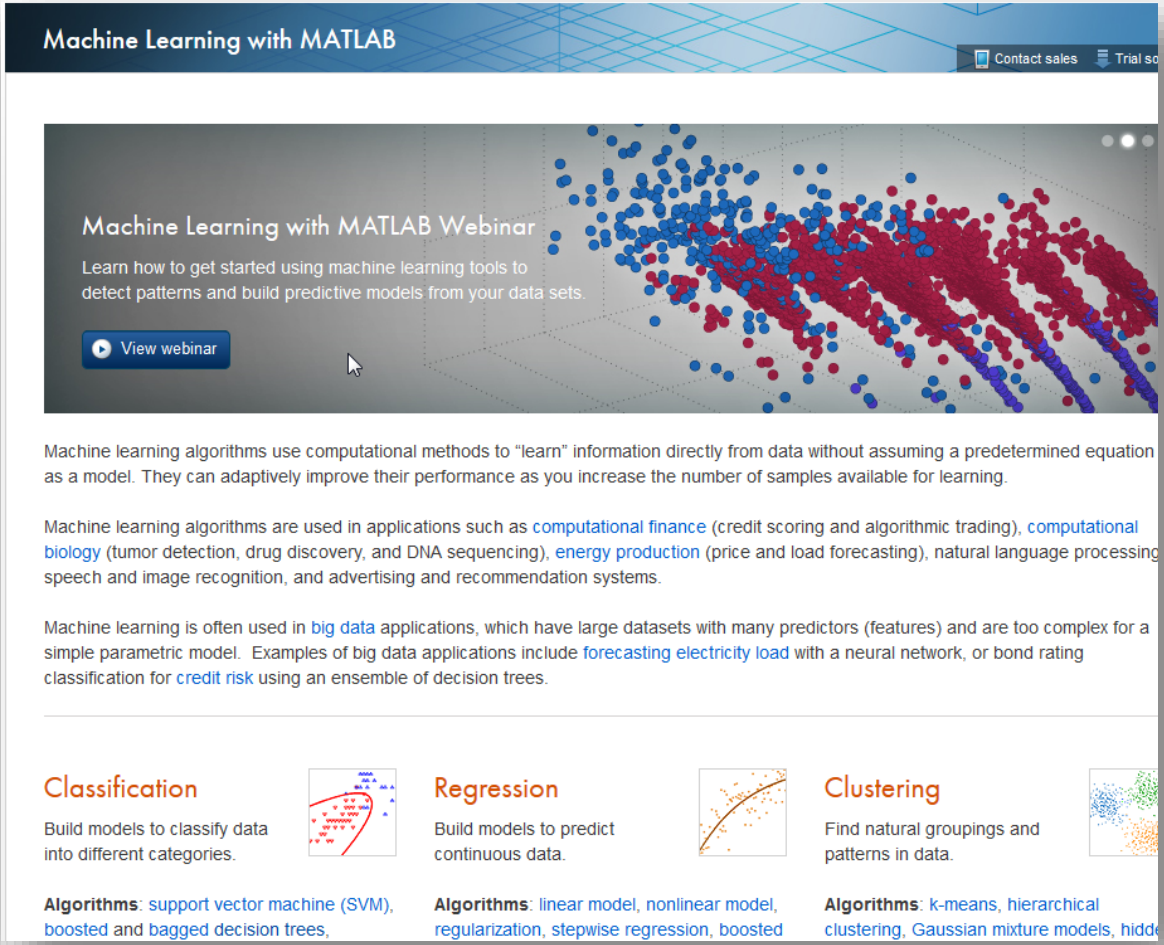
See recorded webinars

» Email Shashank

Additional Resources

Documentation: mathworks.com/machine-learning





Q & A