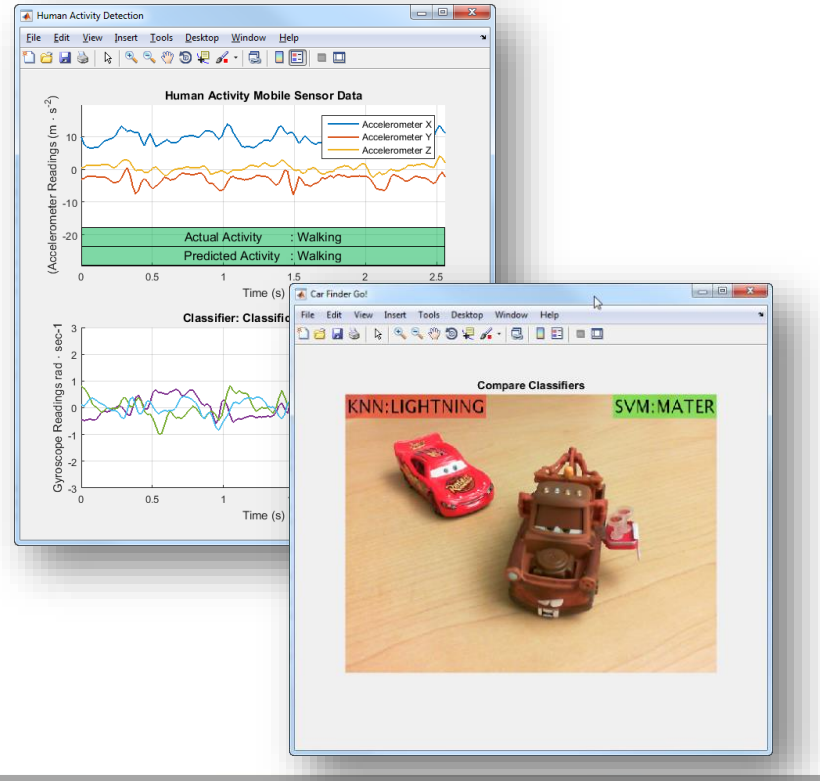
Machine Learning Made Easy



David Willingham

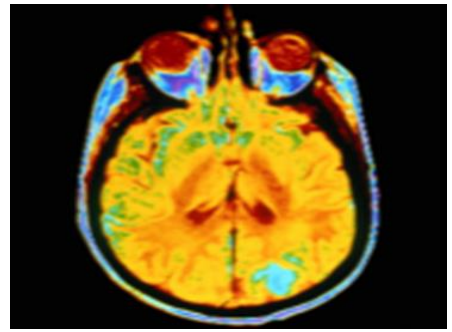
Senior Application Engineer

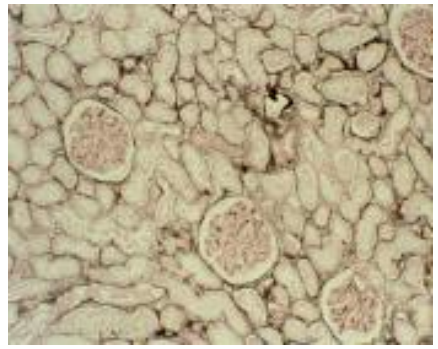
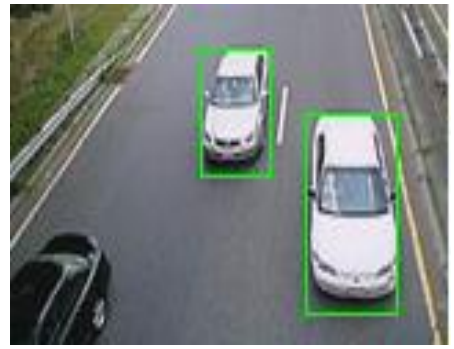
Agenda

- 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…

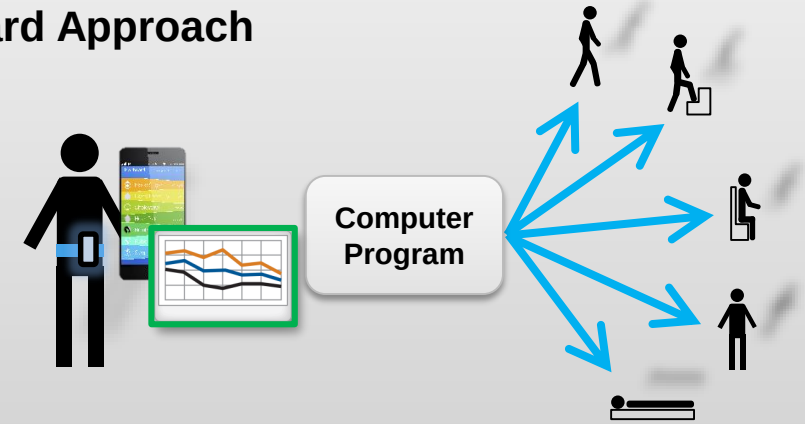


Machine Learning

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

Task: Human Activity Detection

Standard Approach



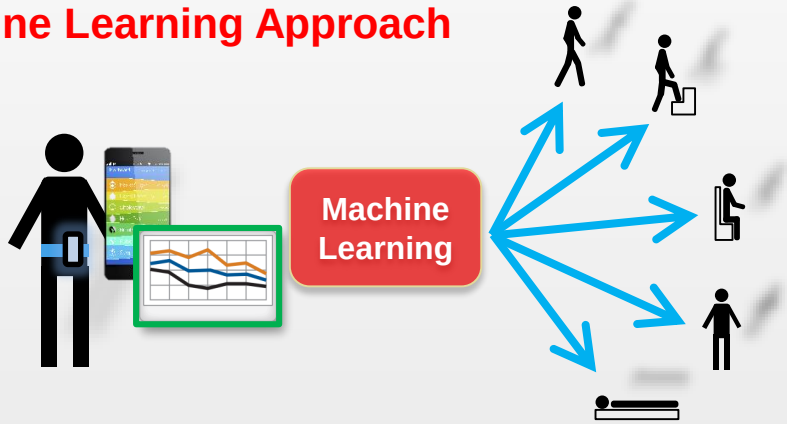
Hand Written Program

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

Formula or Equation

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

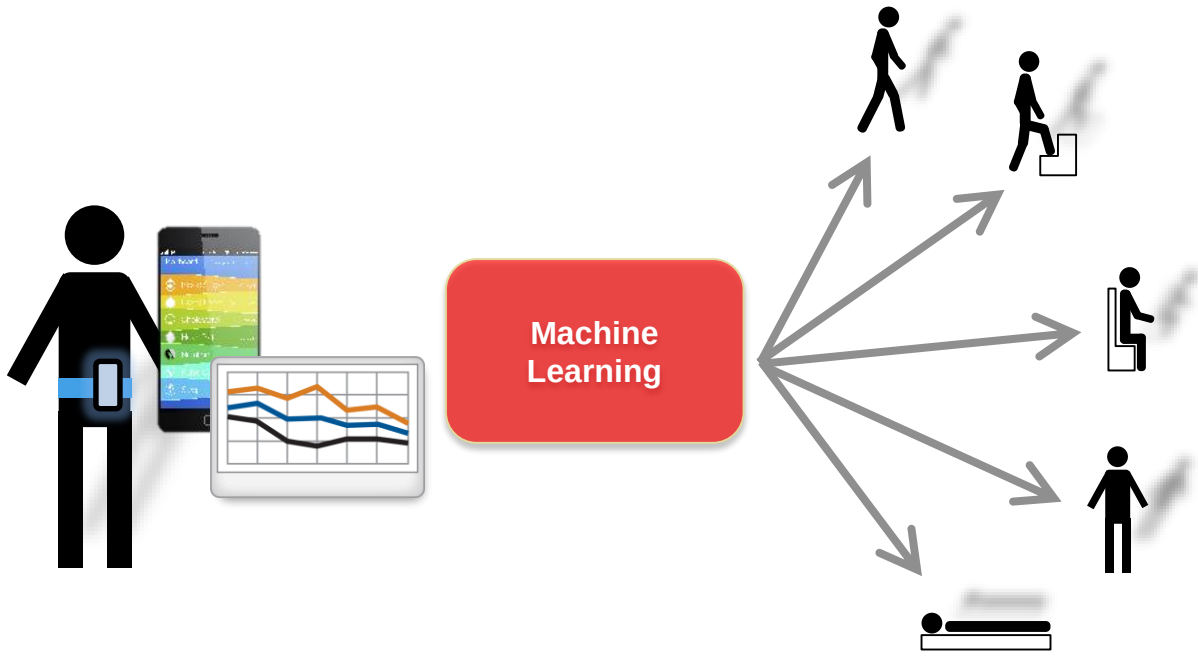
Machine Learning Approach

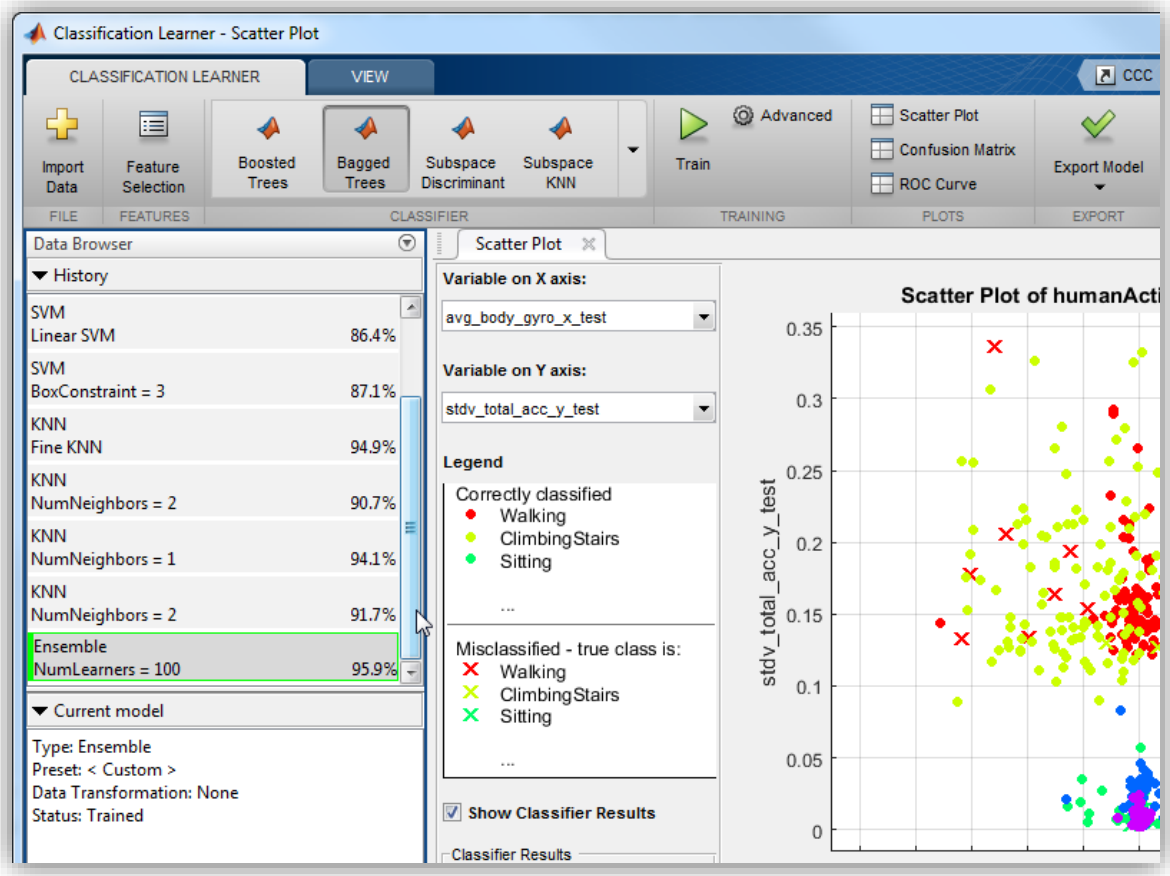


$model$: Inputs → Outputs

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

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

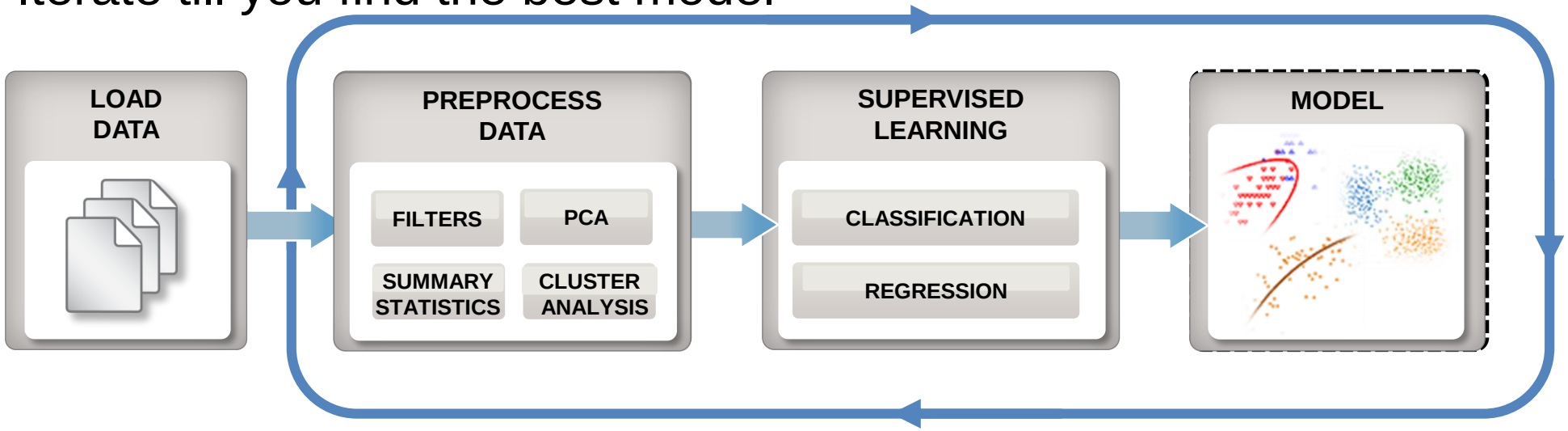
Challenges in Machine Learning

Hard to get started

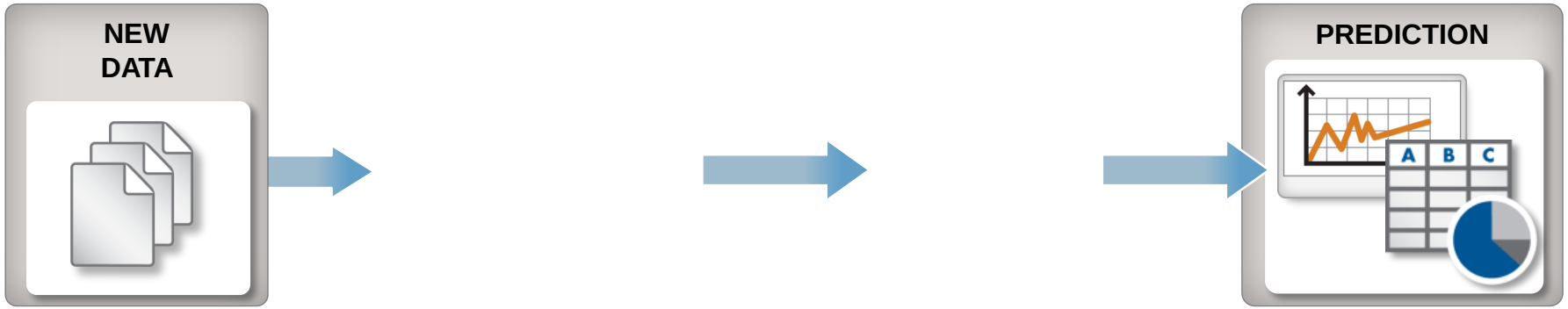
Steps	Challenge
Access, explore and analyze data	**Data diversity** Numeric, Images, Signals, Text – not always tabular

Machine Learning Workflow

Train: Iterate till you find the best model



Predict: Integrate trained models into applications



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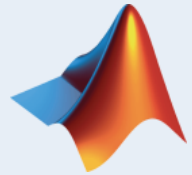

- Example 2: Real-time car identification using images
  - Learning from images
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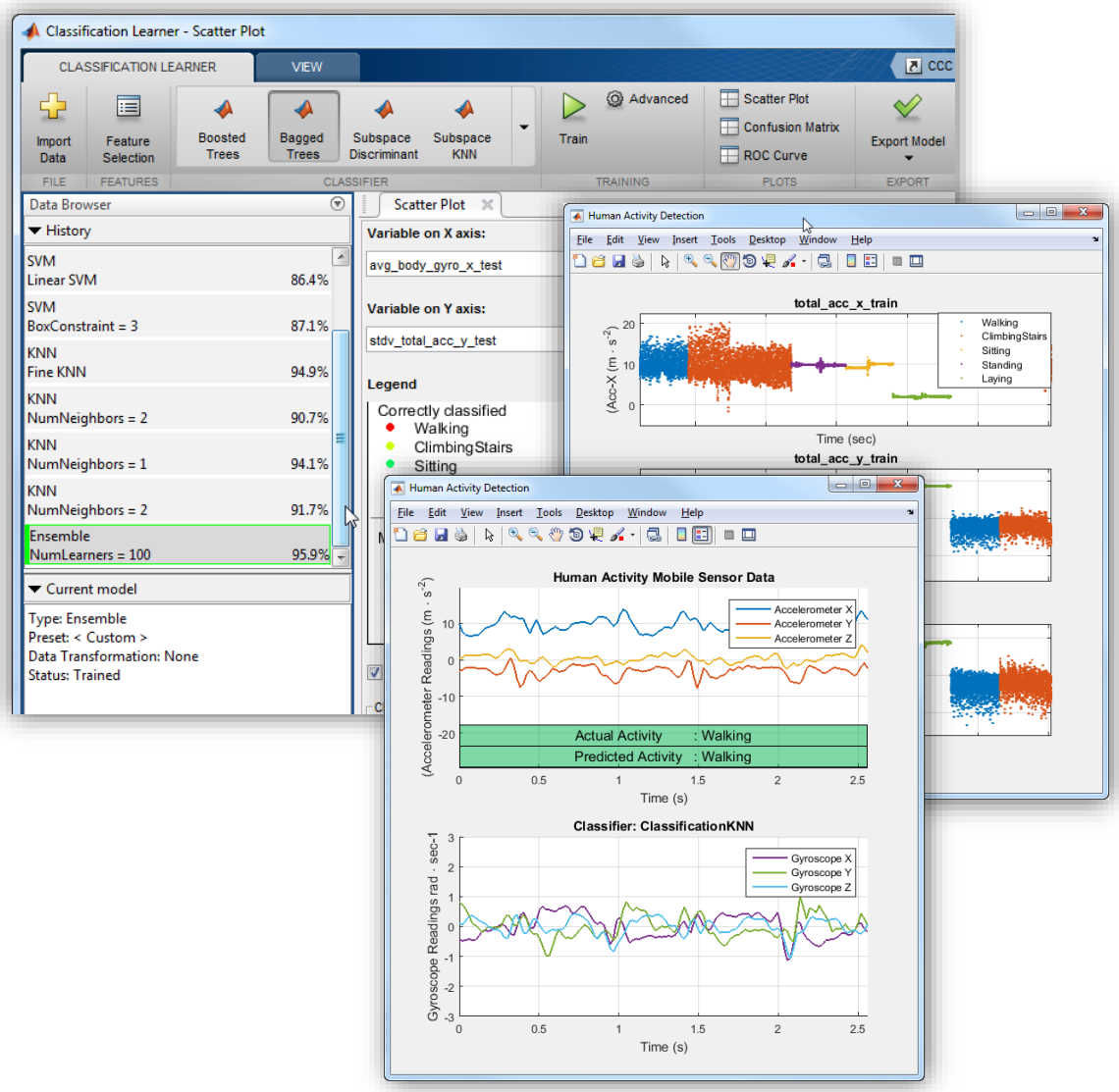
Example 1: Human Activity Learning Using Mobile Phone Data

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

Data:

Predictors	3-axial Accelerometer and Gyroscope data 
Response	Activity: 

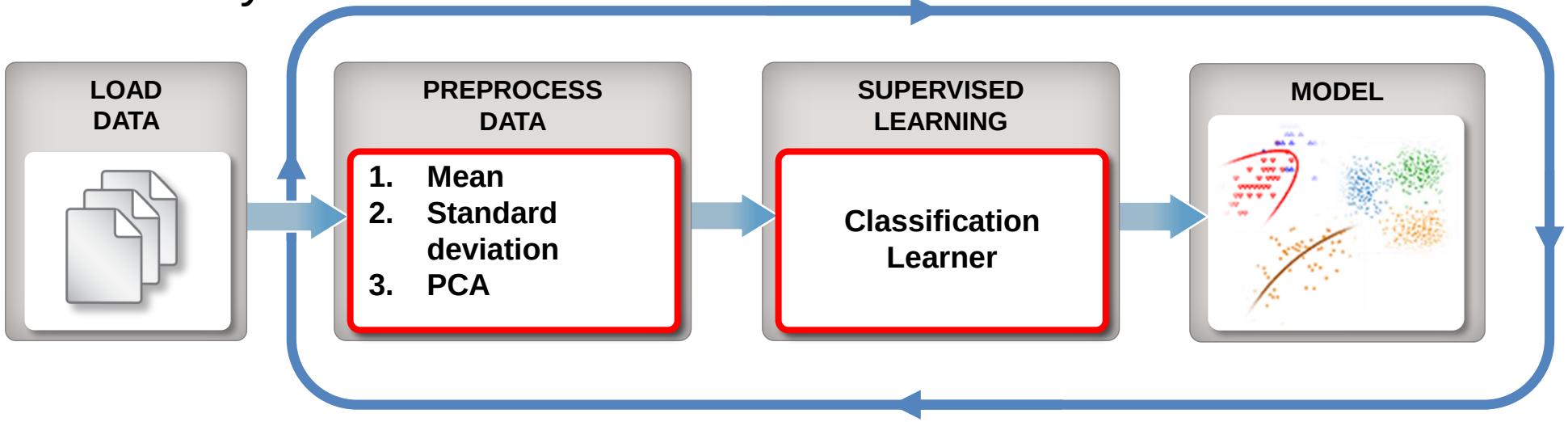


Approach:

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

Machine Learning Workflow for Example 1

Train: Iterate till you find the best model



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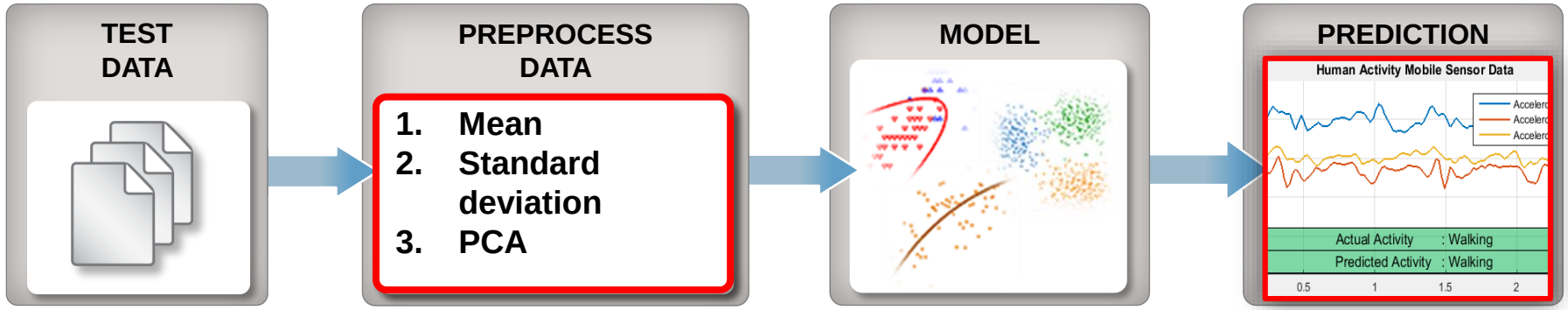

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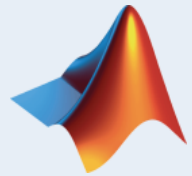


- Summary & Key Takeaways

Example 2: Real-time Car Identification Using Images

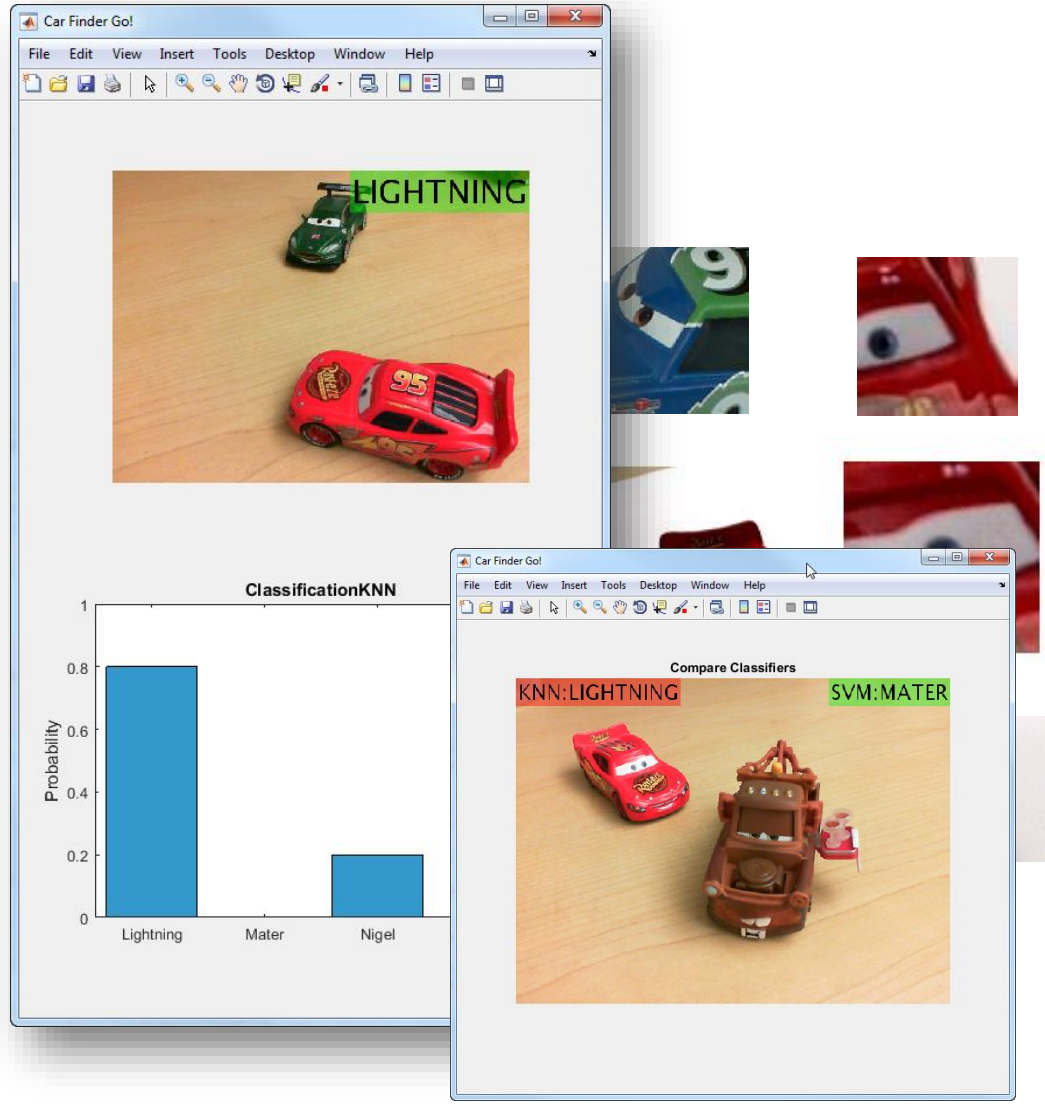
Objective: Train a classifier to identify car type from a webcam video

Data:

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

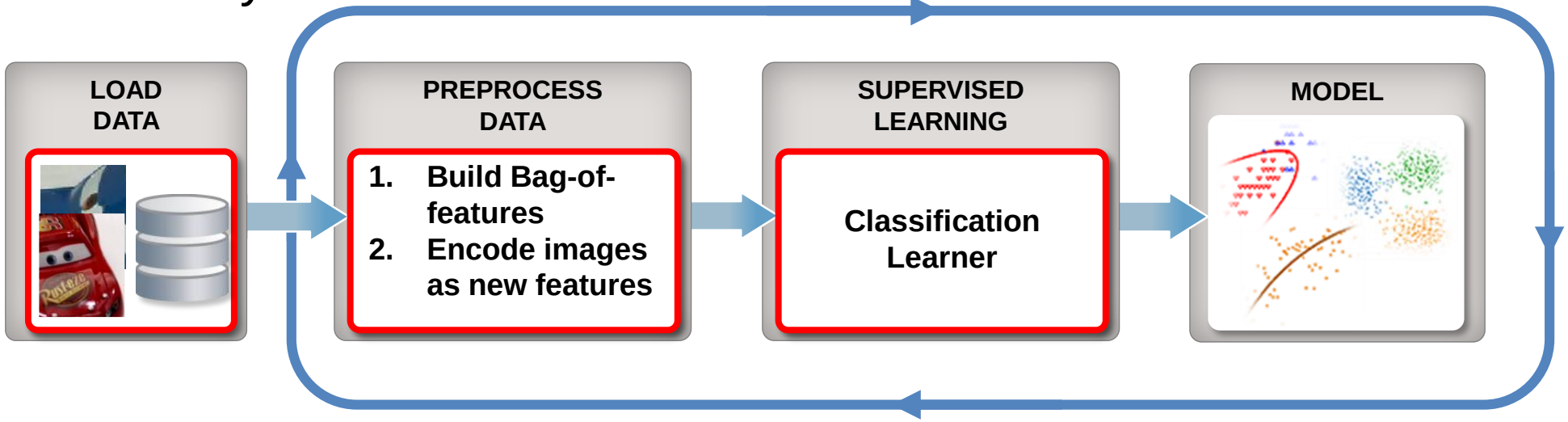
Approach:

- 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



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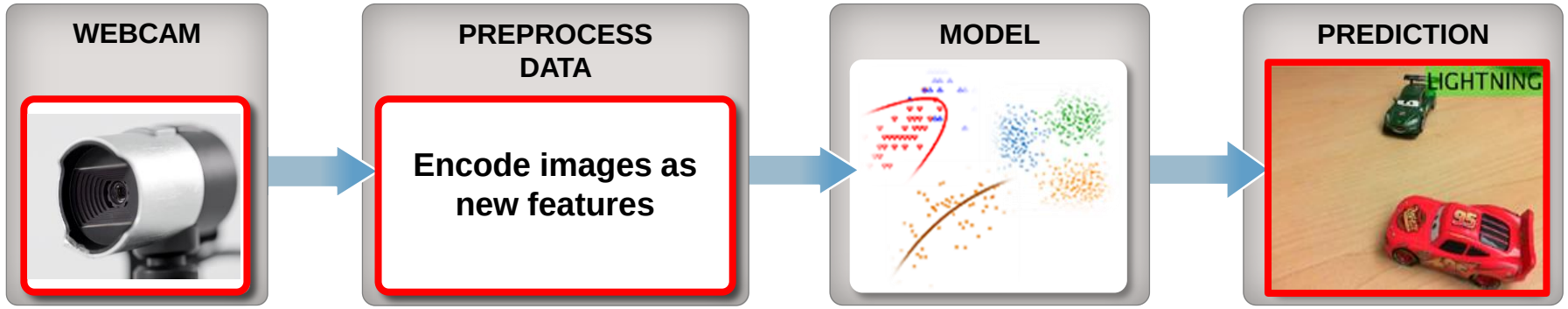

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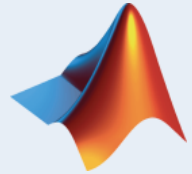
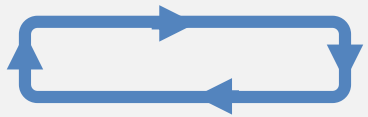
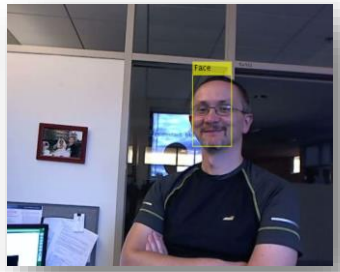


MATLAB Strengths for Machine Learning

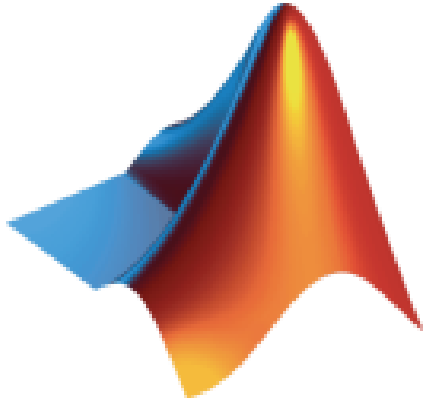
Steps	Challenge
Accessing, exploring and analyzing data	**Data diversity**
Preprocess data	**Lack of domain tools**
Train models	**Time consuming**
Assess model performance	**Avoid pitfalls** Over Fitting, Speed-Accuracy-Complexity
Iterate	

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*



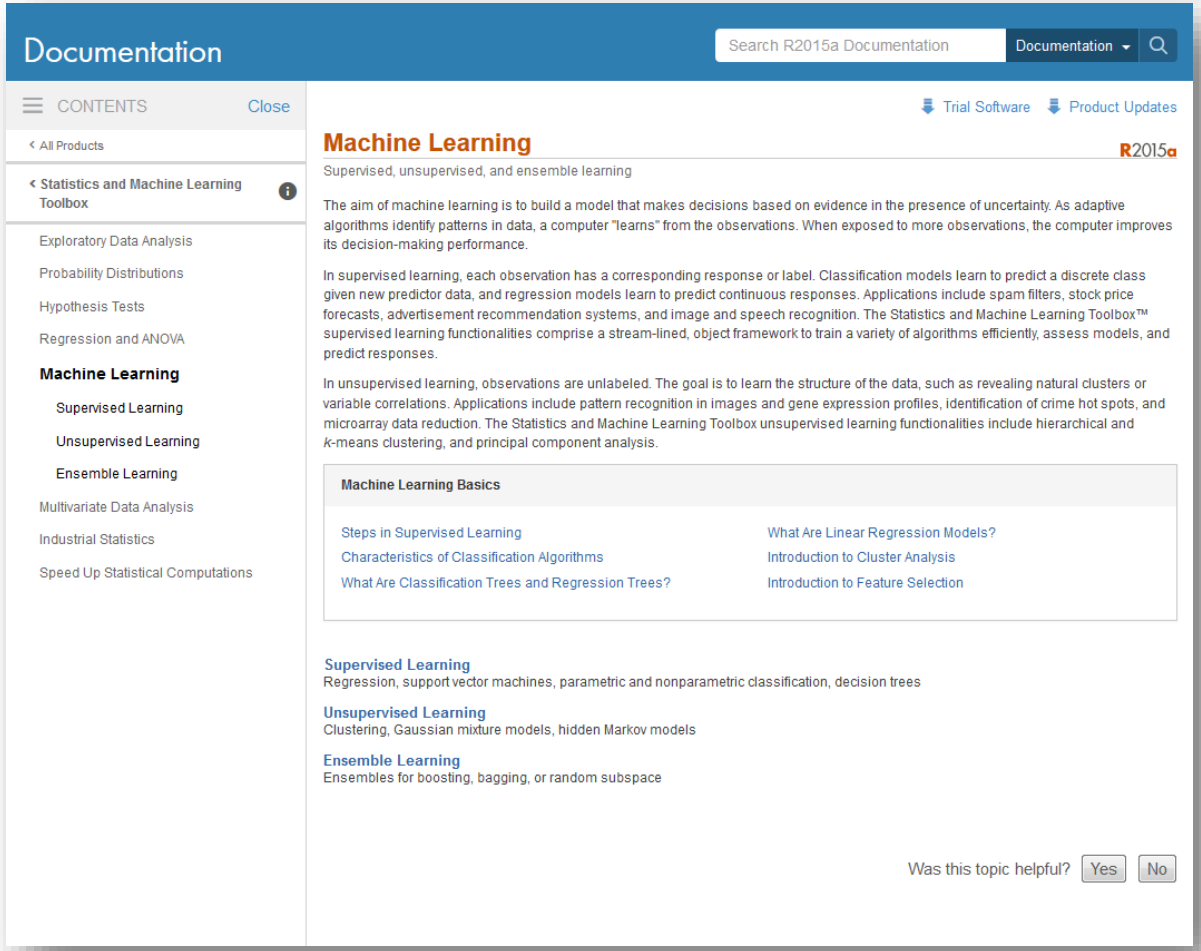
- MATLAB for Machine Learning

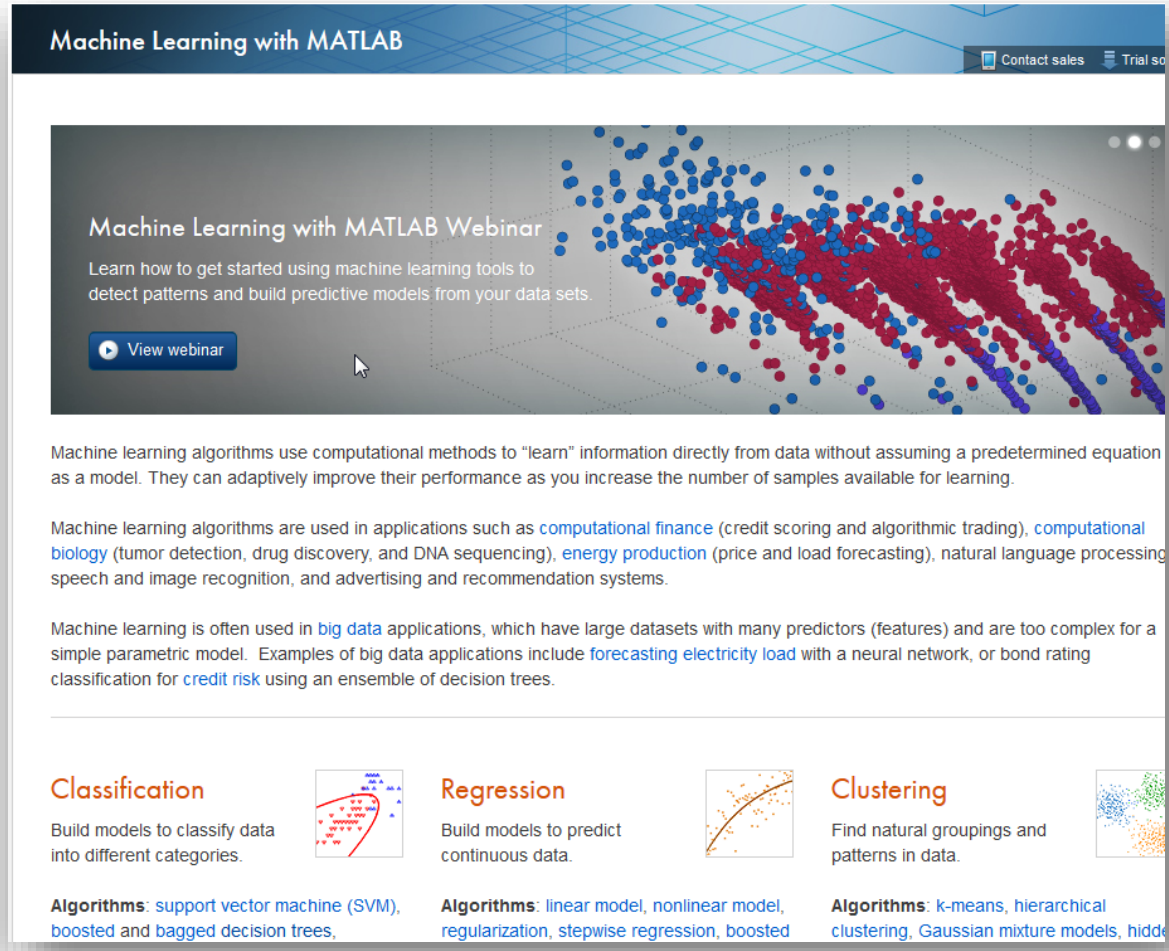


Email me if you have further questions

Additional Resources

Documentation: mathworks.com/machine-learning





Q & A