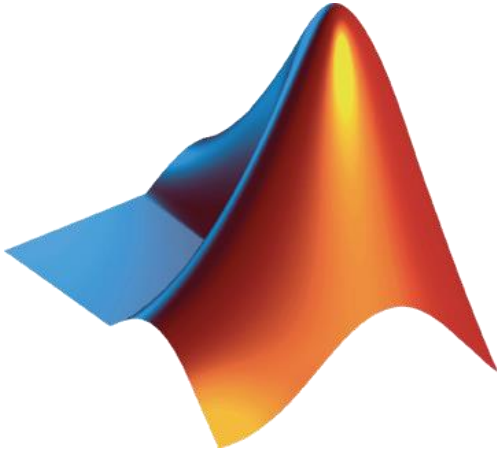
Machine Learning with MATLAB

This session will start at 12:00 PM PST (3:00 PM EST)

If you are having audio issues, please join audio by phone:
US Toll Free: 8773093457
US Toll: +14043971516
Access code: 719565187



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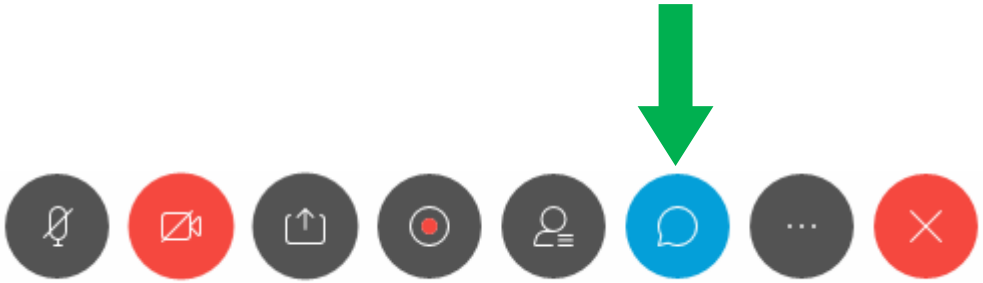
June 18, 2020

If you have questions/participation to the polls

- Please use “ “**Q&A**” or “**Chat**” and direct your questions to “**Panelists**”
- Please **participate in the polls**, presenter will adjust the presentation to the responses



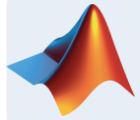
June 18 MATLAB Day Webinars (PST)

- 10:00 AM – 11:00 AM: **Data Analysis and Visualization with MATLAB for Beginners**
- 12:00 PM – 1:00 PM: **Machine Learning with MATLAB**
- 3:00 PM – 4:00 PM: **Deep Learning with MATLAB**
- 4:30 PM – 5:00 PM: **Learning MATLAB and Career Paths**

Agenda

- What is Machine Learning?
- Demo: Building a Classification Model
- Sharing and Deploying Machine Learning Algorithms
- Resources and Support

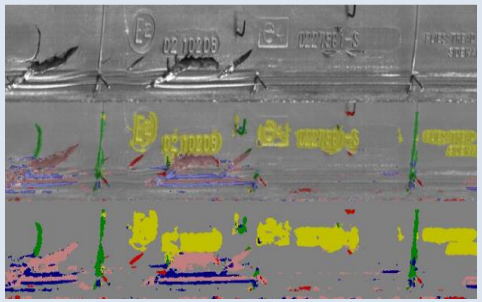
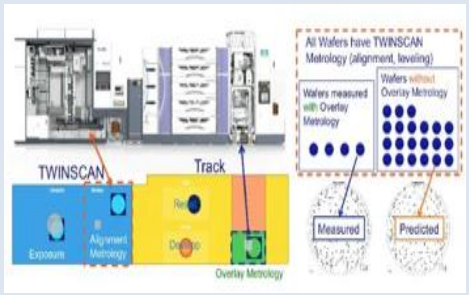
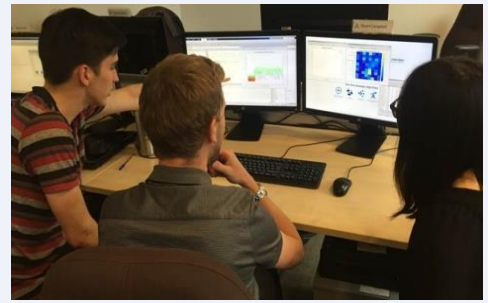
Agenda



What is Machine Learning?

- **Demo: Building a Classification Model**
- **Sharing and Deploying Machine Learning Algorithms**
- **Resources and Support**

Machine Learning is Everywhere

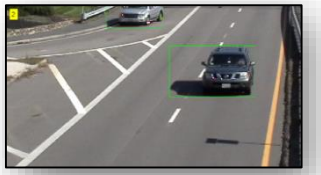
Automobile	Industrial Automation	CES & Aero Defense	Energy & Finance
			
Tire Wear BRIDGESTONE	Overlay metrology improvement ASML	Telecom customer churn prediction Cognizant	Forecasting & Risk Analysis HORIZON WIND POWER
			
Detect Oversteer BMW	Building energy use optimization BuildingIQ	Engine Health (Predictive Maintenance) SAFRAN	Portfolio Allocation Aberdeen Asset management

What is Machine Learning?

Ability to learn from data without being explicitly programmed

Solution is too complex for hand written rules or equations

Speech Recognition


Object Recognition


Engine Health Monitoring

learn complex non-linear relationships

Solution needs to adapt with changing data

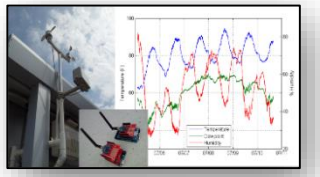

Weather Forecasting


Energy Load Forecasting

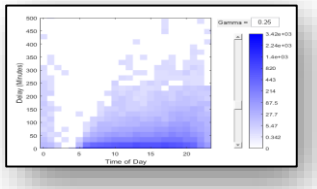

Stock Market Prediction

update as more data becomes available

Solution needs to scale


IoT Analytics

Taxi Availability


Airline Flight Delays

learn efficiently from very large data sets

Machine Learning Workflow

Access and Explore Data

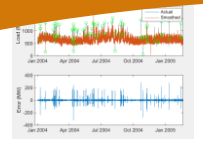
Files

Database

Sensors

Preprocess Data

Working with Messy Data



Data Reduction/ Transformation

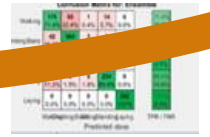
Feature Extraction

Develop Predictive Models

Model Creation e.g. Machine Learning

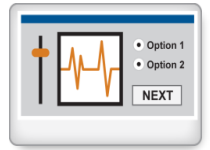
Parameter Optimization

Model Validation



Integrate Analytics with Systems

Desktop Apps

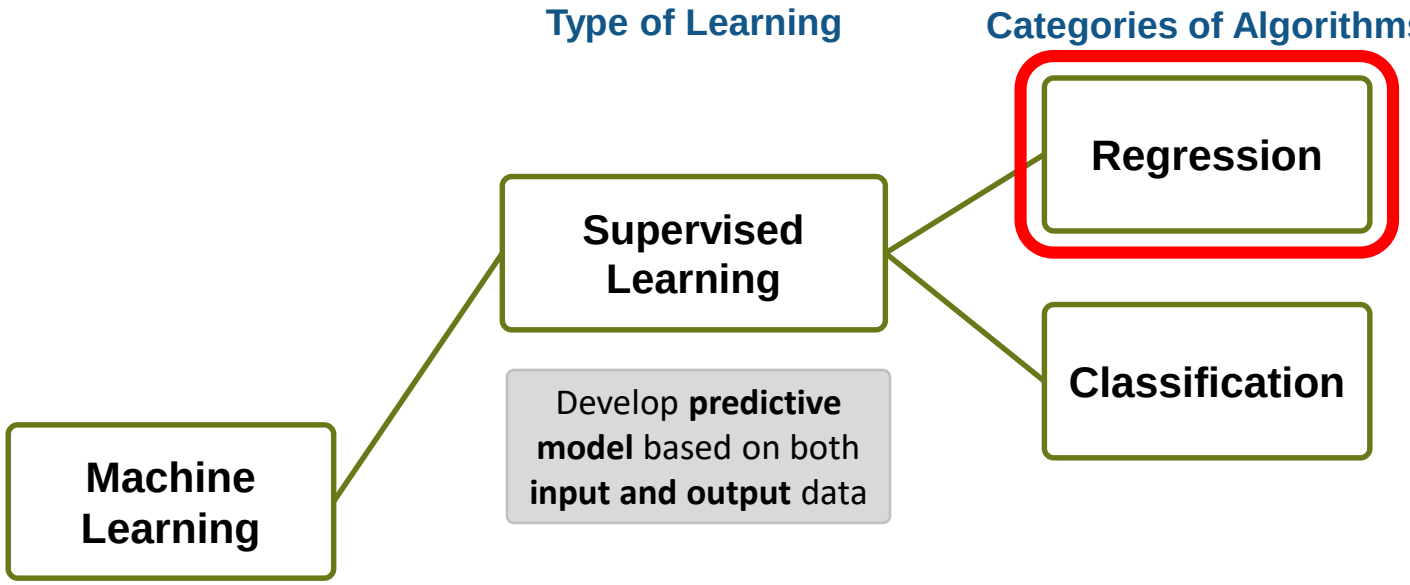


Enterprise Scale Systems

MATLAB Excel .NET C/C++ .exe Java .dll

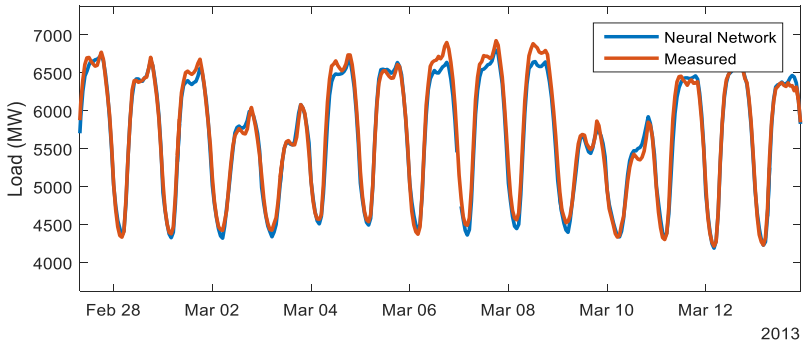
Embedded Devices and Hardware

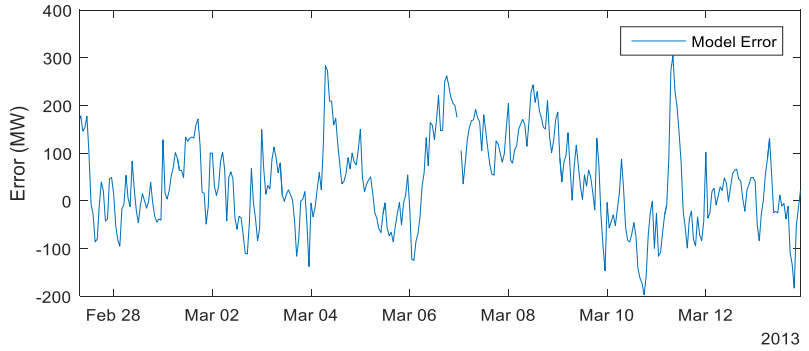
Types of Machine Learning



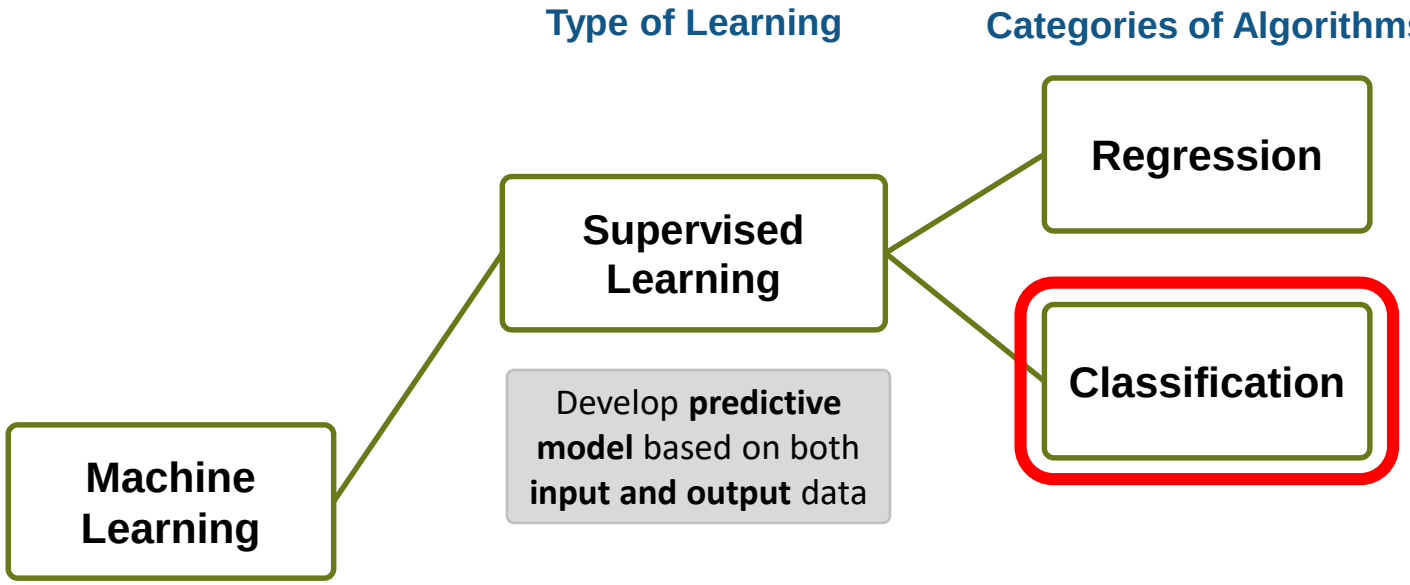
Objective:

Easy and accurate computation of day-ahead system load forecast





Types of Machine Learning



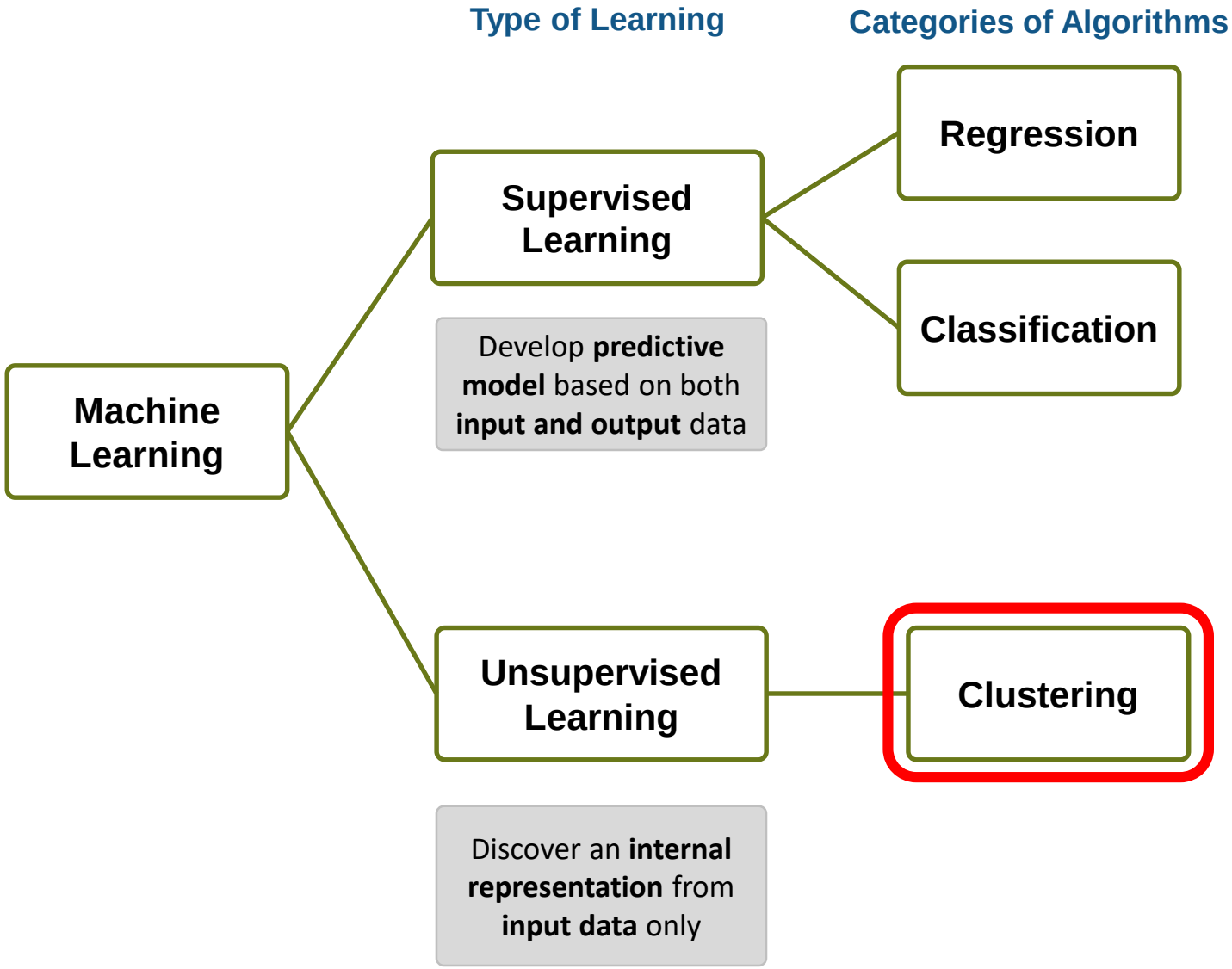
Objective:

Train a classifier to classify human activity from sensor data

Data:

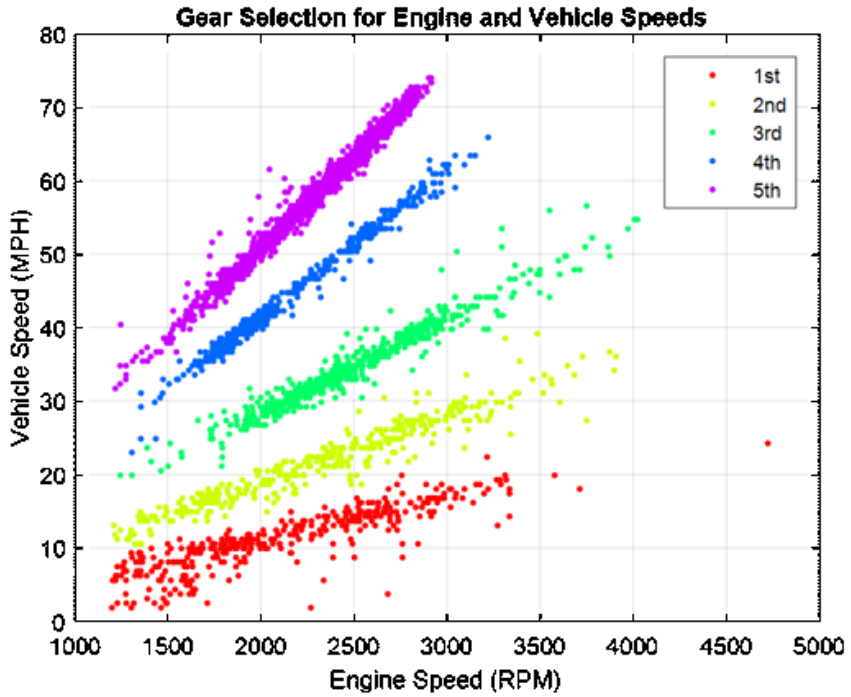
Inputs	3-axial Accelerometer 3-axial Gyroscope 
Outputs	

Types of Machine Learning

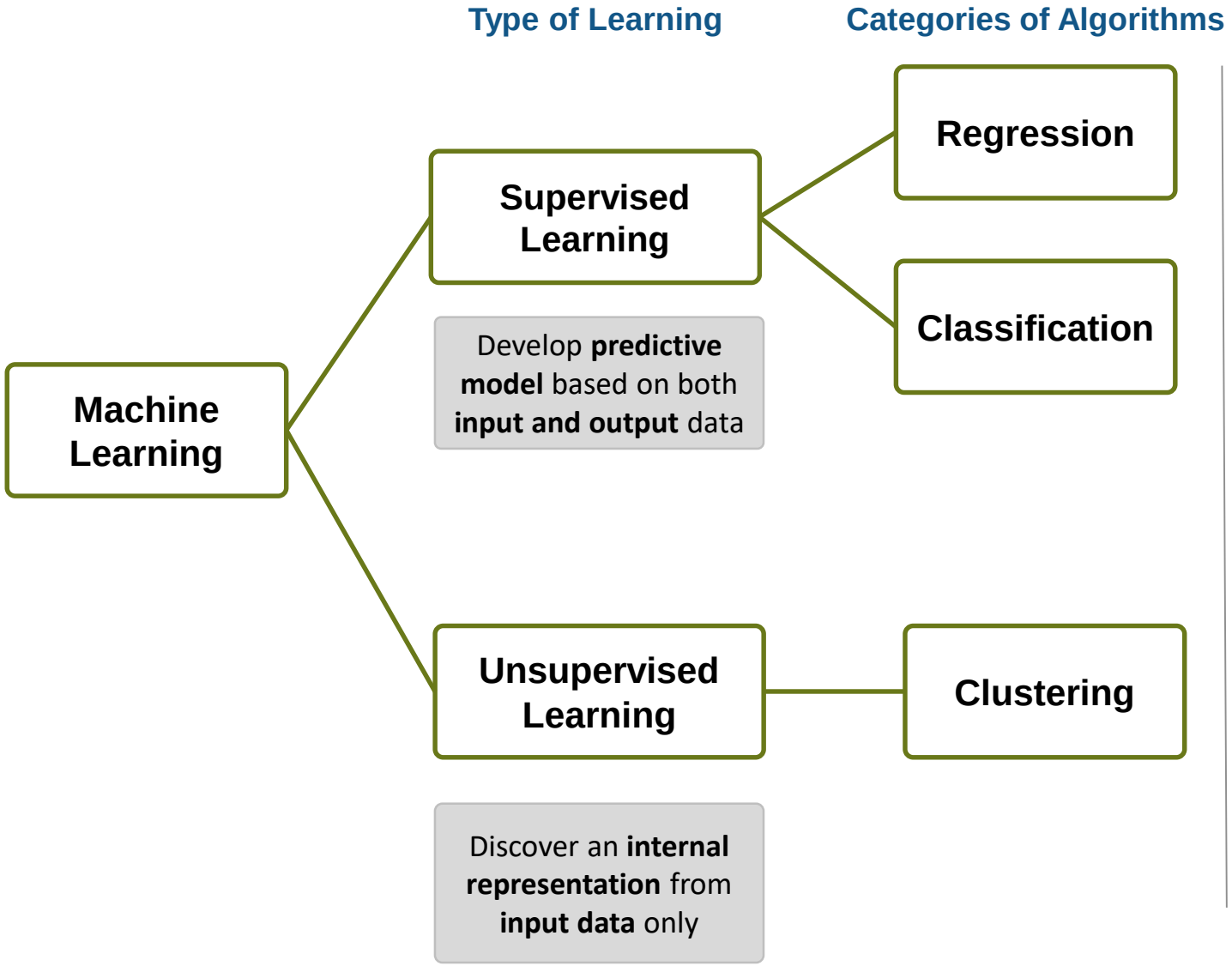


Objective:

Given data for engine speed and vehicle speed, identify clusters



Different Types of Machine Learning



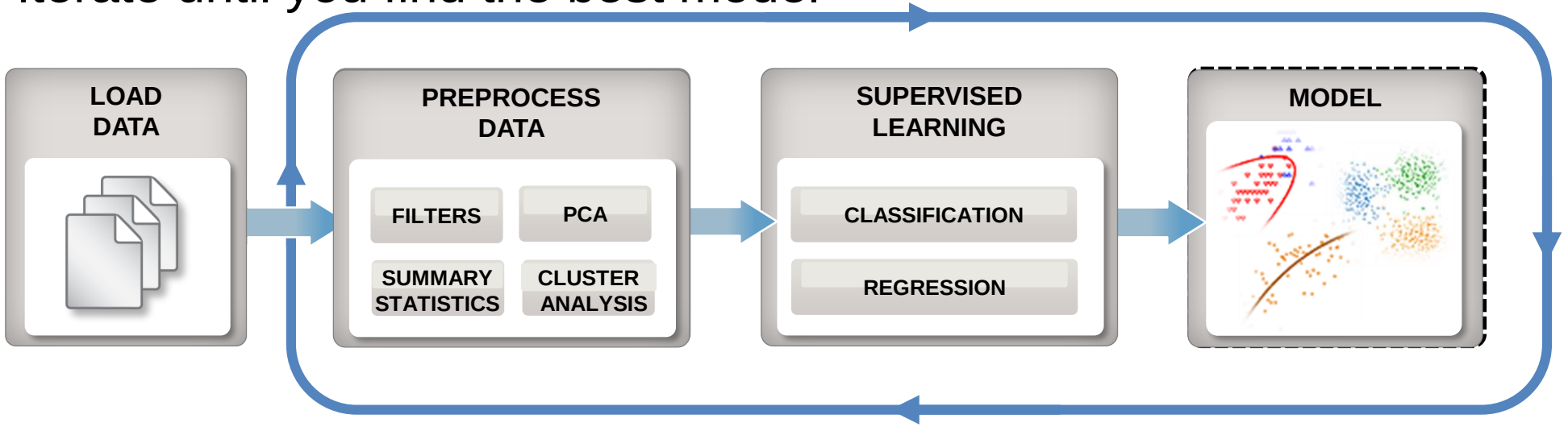
- Output is a real number (temperature, stock prices, load forecasting).

- Output is a choice between classes
- (True, False), (Red, Blue, Green), (Standing, Sitting, Walking,…)

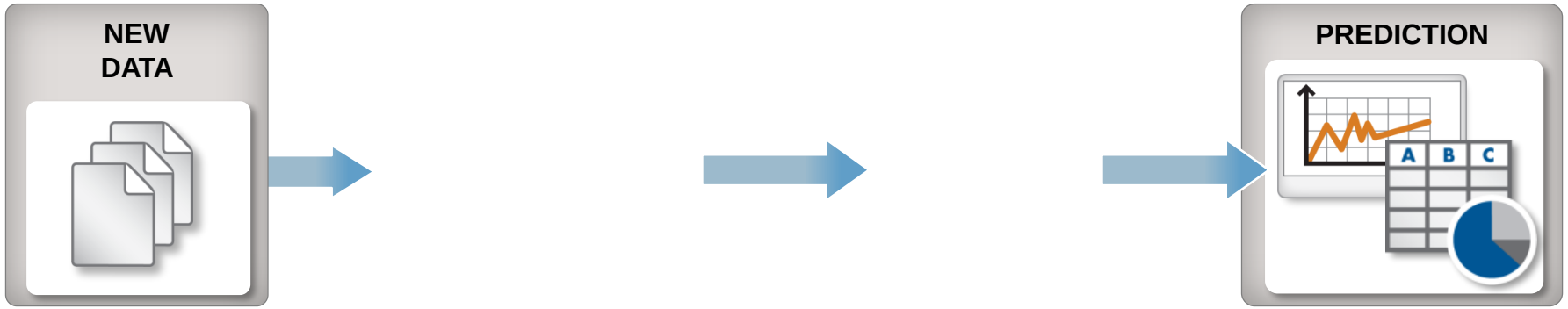
- Discover a good internal representation
- Learn a low dimensional representation

Supervised Learning Workflow

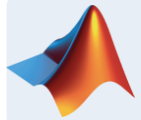
Train: Iterate until you find the best model



Predict: Integrate trained models into applications

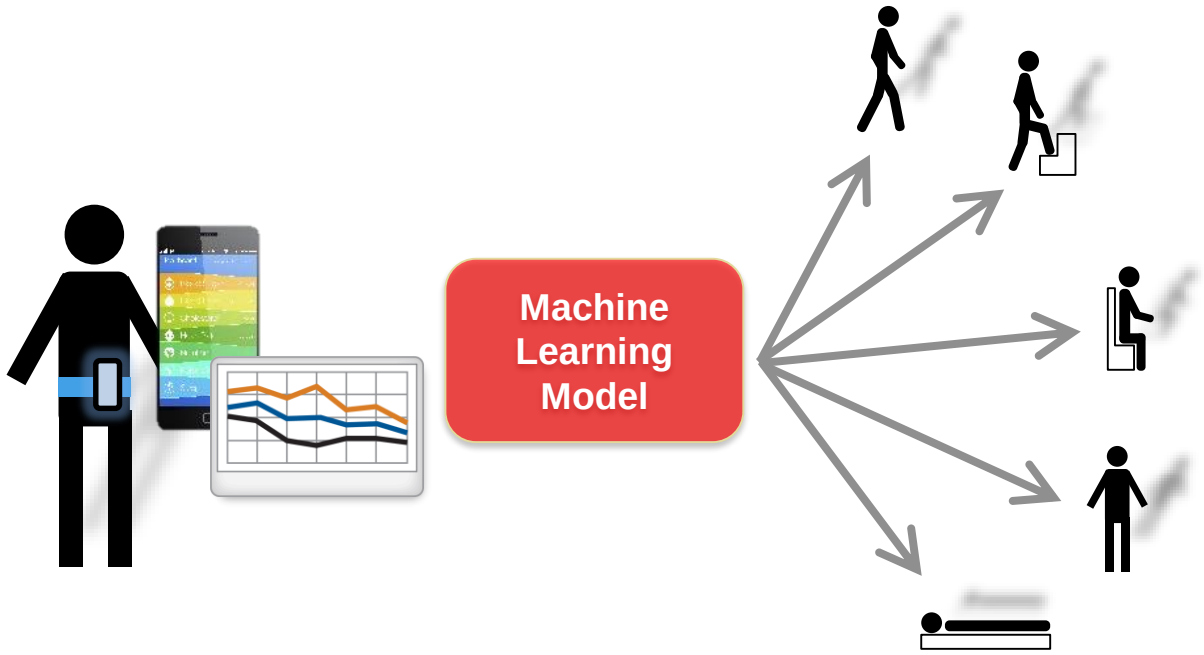


Agenda

- What is Machine Learning?
-  Demo: Building a Classification Model
- Deploying Machine Learning Algorithms
- Resources and Support

Example: Human Activity Recognition

Classification



Data:

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

Dataset courtesy of:
Davide Anguita, Alessandro Ghio, Luca Oneto, Xavier Parra and Jorge L. Reyes-Ortiz.
Human Activity Recognition on Smartphones using a Multiclass Hardware-Friendly Support Vector Machine.
International Workshop of Ambient Assisted Living (IWAAL 2012). Vitoria-Gasteiz, Spain. Dec 2012
http://archive.ics.uci.edu/ml/datasets/Human+Activity+Recognition+Using+Smartphones

Example: Human Activity Recognition

Classification

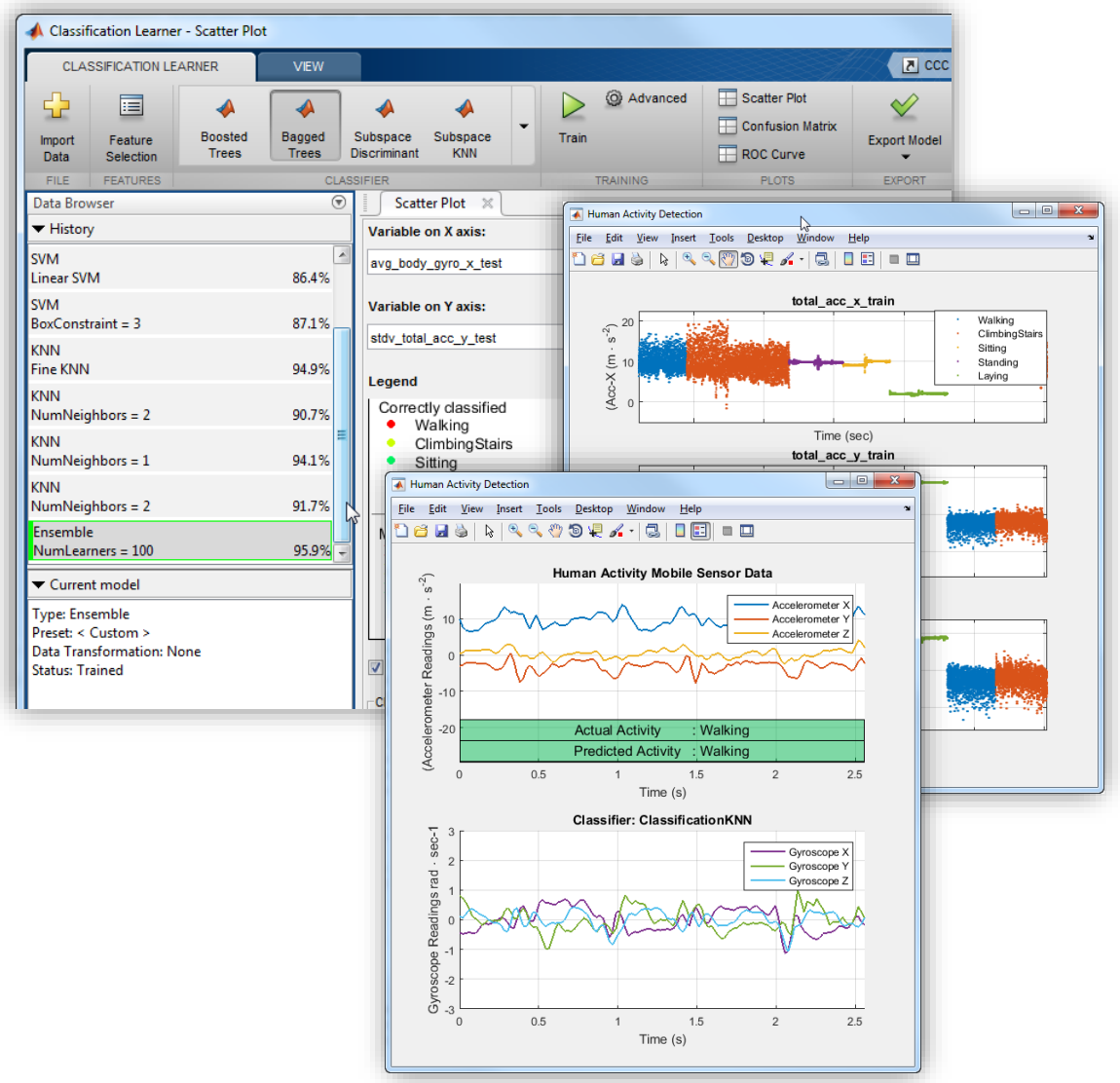
Goal: Train a model to classify human activity from sensor data

Data:

Predictors	3-axis Accelerometer and Gyroscope data 
Response	Activity: 

Approach:

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



Example: Human Activity Recognition

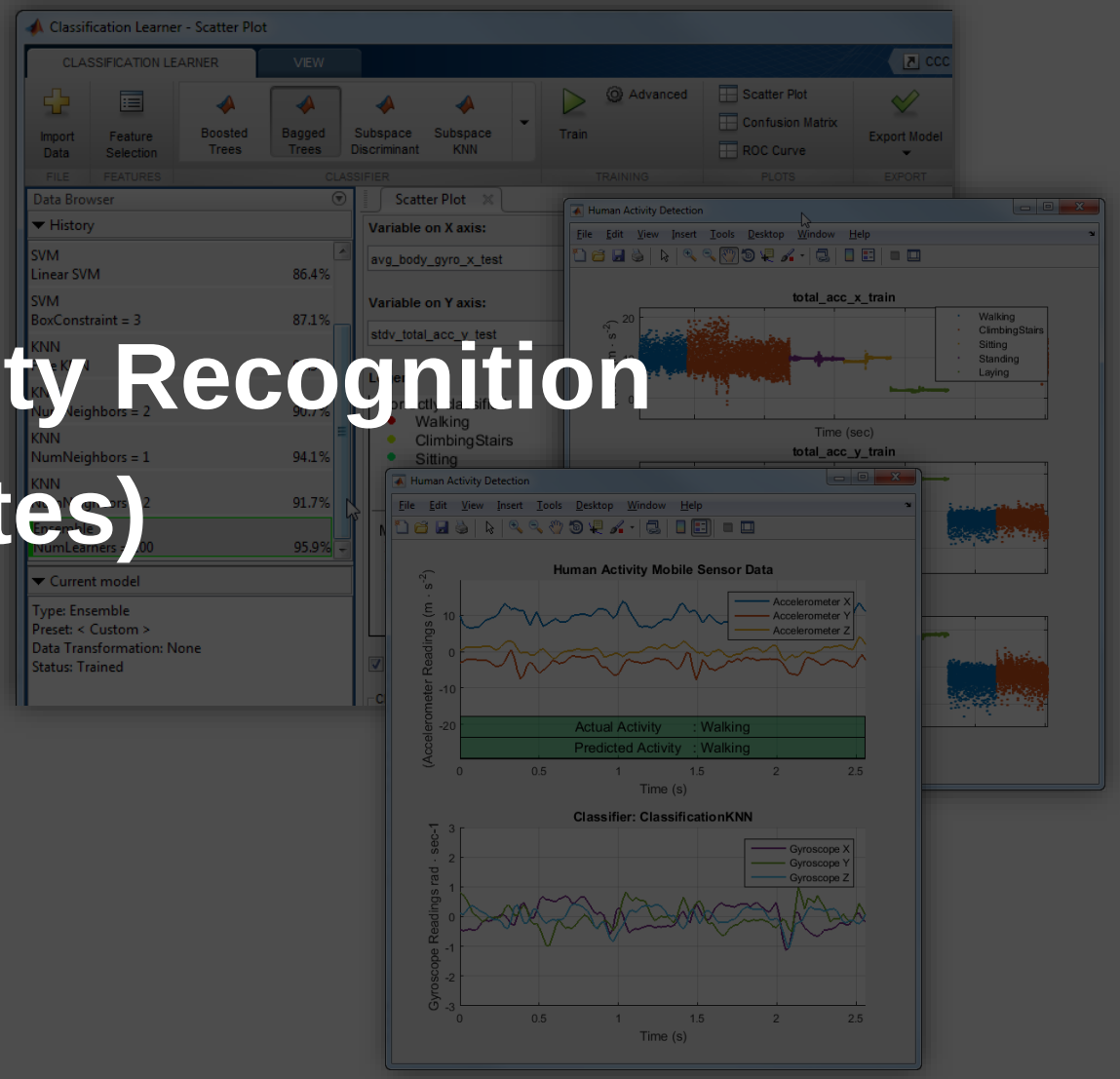
Classification

Goal: Train a model to classify human activity from sensor data

Data:

Predictors	3-axis Accelerometer and Gyroscope data
Response	Activity: 

Demo: Human Activity Recognition (30 minutes)



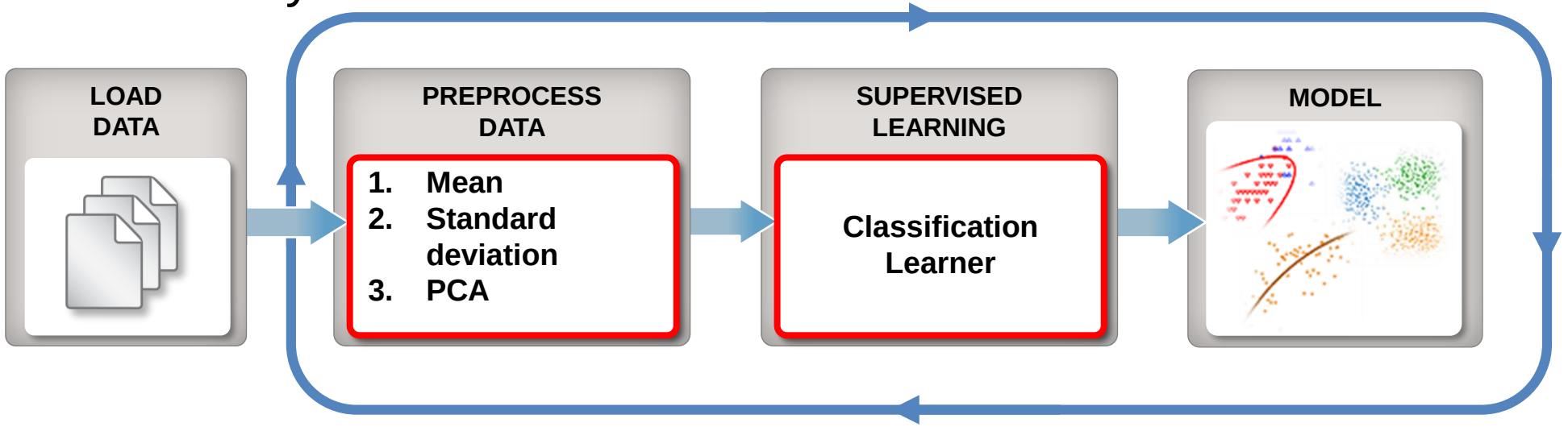
Approach:

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

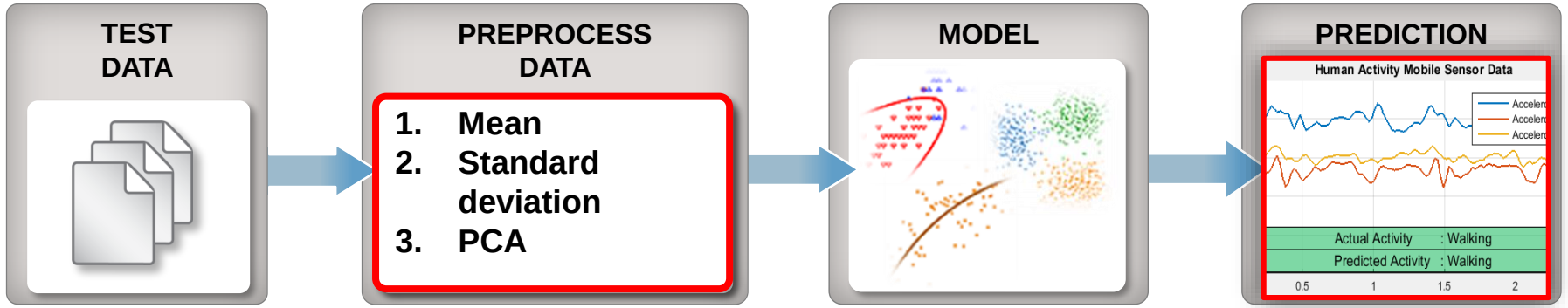
"Essentially, all models are wrong,
but some are useful."
– George Box

Machine Learning Workflow for Classification Example

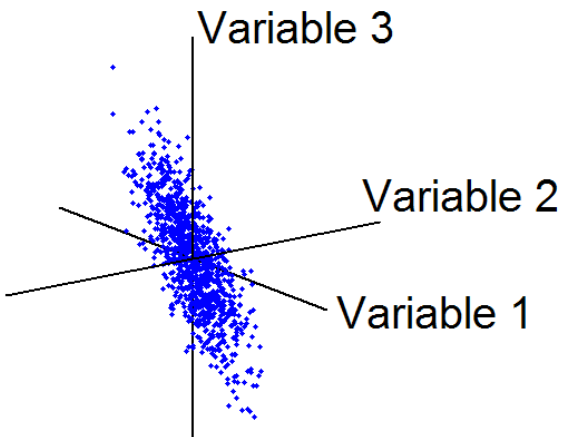
Train: Iterate until you find the best model

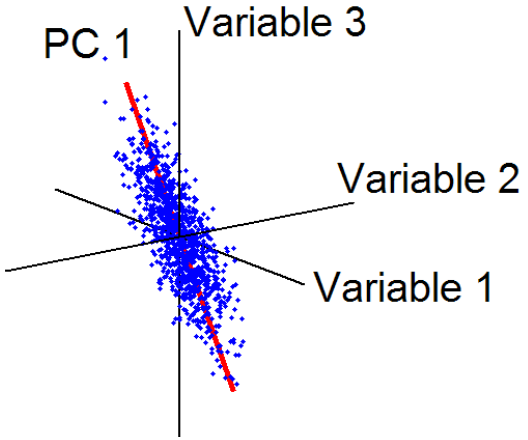


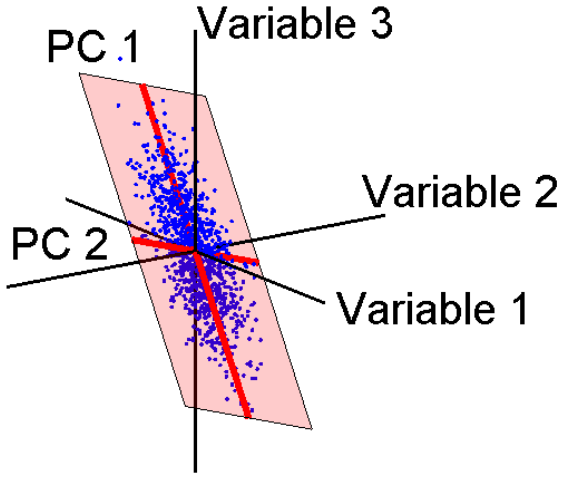
Predict: Integrate trained models into applications

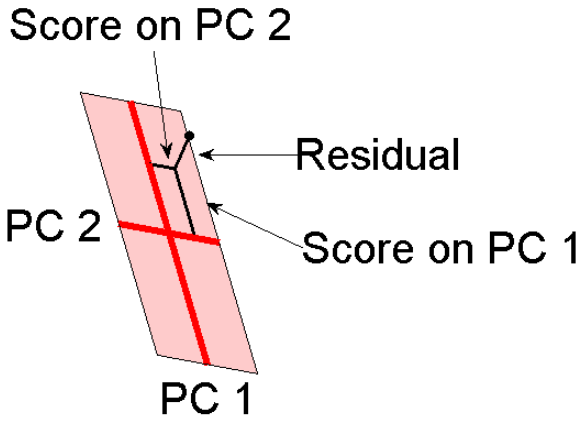


Principal Components Analysis









Feature Engineering

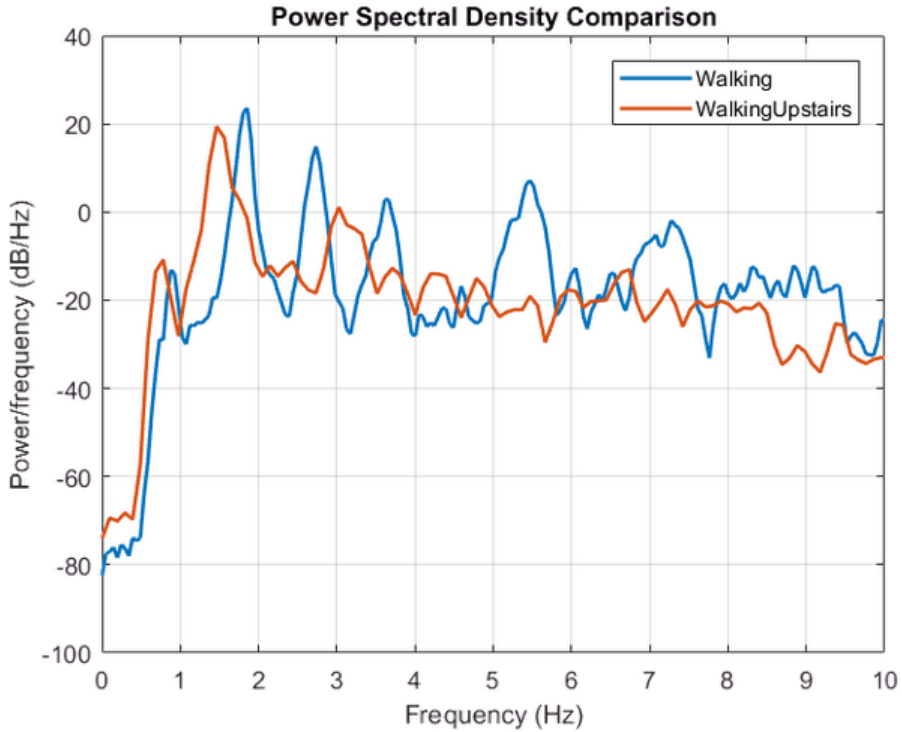
Using domain knowledge to create features for machine learning algorithms

Feature transformation: Reduce dimensionality

Feature selection: Choose subset of most relevant features

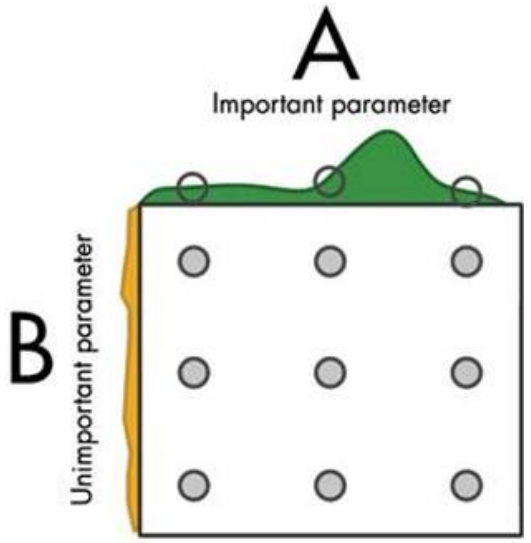
Possible feature engineering ideas:

- Additional statistics – PCA, NCA etc.
- Signal Processing Techniques – power spectral density, wavelets etc.
- Image Processing Techniques – bag of words, pixel intensity etc.
- Get creative!

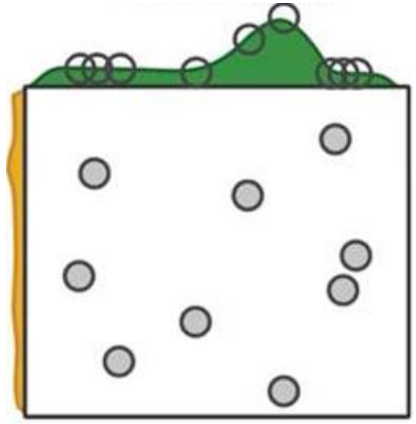


Hyperparameter Tuning

Standard:
Grid Search

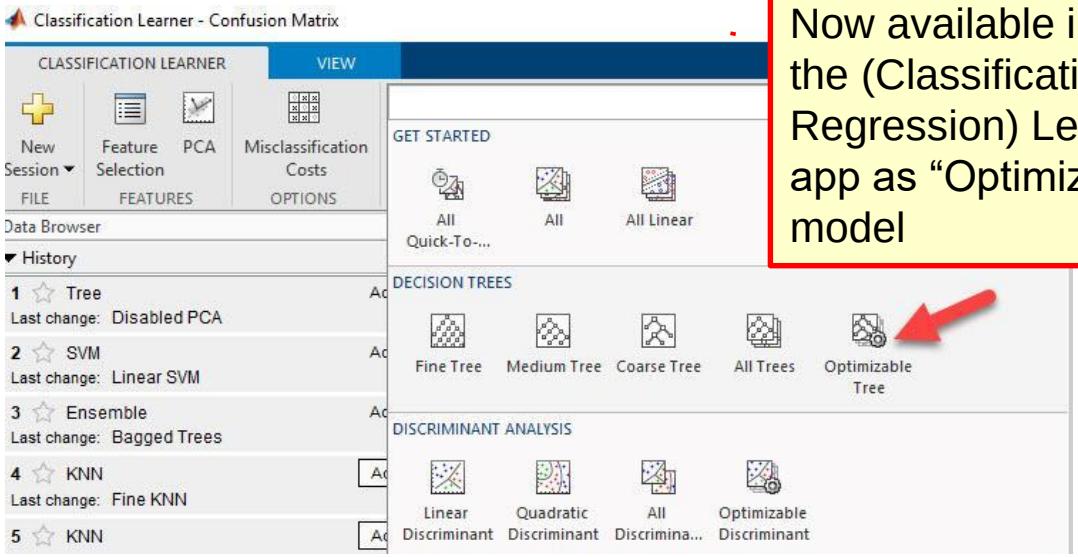


Maybe Better:
Random Search



Bayesian Optimization

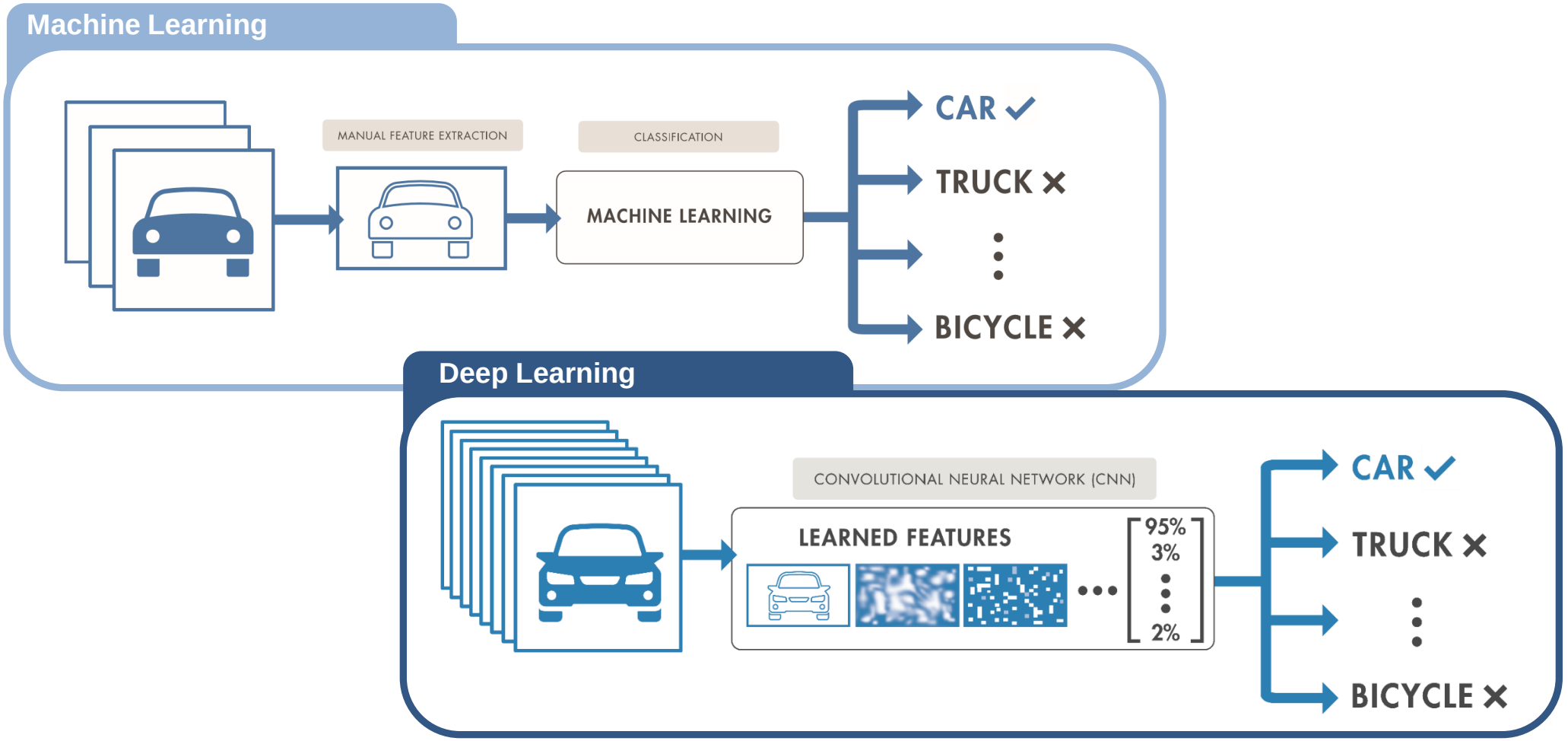
- Bayesian model indicates impact of change
- Model picks “good” point to try next
- Much more efficient!
- Scale to multi-cores (using PCT) for larger datasets



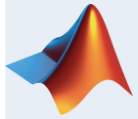
Now available inside the (Classification/ Regression) Learner app as “Optimizable” model

Machine Learning vs Deep Learning

Deep learning performs **end-to-end learning** by learning **features, representations and tasks** directly from **images, text and sound**

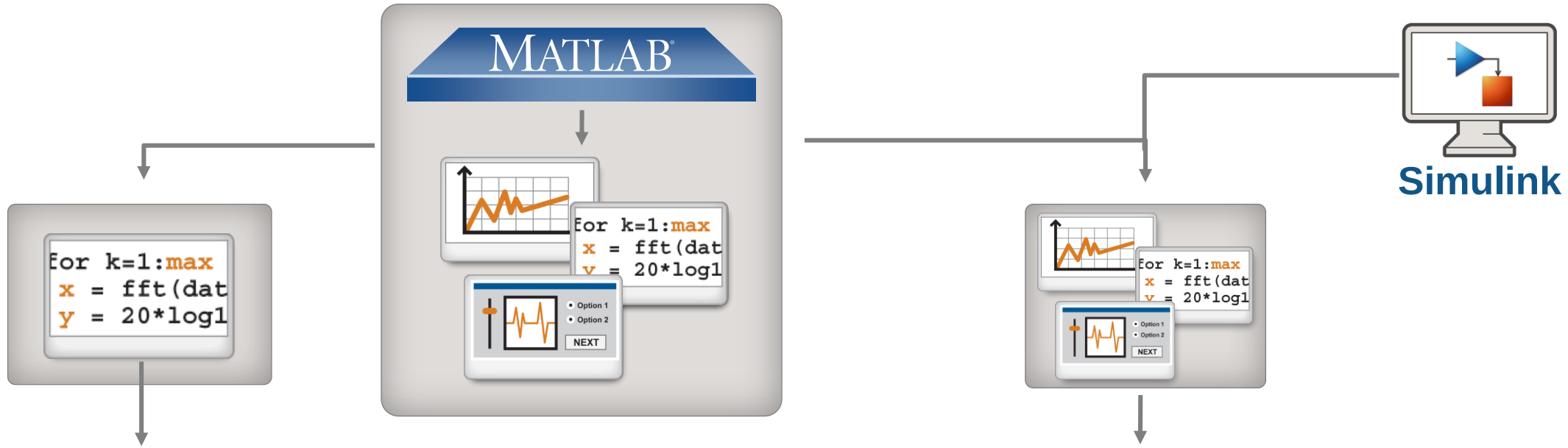


Agenda

- Machine Learning Introduction
- Demo: Building a Classification Model
-  Sharing and Deploying Machine Learning Algorithms
- Resources and Support

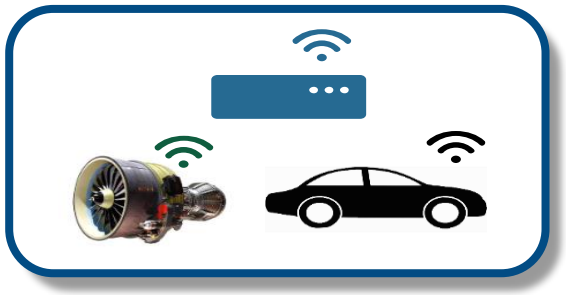
Deploying Algorithms and Models

MATLAB Analytics
run anywhere



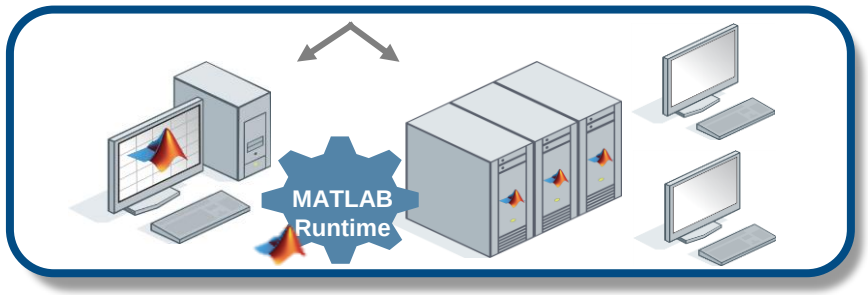
Embedded Hardware

C, C++ | HDL | PLC | CUDA



Enterprise Systems

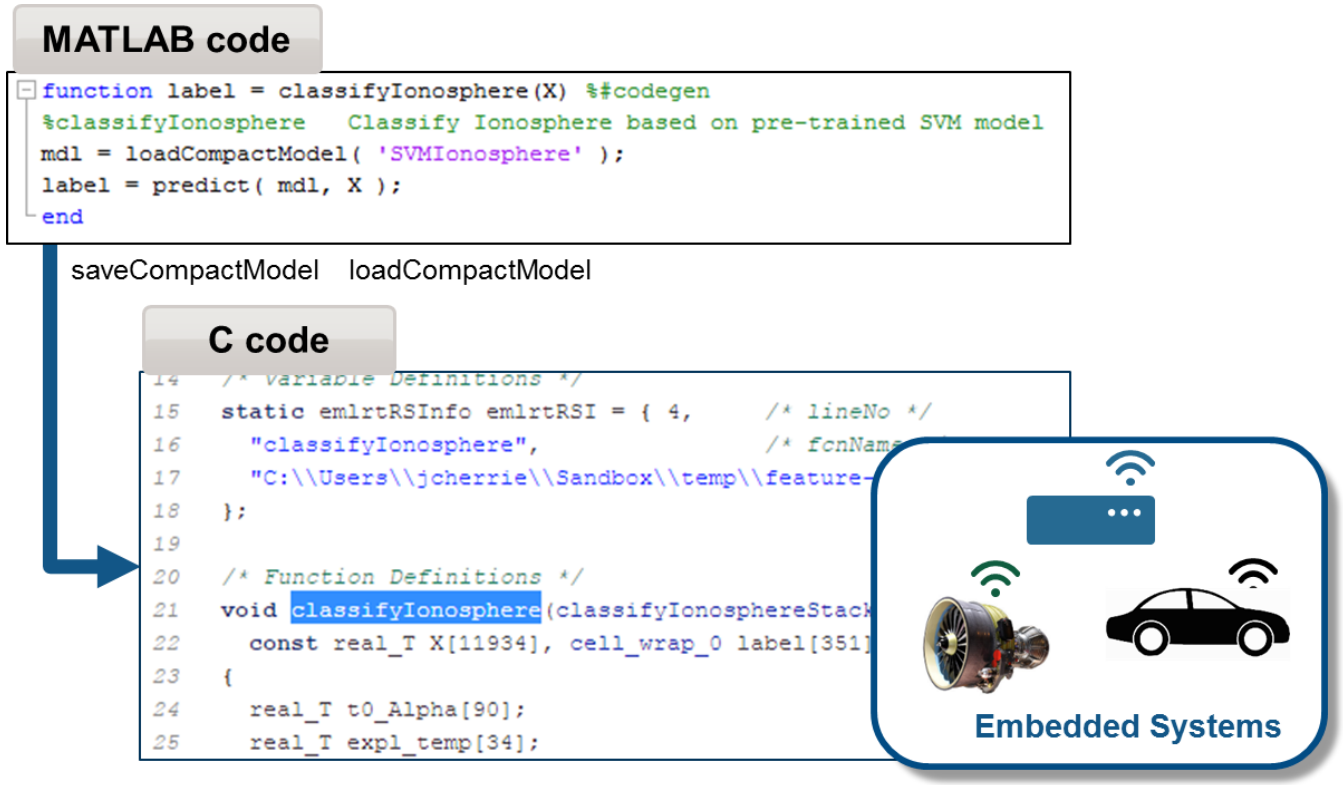
Standalone Application | Web App | Excel Add-in | Hadoop/ Spark | C/C++ | Java | Python | .NET | MATLAB Production Server



Machine Learning for Edge Analytics and Code Deployment

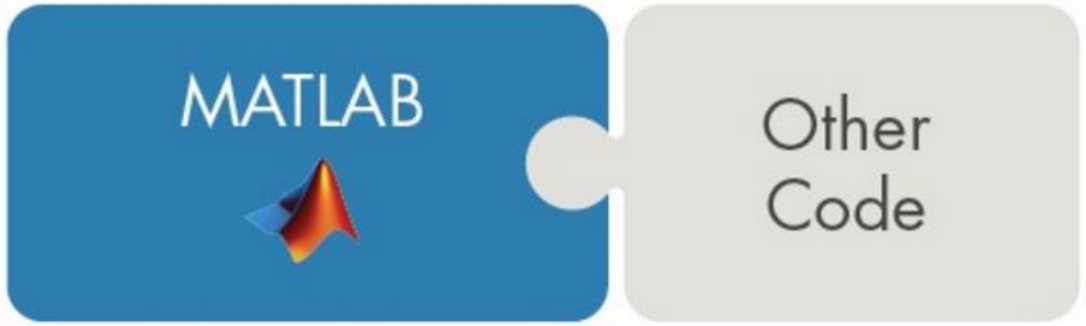
Deploy trained models as standalone C/C++ code

- Apply algorithms to out-of-memory data using tall arrays
- Generate C/C++ code for predictive models
- Generate fixed-point C/C++ code for SVM models, decision trees, and ensembles of decision trees
- Update deployed models without regenerating code



Using MATLAB with Other Languages

Calling Libraries Written in Another Language From MATLAB



- Java
- Python
- C
- C++
- Fortran
- COM components and ActiveX® controls
- RESTful, HTTP, and WSDL web services

Execute Python functions out of process R2019b

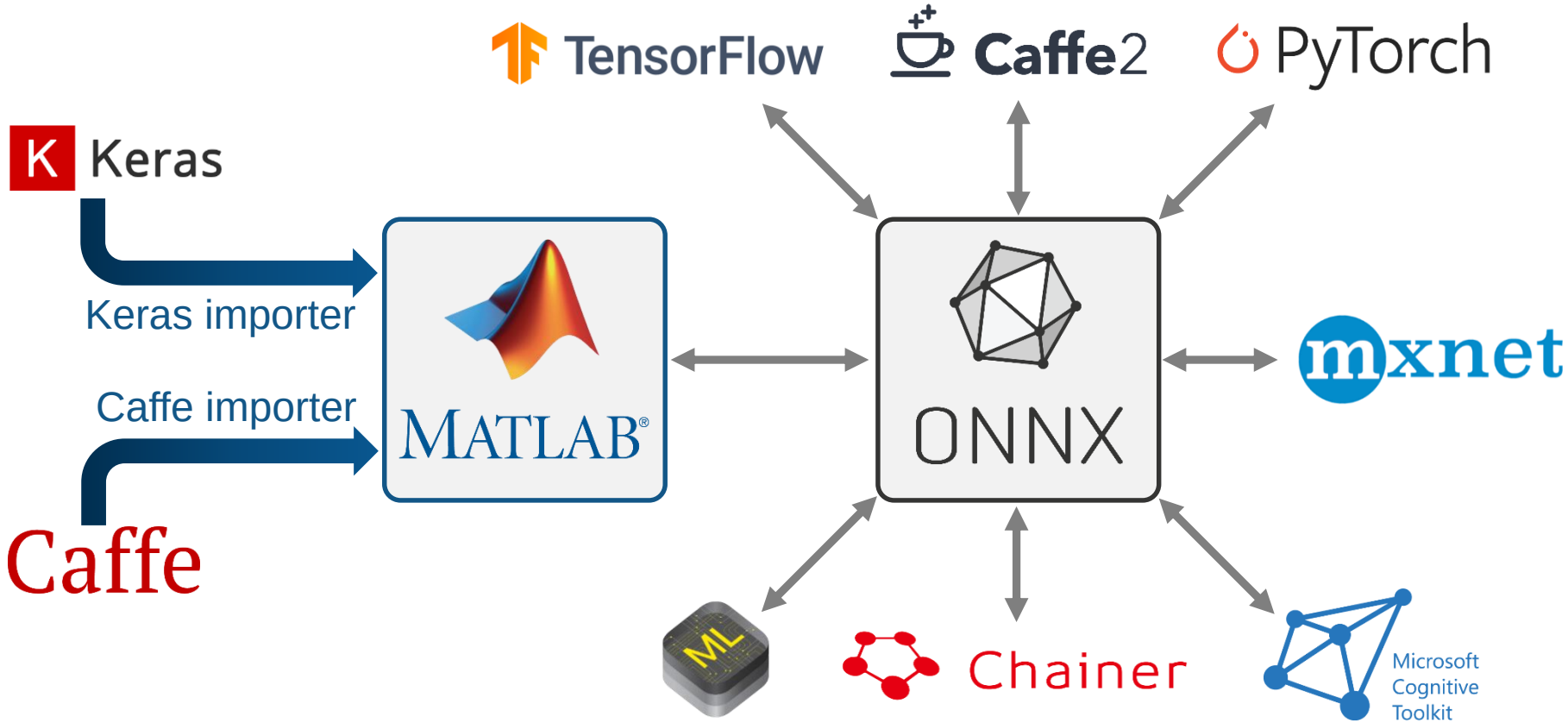
Call C++ libraries directly from MATLAB R2019a

Calling MATLAB from Another Language

- Java
- Python
- C/C++
- Fortran
- COM Automation server

MATLAB interoperates with other frameworks

Supports ONNX and can exchange models with PyTorch, TensorFlow, and other frameworks.



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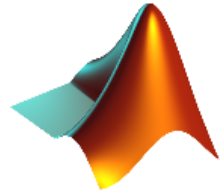
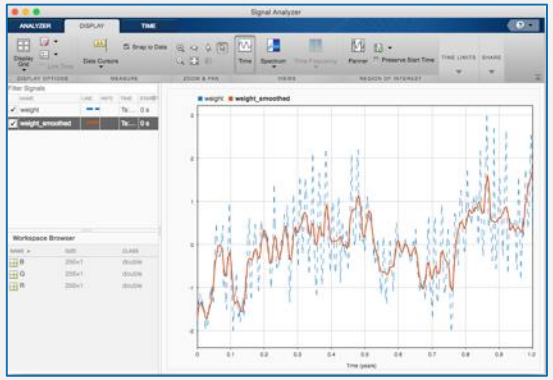
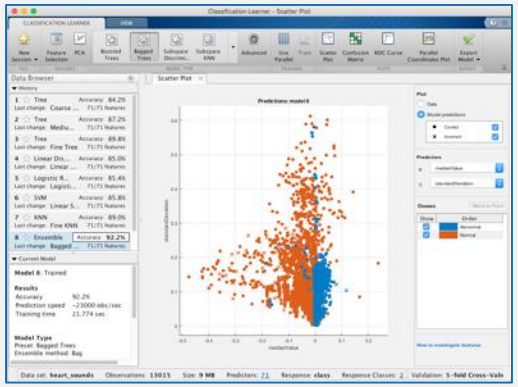
Summary: Complete Machine Learning Workflow



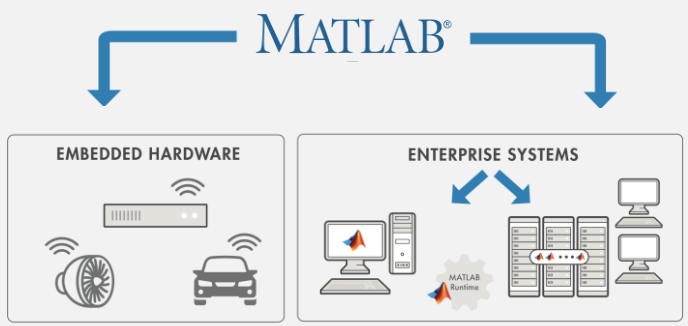
Access and explore data | Preprocessing | Feature Engineering | Model Training | Model Tuning | Integrate Analytics



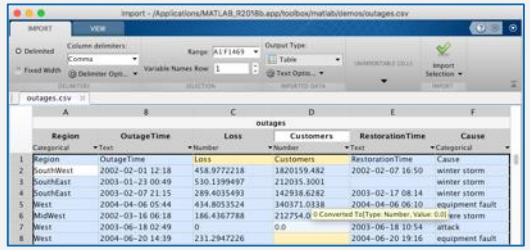
Datatypes and tools for missing data, outliers, time-alignment, etc.



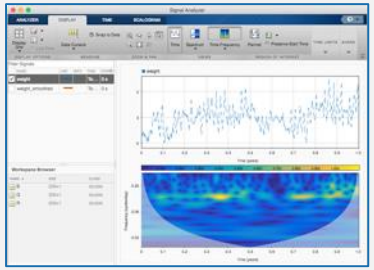
Machine Learning apps

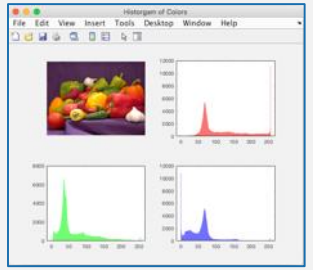


C/C++ Code Generation and Enterprise IT Integration

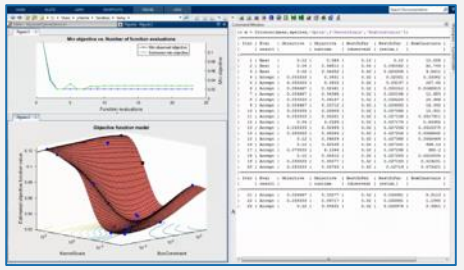


Text files, spreadsheets, databases, binary files, data feeds, web, cloud storage





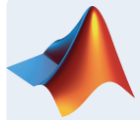
Domain-specific techniques for Signals, Images, Video, Audio, and Text



Automated Parameter Tuning

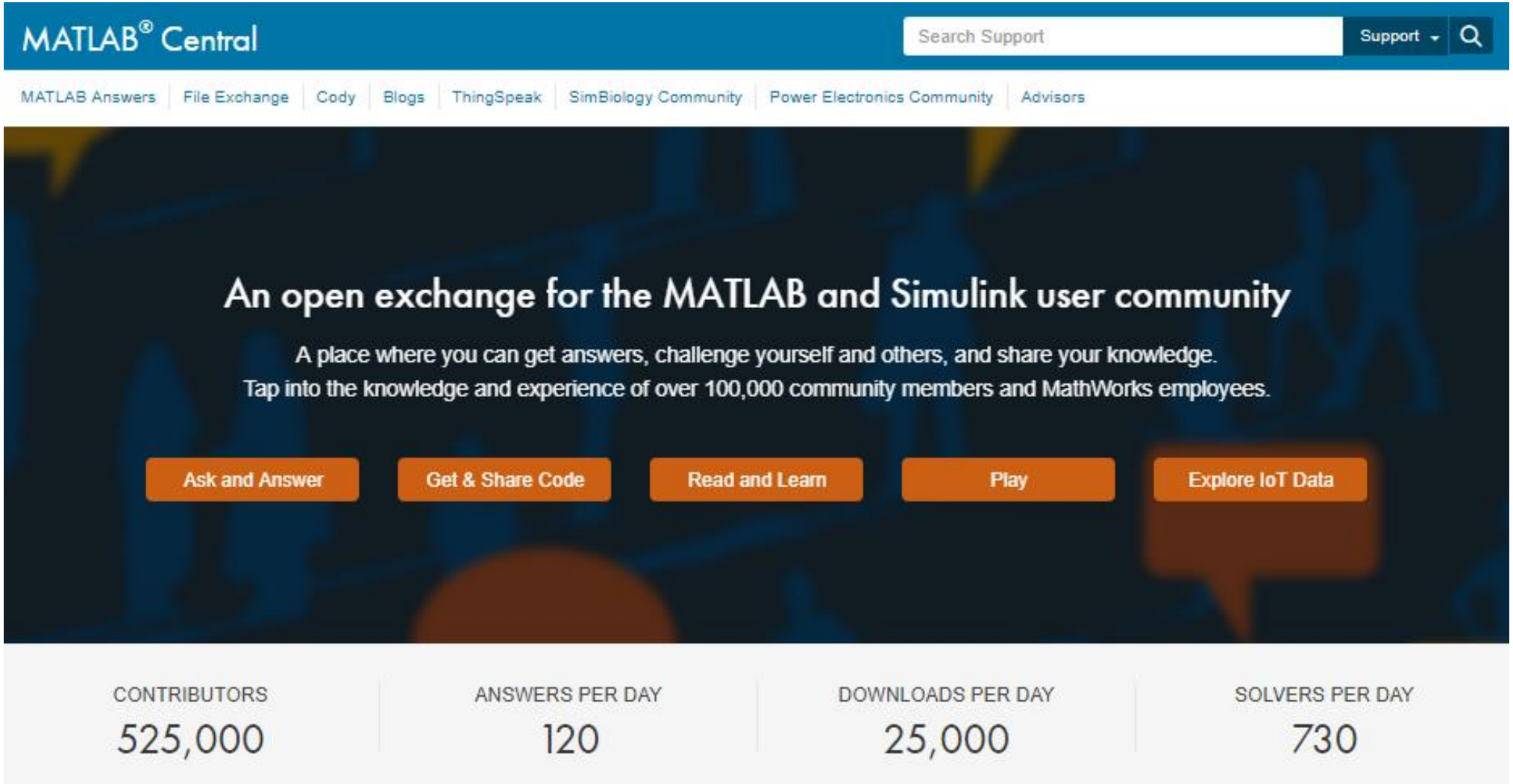
Agenda

- Machine Learning Introduction
- MATLAB Demo: Fuel Economy Analysis
- Sharing and Deploying Machine Learning Algorithms

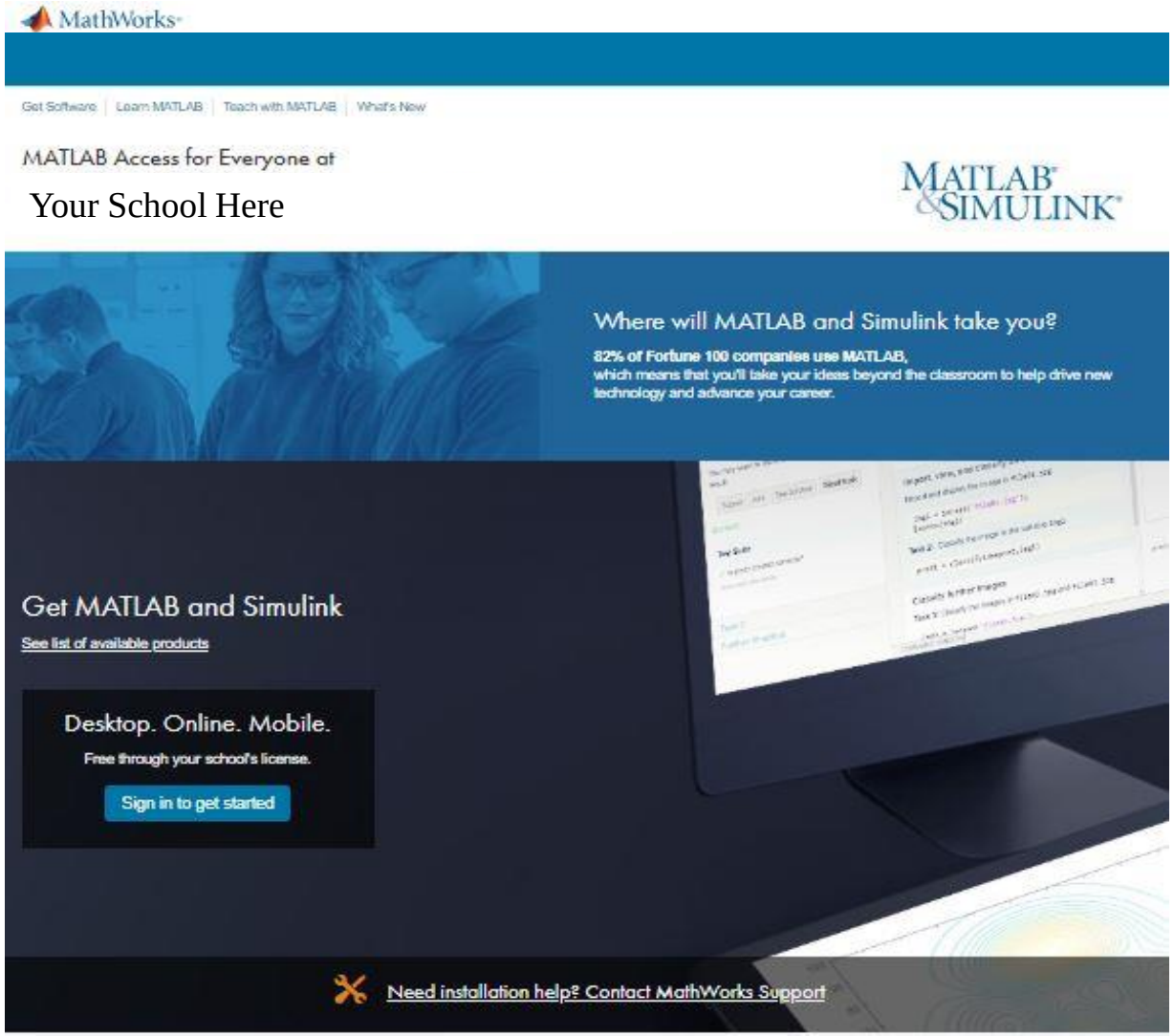


Resources and Support

MATLAB Central

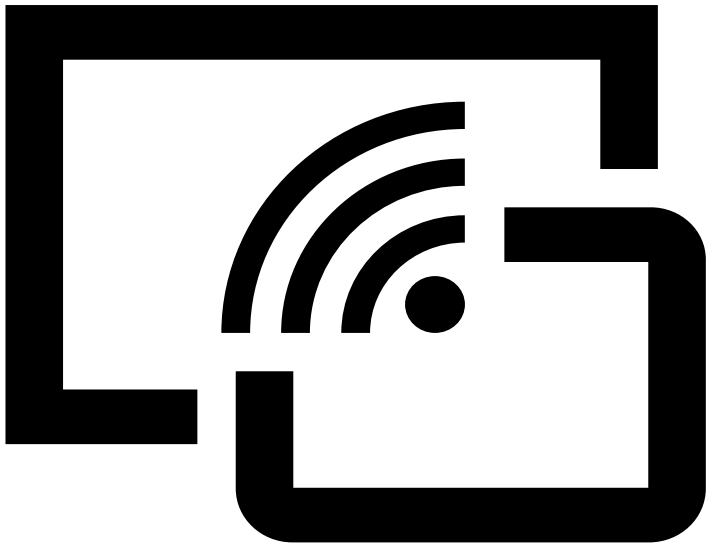


Campus-wide access

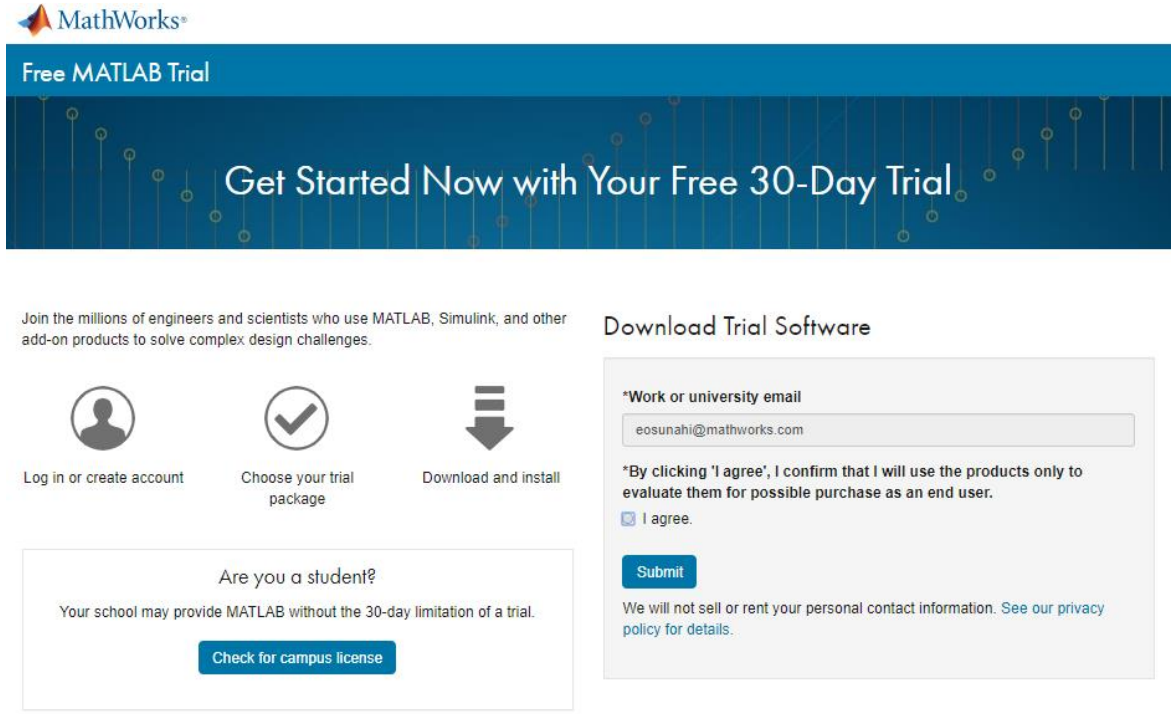


Access for universities without campus licenses

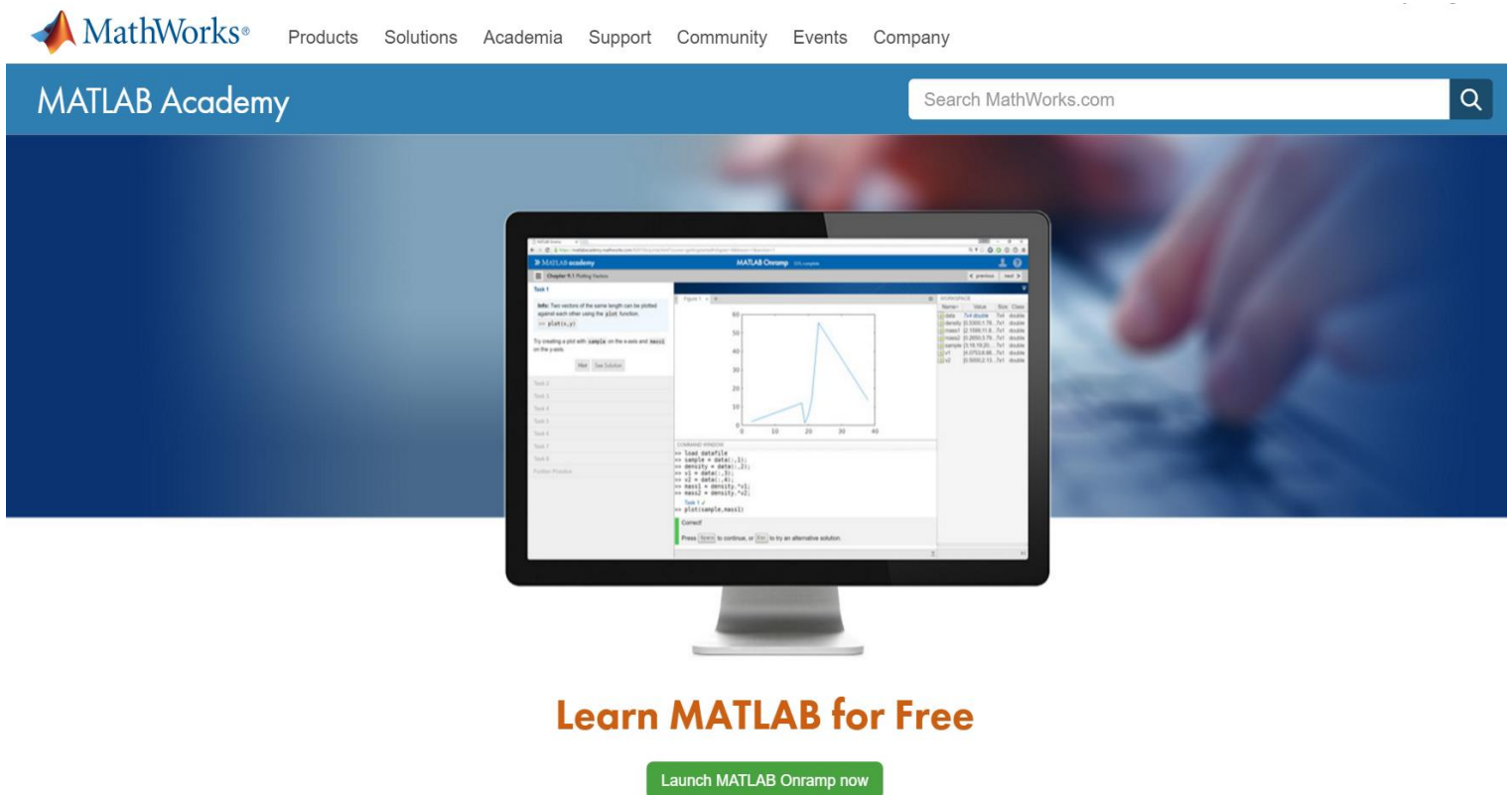
If available, access secure connection



For immediate needs, download 30 day trial



Self-Paced Courses



FREE COURSES (2-3 hours)

- MATLAB Onramp
- Simulink Onramp
- Stateflow Onramp
- Machine Learning Onramp
- Deep Learning Onramp

FOCUSED COURSES

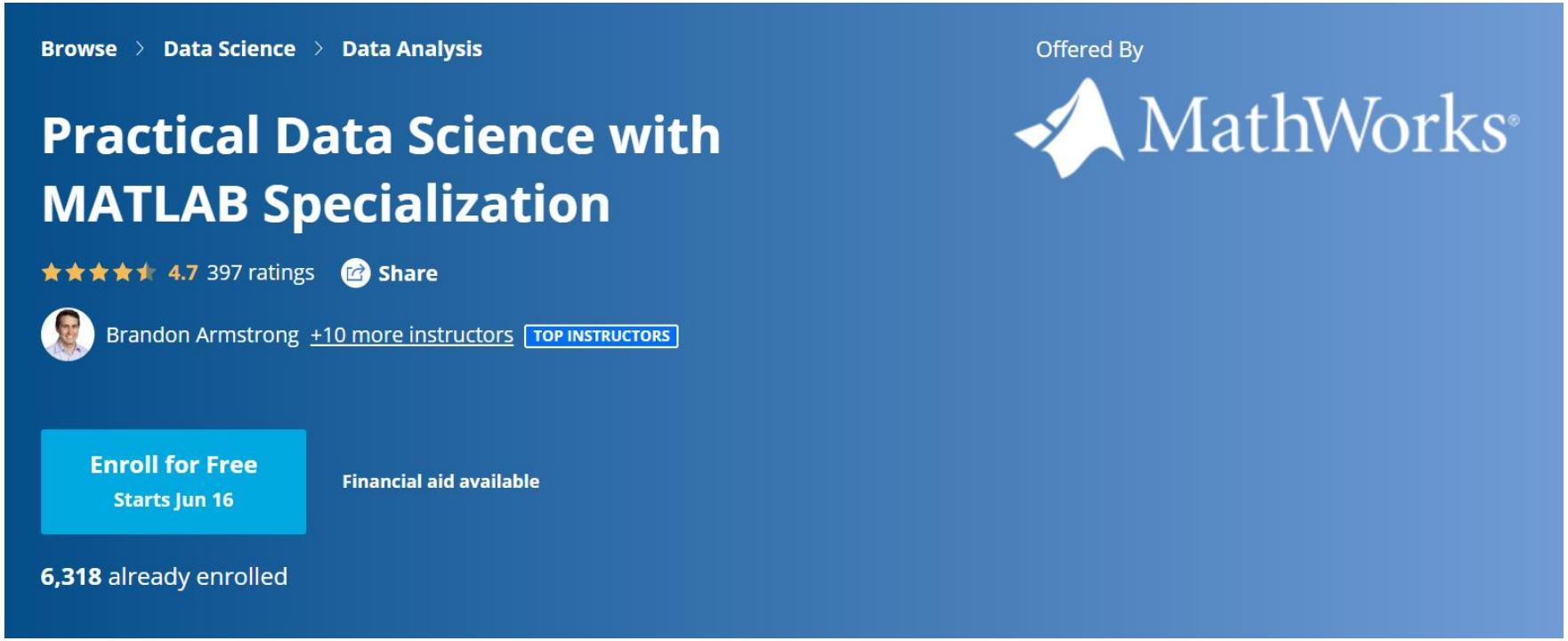
FOUNDATIONAL COURSES (17-21 hours)

- MATLAB Fundamentals
- MATLAB Programming Techniques
- MATLAB for Financial Applications
- MATLAB for Data Processing and Viz
- Machine Learning with MATLAB
- Deep Learning with MATLAB

COMPUTATIONAL MATH COURSES (2-3 hours)

- Introduction to Linear Algebra
- Solving Ordinary Differential Equations
- Introduction to Statistical Methods
- Solving Non-Linear Equations
- Introduction to Symbolic Math

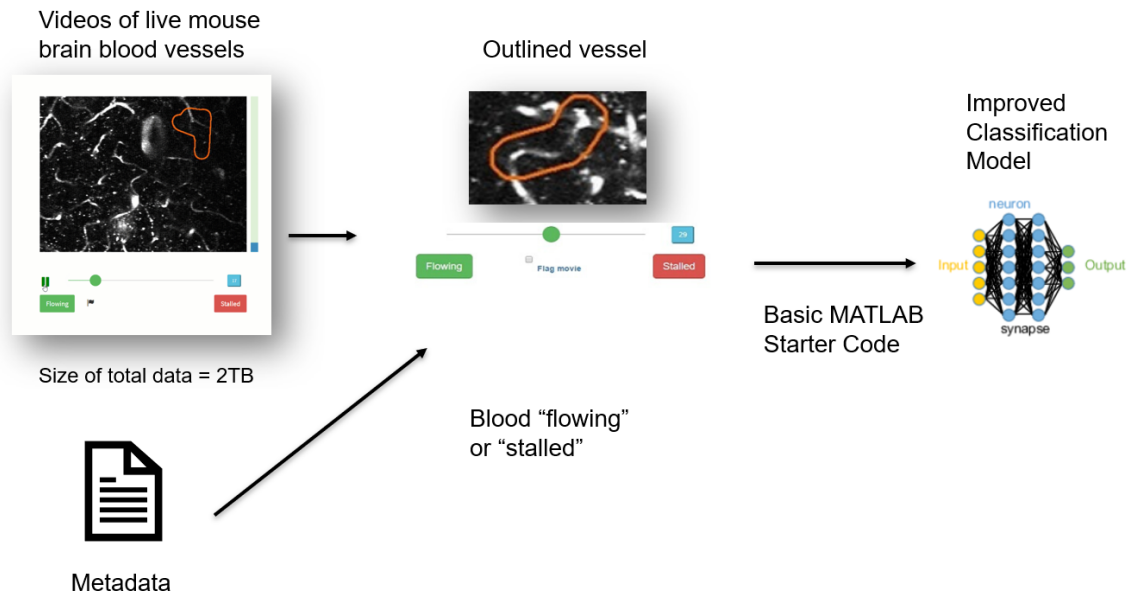
Data Science 4-Course Specialization



https://www.coursera.org/specializations/practical-data-science-matlab

Advance Alzheimer's Research Data Science Challenge

- Online data science competition hosted by DrivenData and supported by MathWorks
- No Eligibility Criteria
  - Open to students, professors, employers and at-home
  - Participate Individually or in a Team
  - Submit multiple entries
  - Online and around the globe
- Prizes worth $10K
- MathWorks support:
  - MATLAB benchmark code
  - Complimentary licenses
  - Technical assistance



Open to all until **August 3, 2020**

Register at : https://www.drivendata.org/competitions/65/clog-loss-alzheimers-research/

Resources

Teaching Data Science with MATLAB

Machine Learning Onramp (2-hour online introduction)

Machine Learning with MATLAB:

- Quick Start Guide
- Machine Learning Intro (Tech talk videos)
- Mastering Machine Learning (eBook)
- Practical Data Science with MATLAB (Coursera Specialization)
- Try the Classification Learner App in a browser

Machine and Deep Learning

- Deep vs. Machine Learning: Choosing the Best Approach (eBook)
- Deep learning Onramp (2-hour online introduction)

MathWorks® is a **Leader** in the Gartner Magic Quadrant for 2020 Data Science and Machine Learning Platforms

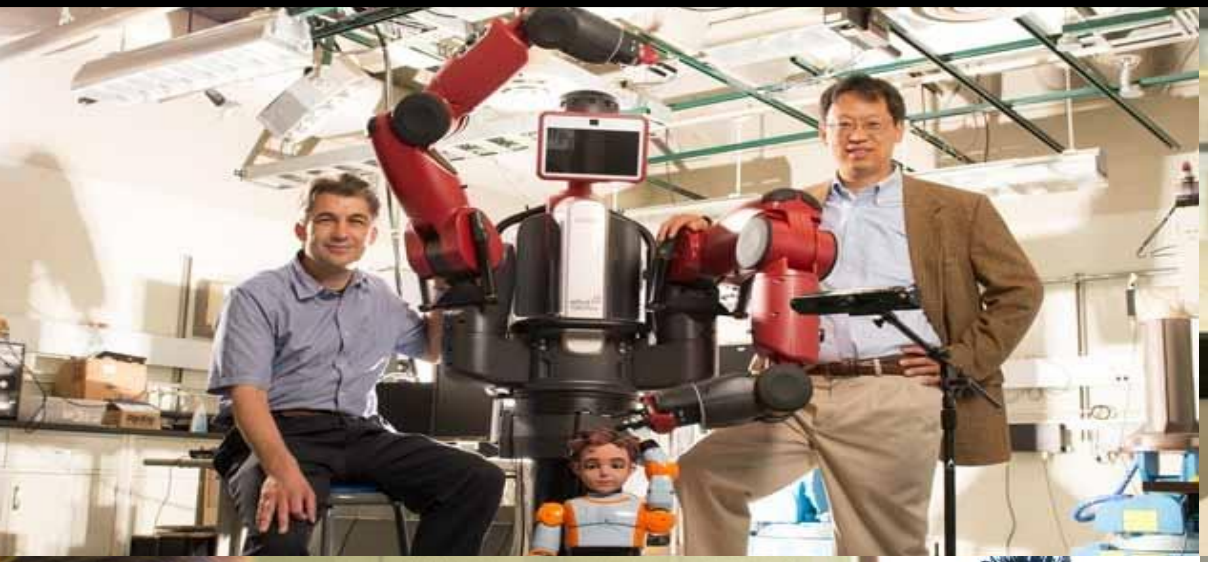
MathWorks has the furthest completeness of vision in the Leaders quadrant

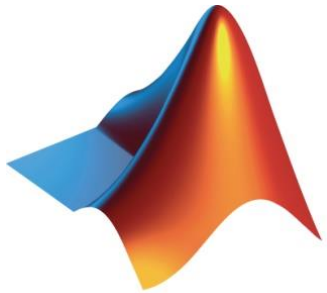
We believe this recognition demonstrates our ability to:

- Empower your team, including those with limited AI or data science experience
- Provide complete workflows for data preparation, AI modeling, system design, and production
- Deploy AI models on embedded devices, edge, enterprise systems, and the cloud
- Use Simulink to tackle integration challenges and reduce risk in designing AI-driven systems

*Gartner Magic Quadrant for Data Science and Machine Learning Platforms, Peter Krensky, Erick Brethenoux, Jim Hare, Carlie Idoine, Alexander Linden, Svetlana Sicular, 11 February 2020 .

MathWorks Customer Success Engineers *education@mathworks.com*
consult with faculty and researchers to support them with their STEM initiatives,
including integrating computational or systems thinking into their curriculum.





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