

Transformation to Artificial Intelligence with MATLAB

Roy Lurie, PhD
Vice President of Engineering
MATLAB Products

A brief history of the automobile

1885

First Commercial Gas Car



Benz Patent Motor Car

A brief history of the automobile

First Affordable Car

1908



Ford Model T

A brief history of the automobile

1981

First ECU



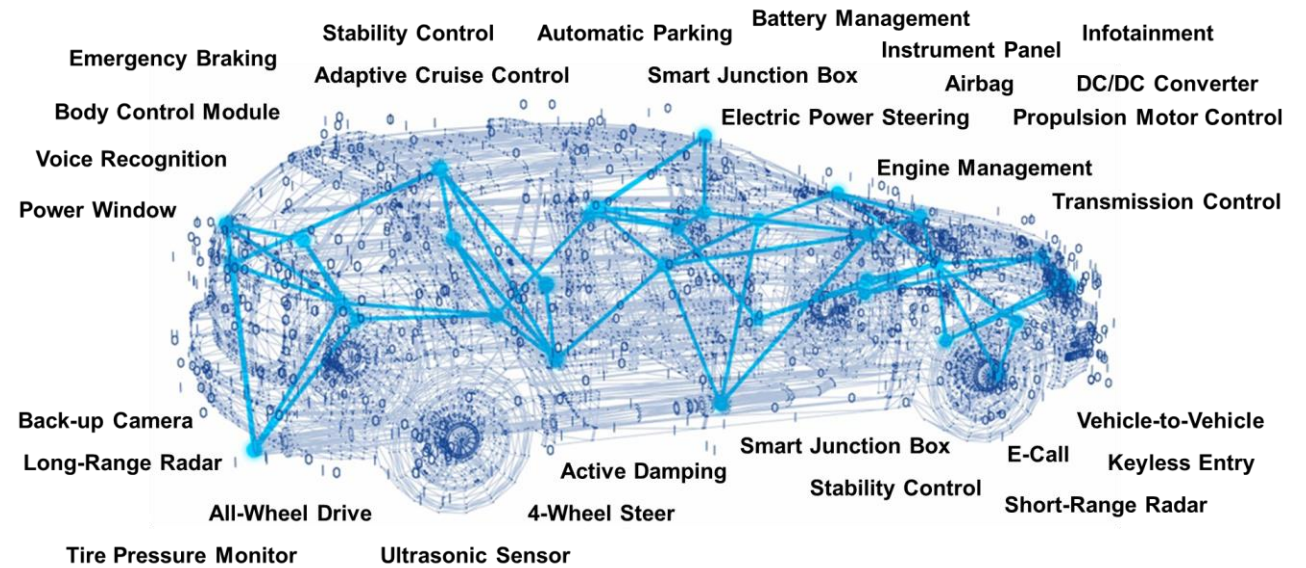
GM Vehicles

A brief history of the automobile

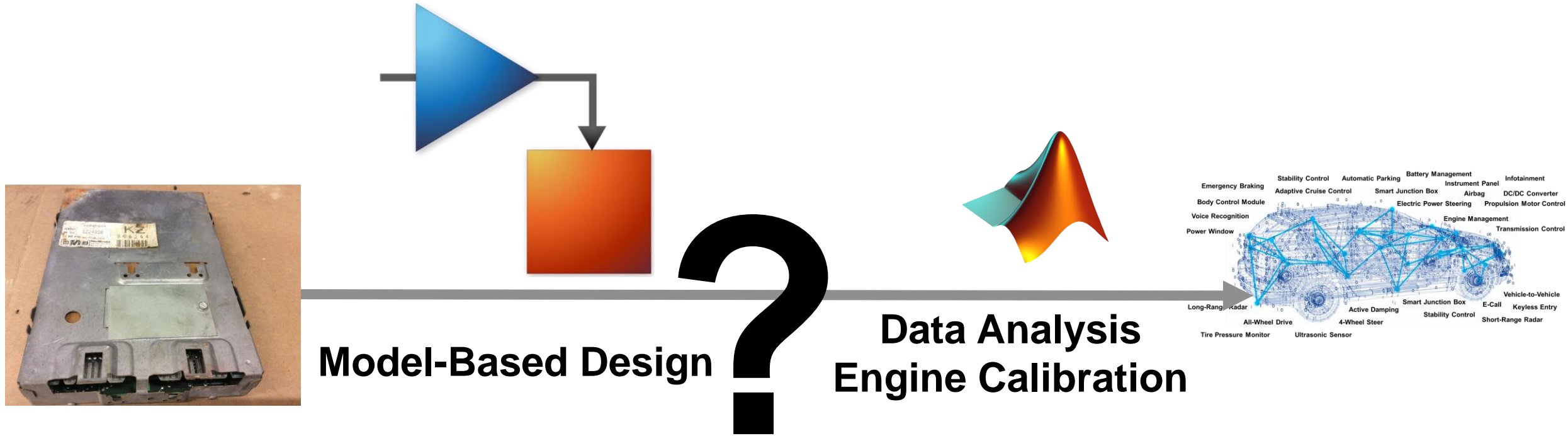
1981



TODAY



The First Digital Transformation: Embedded Controls in Everything



A brief history of the automobile

First Connected Cars

1996



GM OnStar

A brief history of the automobile

2000

First ADAS



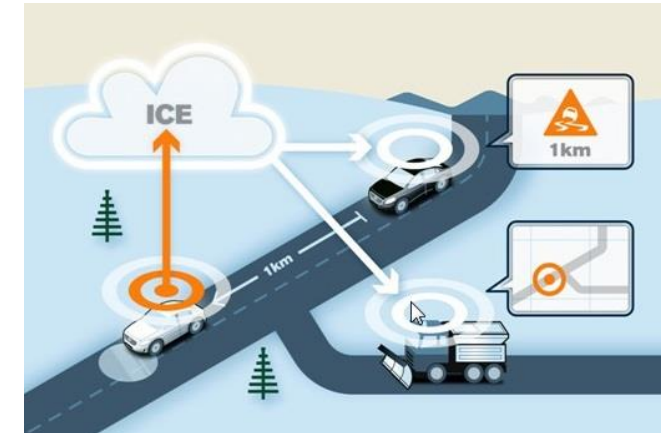
Mercedes-Benz Actros
Lane Departure Warning System

A brief history of the automobile

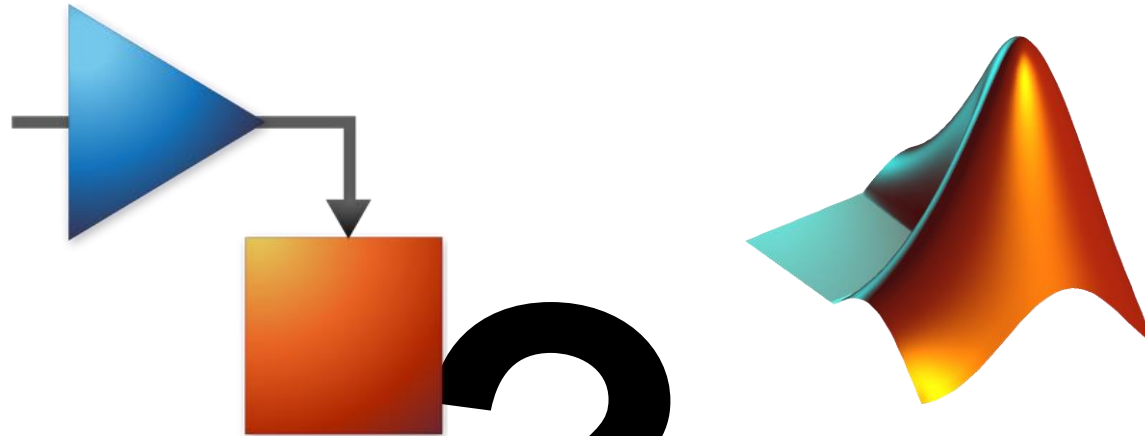
2000



Today/Soon

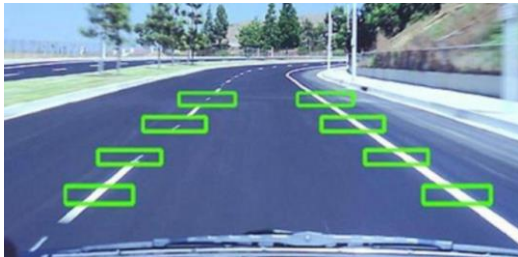


The **Second** Digital Transformation: **Artificial Intelligence** Everywhere



Model-Based Design

Data-Driven Algorithms





5\" 12,000 PSI

5\" 12,000 PSI

5\" 12,000 PSI

BAKER
HUGHES

Using Machine Learning

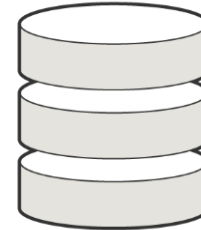
to build and deploy a predictive maintenance system



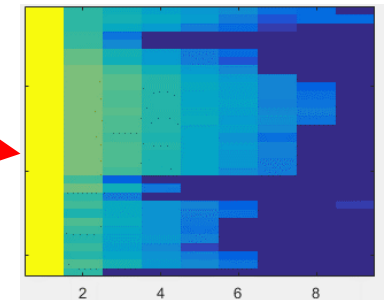
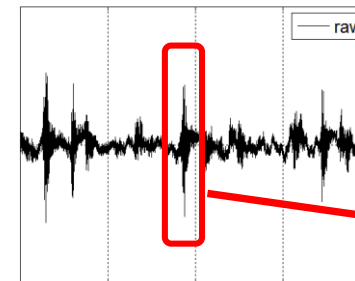
Pump logs
of temperature, pressure
& other data



1TB



**Analytics and
Machine Learning**
plus signal processing,
neural networks & more



Predictive Model
deployed to drill site

Catchup of moving object



Using Model-Based Design and Data Analytics to design and verify an automated driving system



80 TB



Machine Learning
extract interesting events

2013-05-20 13:45	CW	CW	CW	CW	Green
2013-05-20 19:12	WB	WB	CW	CW	Yellow
2013-05-22 09:27			CW	CW	Green
2013-05-27 06:05	CW	CW			Red

Generate statistics and compare candidates

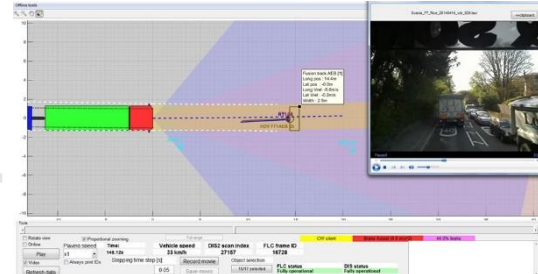


Analyze of situations

Vehicle Logs
of video and radar data



Visualize Sensor Data



Sensor Fusion

Algorithms
deployed on vehicle

Re-simulate
Refine Algorithm

Challenges of developing and integrating AI

- Big Data Analytics
- Machine Learning and Deep Learning
- Cloud and Embedded Algorithm Deployment

MATLAB makes AI easy and accessible for Engineers

MATLAB makes **big data** easy and accessible for Engineers

Working with Real-World Data

Numeric



double,
single, ...



logical



categorical



datetime



duration



calendarDuration



timetable

Heterogeneous



structure



cell



table

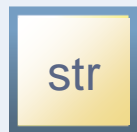
Text



char



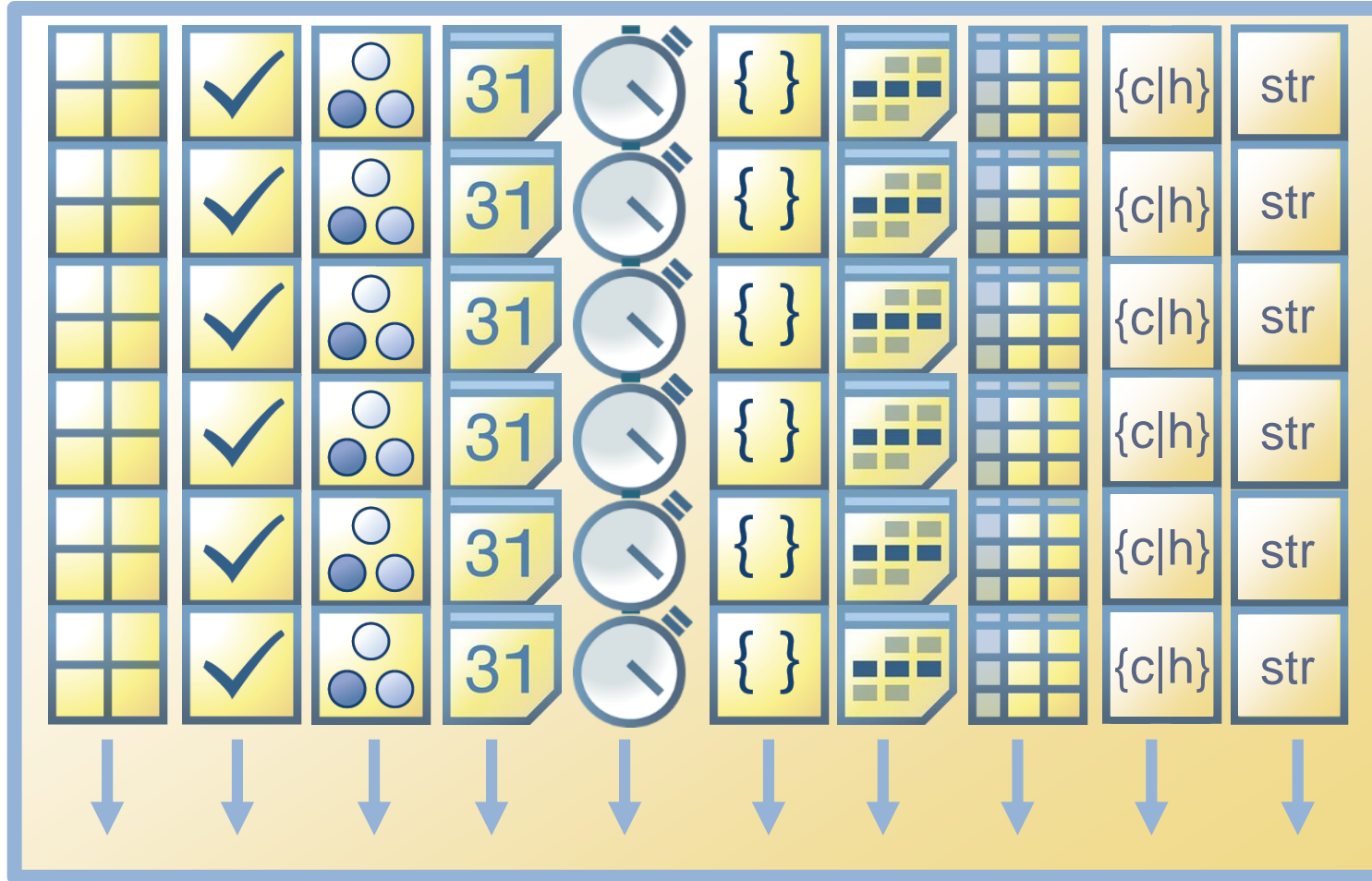
cell string



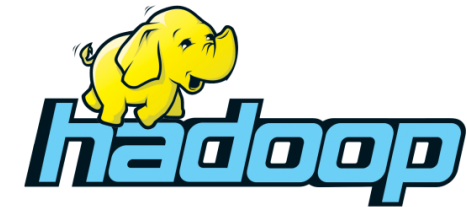
string

MATLAB makes **big data** easy and accessible for Engineers

Working with Really Big Data

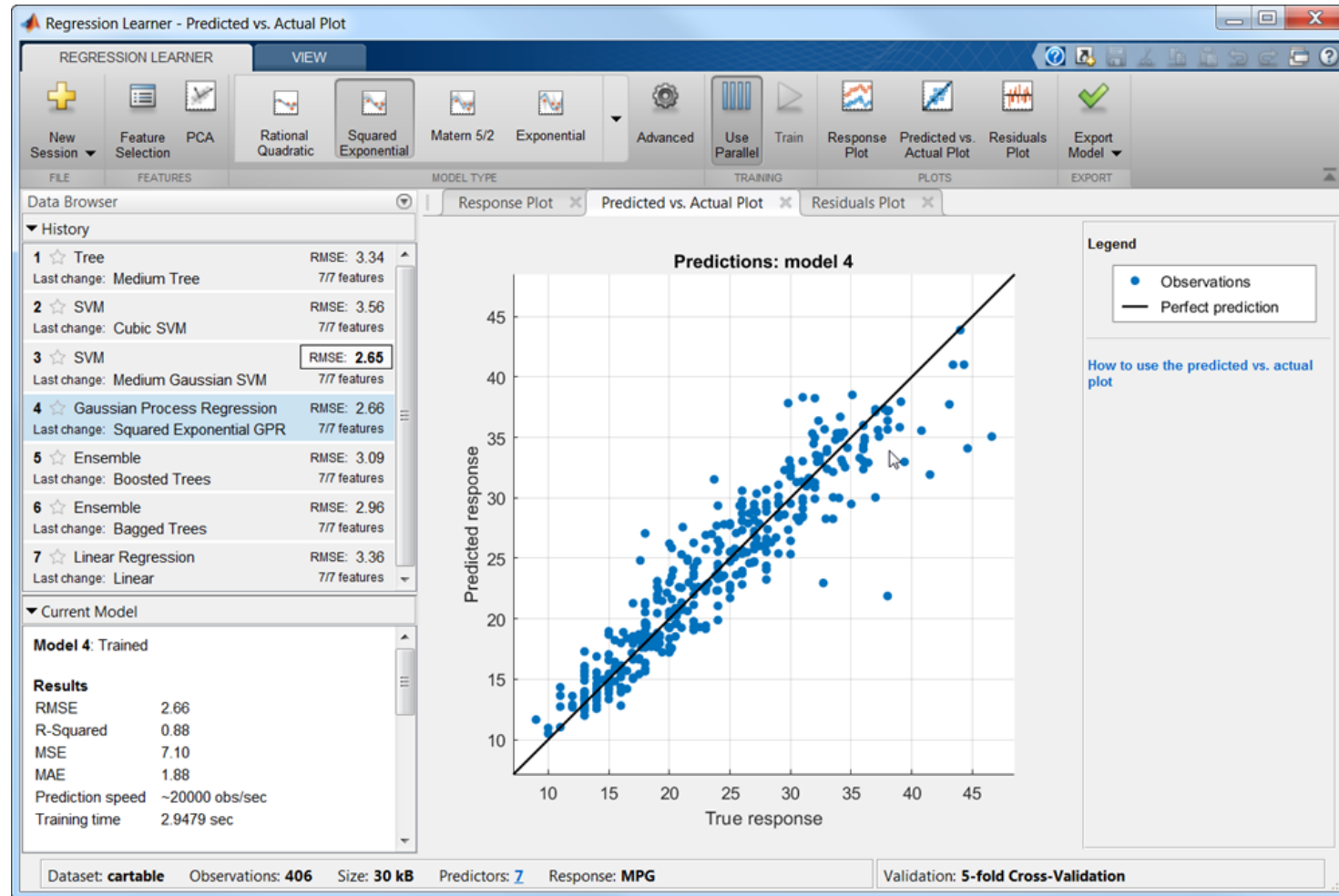


Tall arrays



MATLAB makes **big data** easy and accessible for Engineers

Data Analysis Apps



Regression Learner

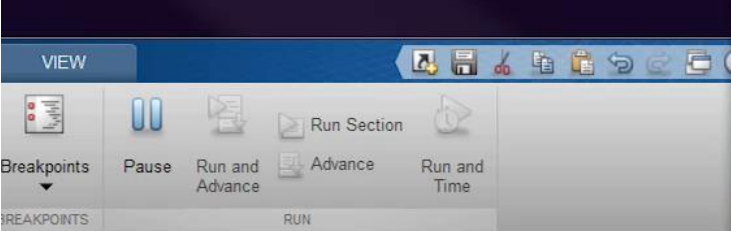
Deep Learning is changing the world



Deep Learning Tools are for **Programmers**

Caffe  TensorFlow™
 torch theano

MATLAB makes **deep learning** easy and accessible for Engineers



```

c.m

= webcam; % Connect to the camera
alexnet; % Load the neural net

:run
:picture = camera.snapshot; % T
:picture = imresize(picture, [227,227]); % R

:label = classify(nnet, picture); % C

:figure(picture); % Show the picture
:label(char(label)); % Show the label
:close(gcf);
:runnow;
        
```

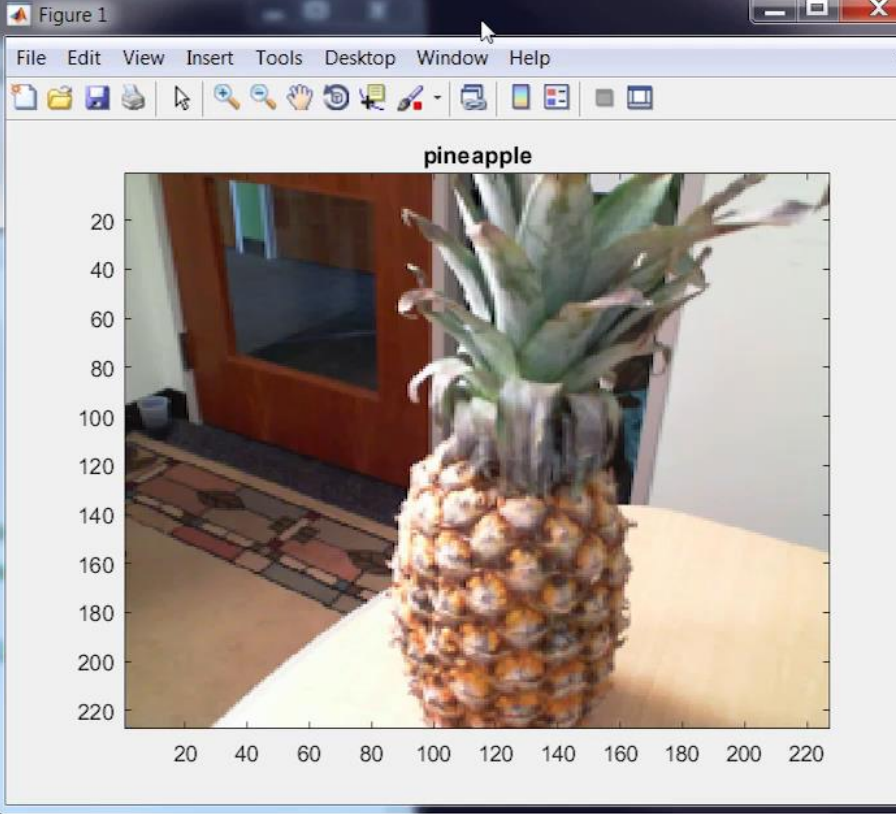


Figure 1

File Edit View Insert Tools Desktop Window Help

pineapple

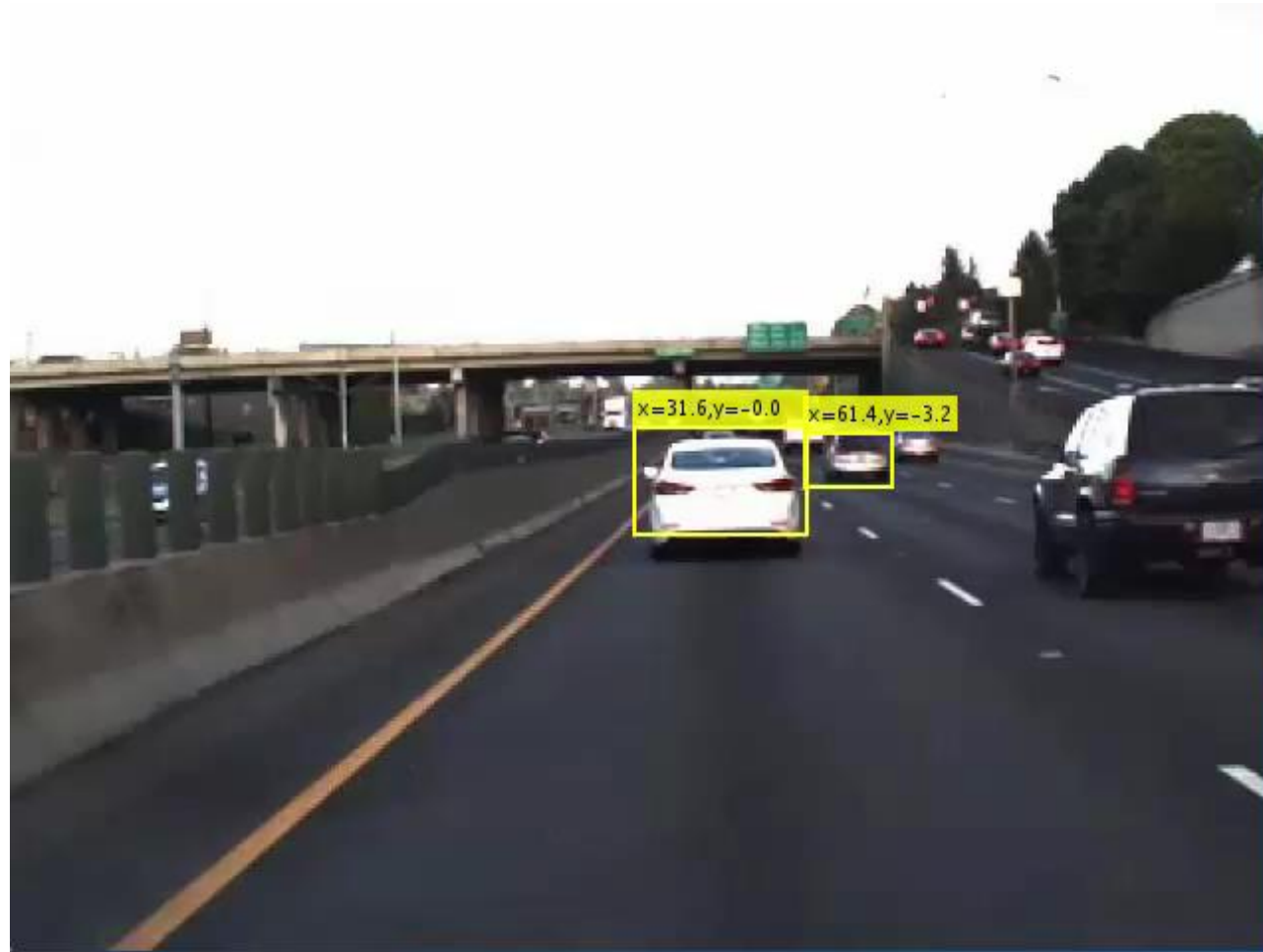
20 40 60 80 100 120 140 160 180 200 220

20 40 60 80 100 120 140 160 180 200 220

MATLAB makes **deep learning** easy and accessible for Engineers

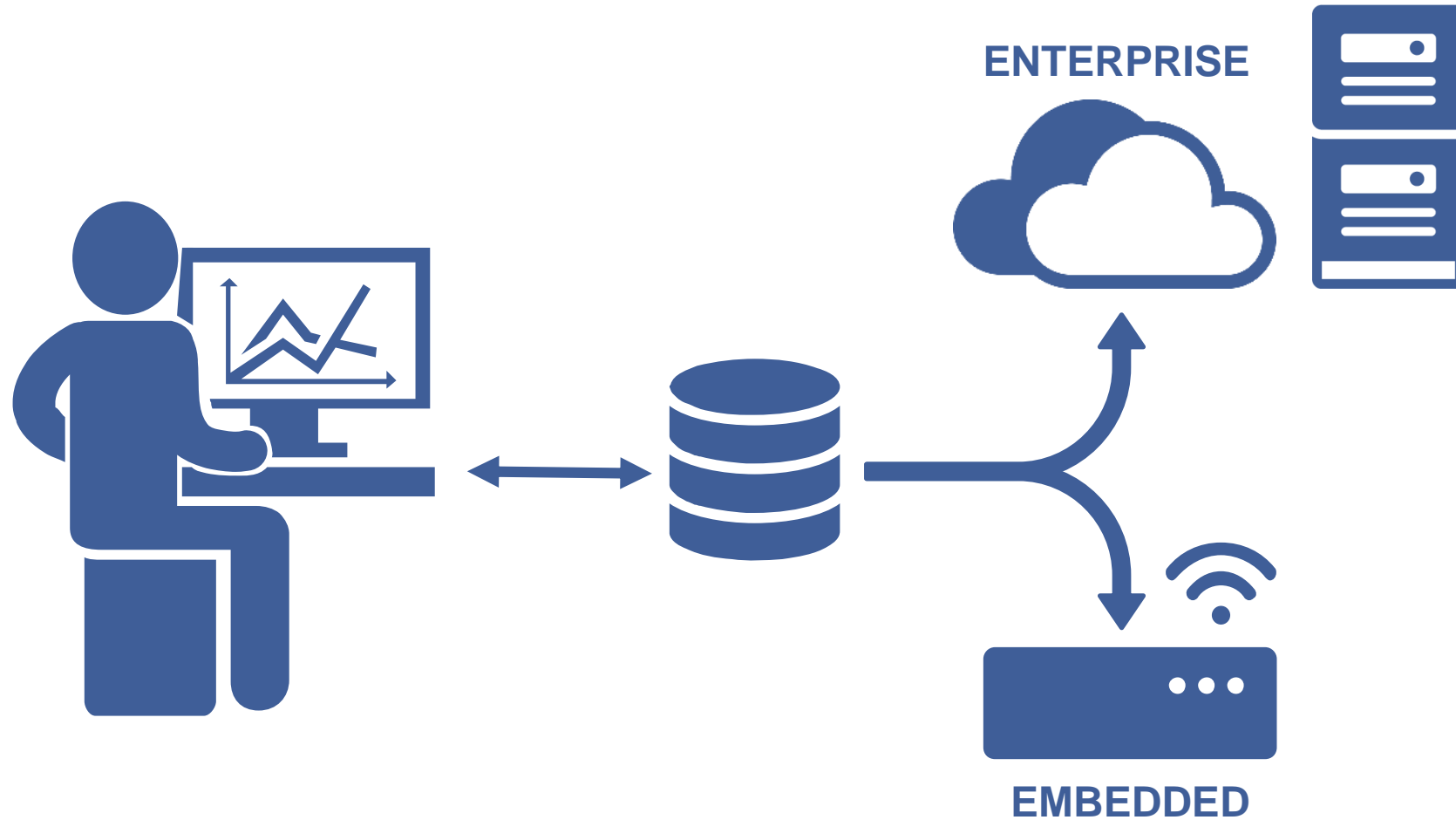
```
camera = webcam;  
img = snapshot(camera);  
  
net = alexnet;  
label = classify(net, img)
```

MATLAB makes **deep learning** easy and accessible for Engineers



Vehicle Detection with Deep Learning

Only MATLAB and Simulink get analytics to both **embedded** and **enterprise** systems



Each release makes AI easy and accessible

R2016b

JSON
Neo4j
Mobile Sensors Cloud Logging
Timetable
String
Preprocessing Functions
Missing Data Functions
Tall Arrays
Big Data Algorithms
Deep Learning
Hyperparameter Optimization
Spark
MATLAB on ThingSpeak
ThingSpeak Paid Options
Machine Learning Code Generation
MATLAB Production Server RESTful Interface
Deep Learning on Amazon GPU
Live Script Equation Editor
Live Script Interactive Plots
Live Scripts in MATLAB Online
Live Scripts in MATLAB Examples
App Designer UITable
MATLAB Mobile Editor
MATLAB Mobile Open Access
MATLAB Online for All Named users
AlexNet

R2017a

Live Script Editable Figures
App Designer full 2D plotting
App Designer Interactive Tutorial
MATLAB Drive
Heatmap Charts
Regression Learner app
Machine Learning Classification Code Generation
Deep Learning Regression
Deep Learning on CPU and Multiple GPU
VGG-16, VGG-19
CAFFE Model Zoo
Tall timetable
Add-On Explorer Categories
Live Legends
Categorical Plotting
Preprocessing Functions
Faster Object Property Setting
Object Property Typing
Offline Mobile Sensing
Bayesian Statistics
Symbolic Variable Units

Unique Platform Combination

Powering New Applications

Control Systems

Verification & Validation

Code Generation

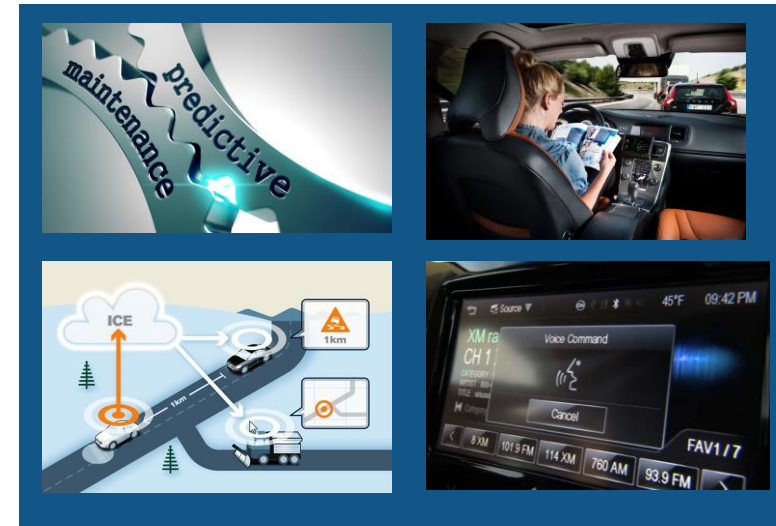
Big Data

Machine Learning

Signal and Image Processing

Model-Based Design

Data Analytics





MATLAB®

