

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

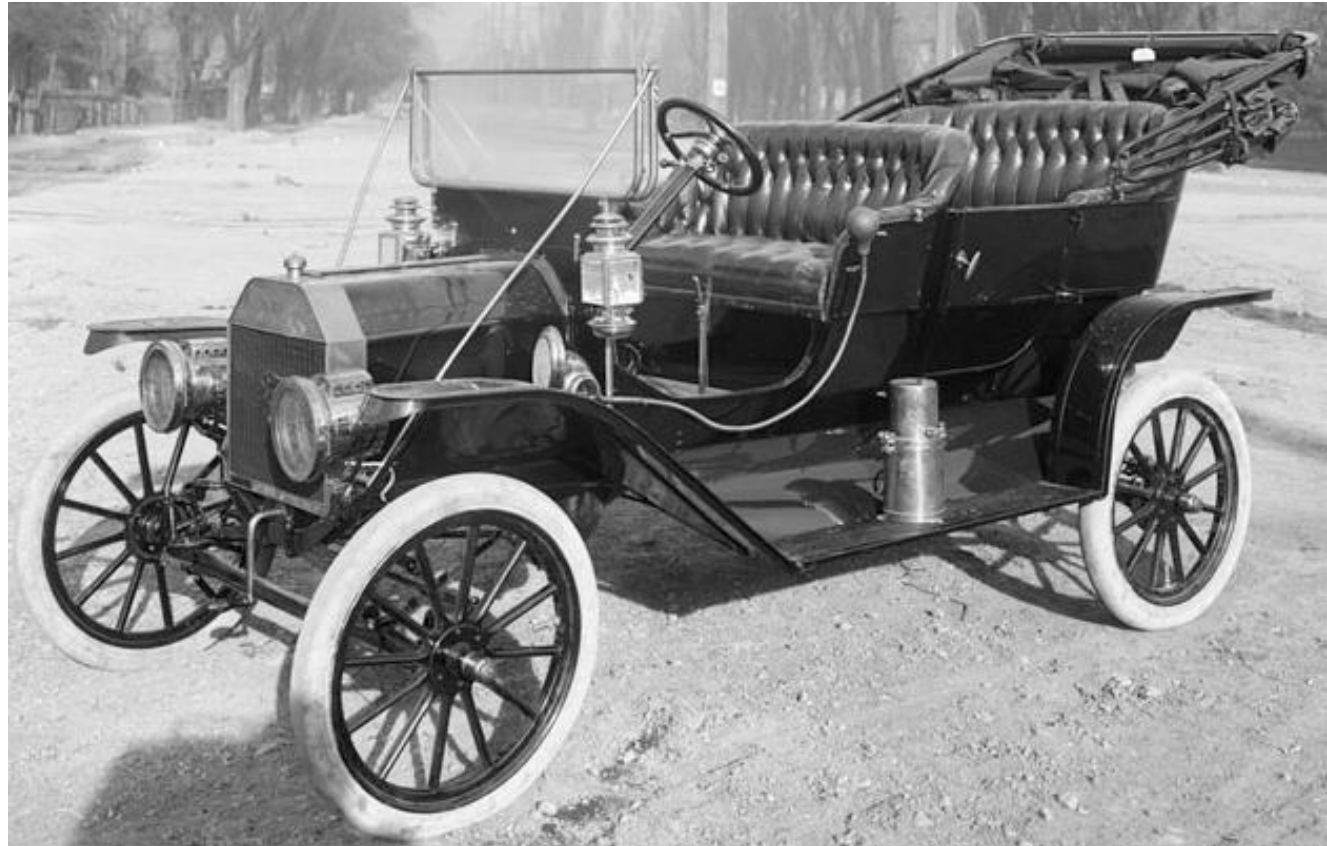


Benz Patent Motor Car

A brief history of the automobile

First Affordable Car

1908



Ford Model T

A brief history of the automobile

1981

First ECU



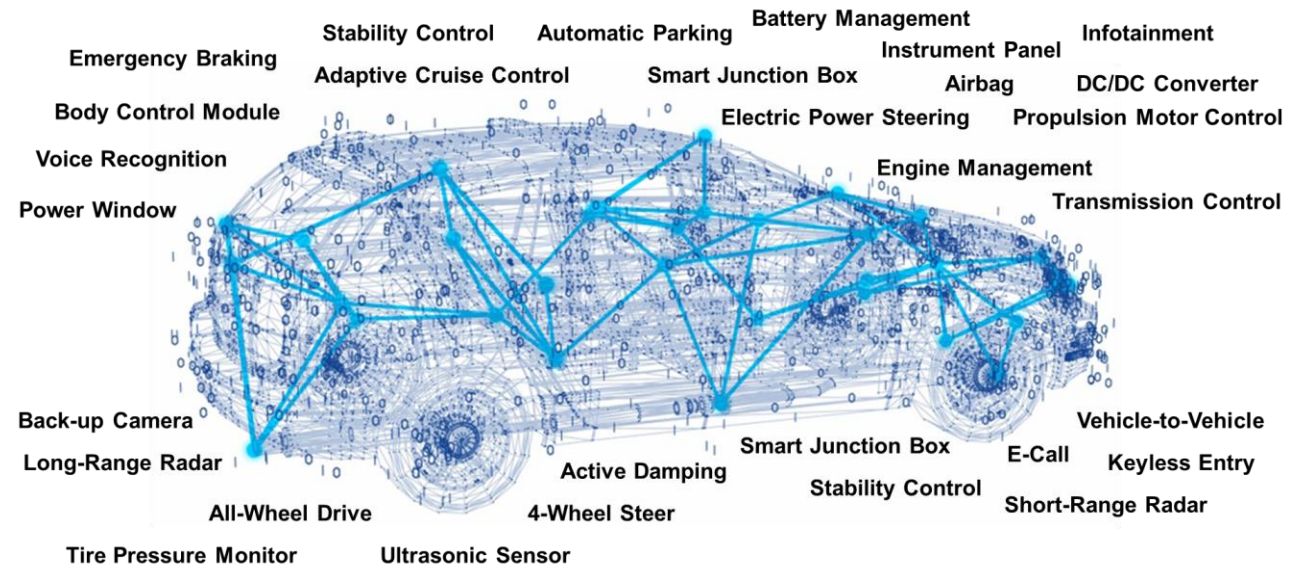
GM Vehicles

A brief history of the automobile

1981



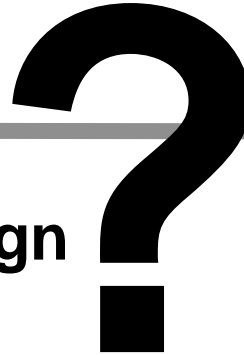
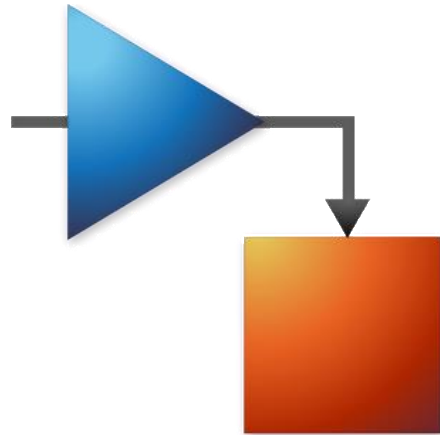
TODAY



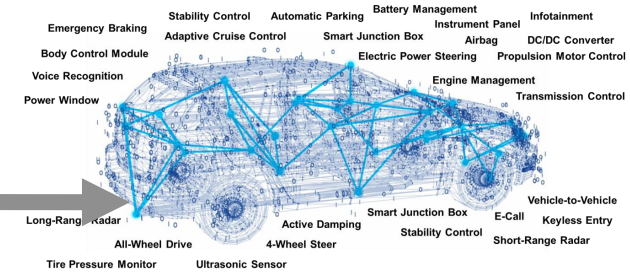
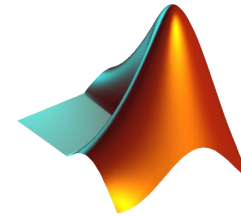
The First Digital Transformation: Embedded Controls in Everything



Model-Based Design



**Data Analysis
Engine Calibration**



A brief history of the automobile

First Connected Cars

1998

BMW Assist

Safety & Convenience Services

A brief history of the automobile

First ADAS

2000



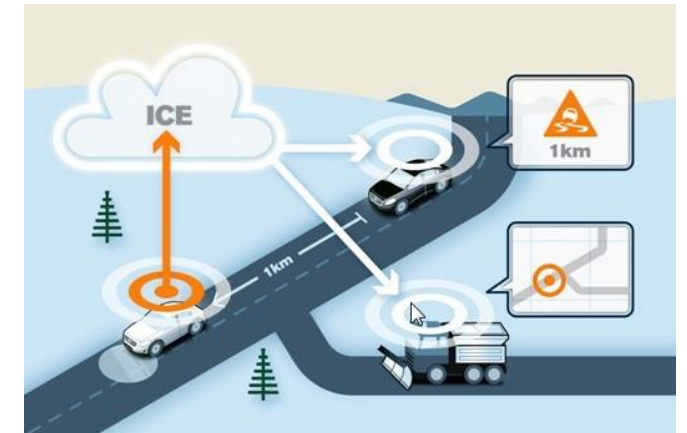
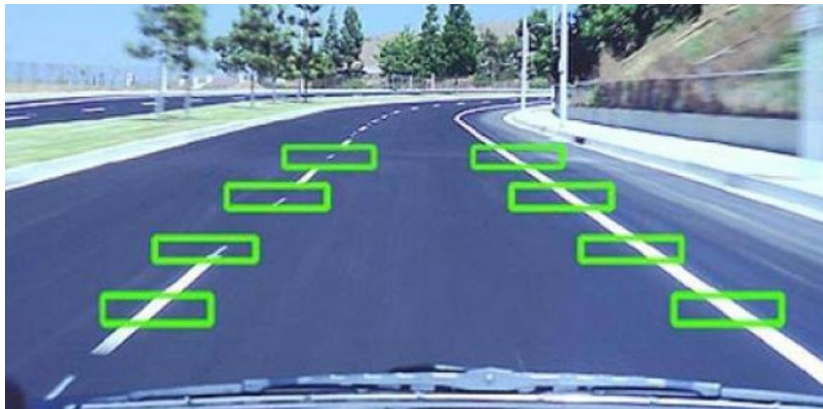
Mercedes-Benz Actros
Lane Departure Warning System

A brief history of the automobile

2000

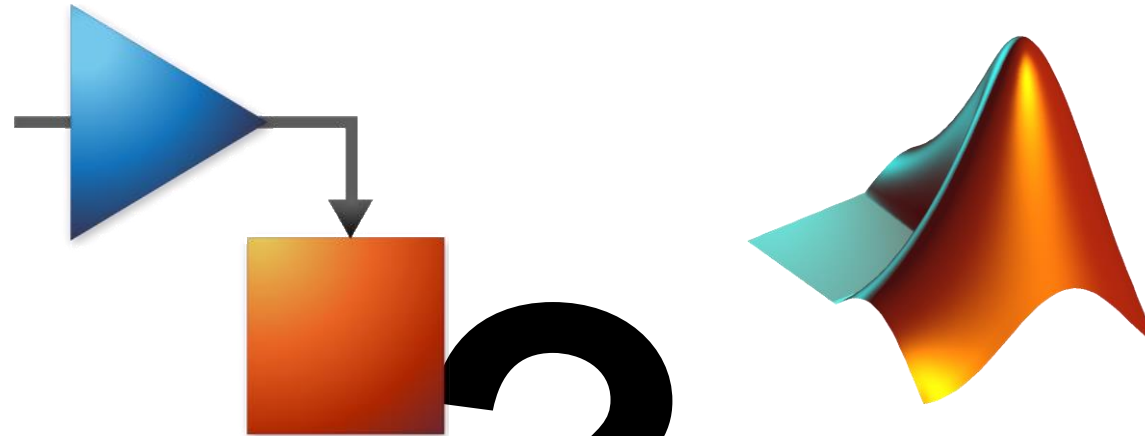
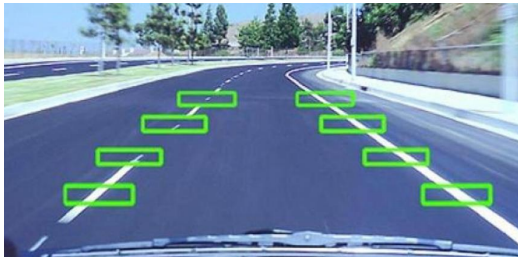
Today/Soon

BMW Assist
Safety & Convenience Services



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

BMW Assist
Safety & Convenience Services



Model-Based Design

Data-Driven Algorithms





Using Machine Learning

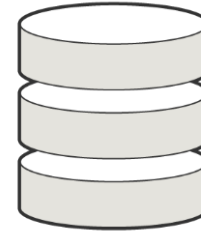
to build and deploy a predictive maintenance system



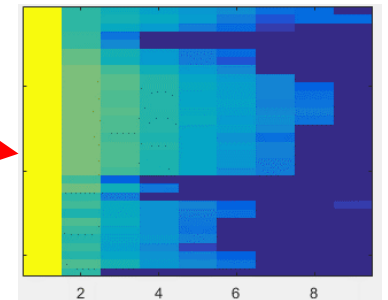
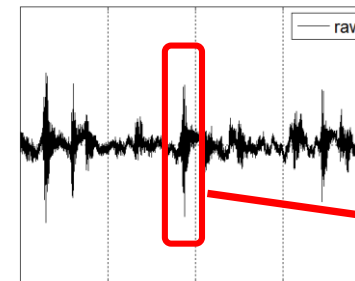
Pump logs
of temperature, pressure
& other data



1TB



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



Maintenance
Needed

Predictive Model
deployed to drill site

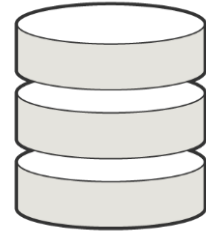
Catchup of moving object



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

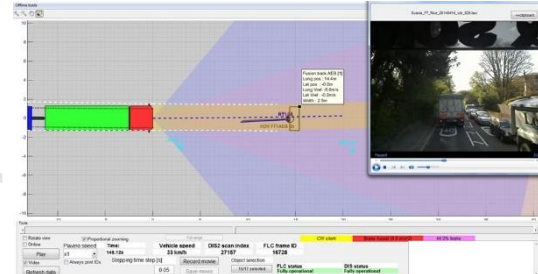


Analyze of situations

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

Making AI easy and accessible for Engineers

Making **big data** easy and accessible for Engineers

Working with Real-World Data

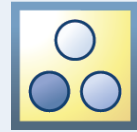
Numeric



double,
single, ...



logical



categorical



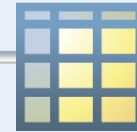
datetime



duration



calendarDuration



timetable

Heterogeneous



structure



cell



table

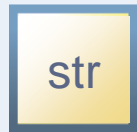
Text



char



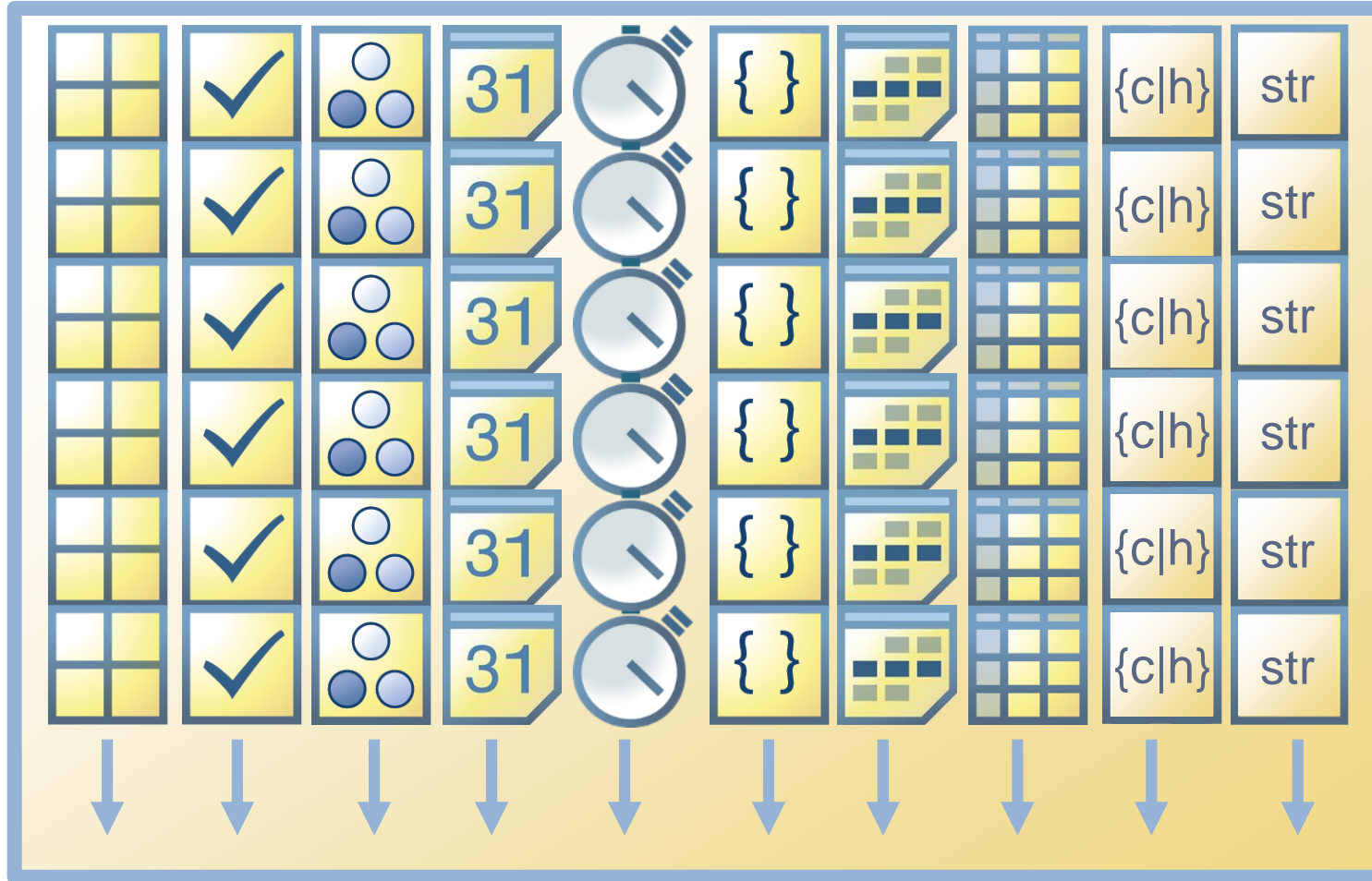
cell string



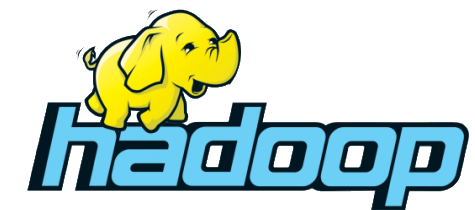
string

Making **big data** easy and accessible for Engineers

Working with Really Big Data

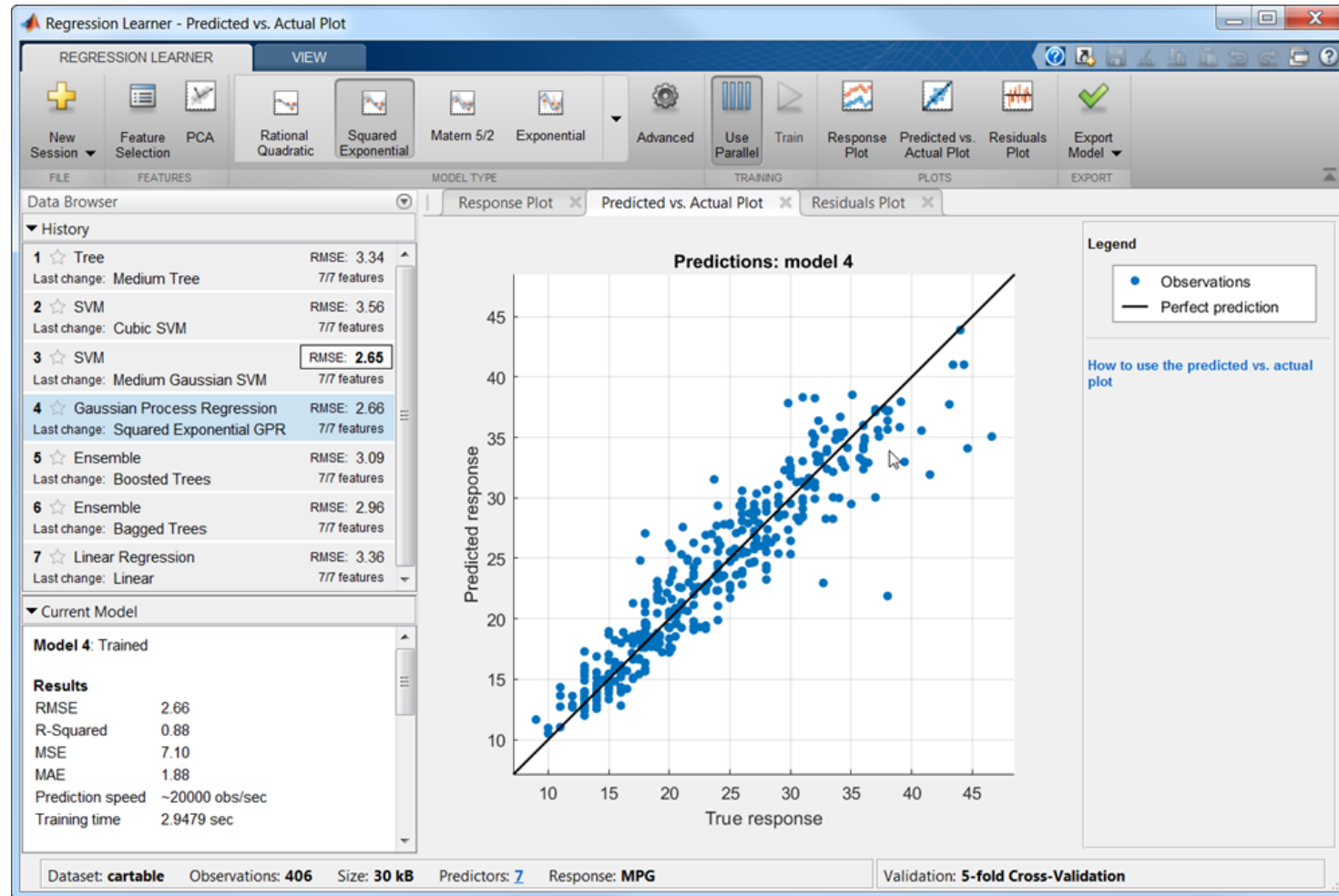


Tall arrays



Making machine learning easy and accessible for Engineers

Machine Learning Apps



Regression Learner

Deep Learning is Changing Expectations



amazon echo



Echo



Echo Tap



Echo Dot



Echo Show

“Alexa, ask Capital One, what’s my balance?”

From tracking your spending to making a payment, now you can manage your Capital One accounts through any Amazon Alexa-enabled devices, including the new Echo Show. Talk about convenient.

[Enable the skill](#)



Manage your Capital One accounts simply using your voice

Deep Learning is Changing Expectations





Deep Learning Tools are for **Programmers**

Caffe  TensorFlow™
 torch theano

Making deep learning easy and accessible for Engineers

VIEW

Breakpoints Pause Run and Advance Run Section Run and Time

```

c.m

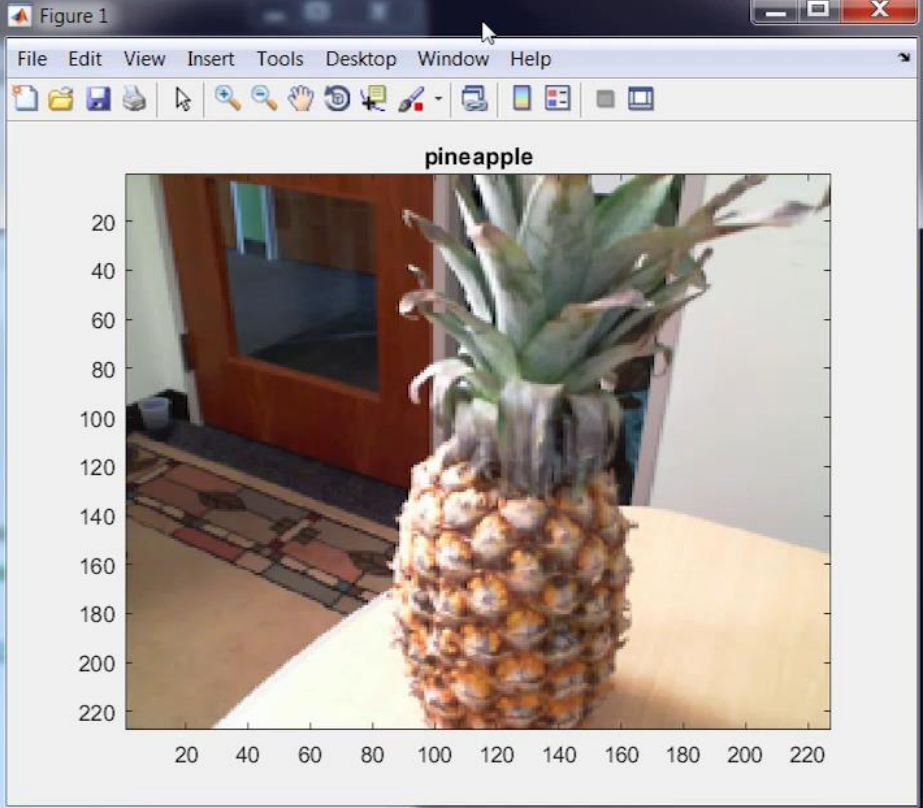
= webcam; % Connect to the camera
alexnet; % Load the neural net

: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
:show;

```

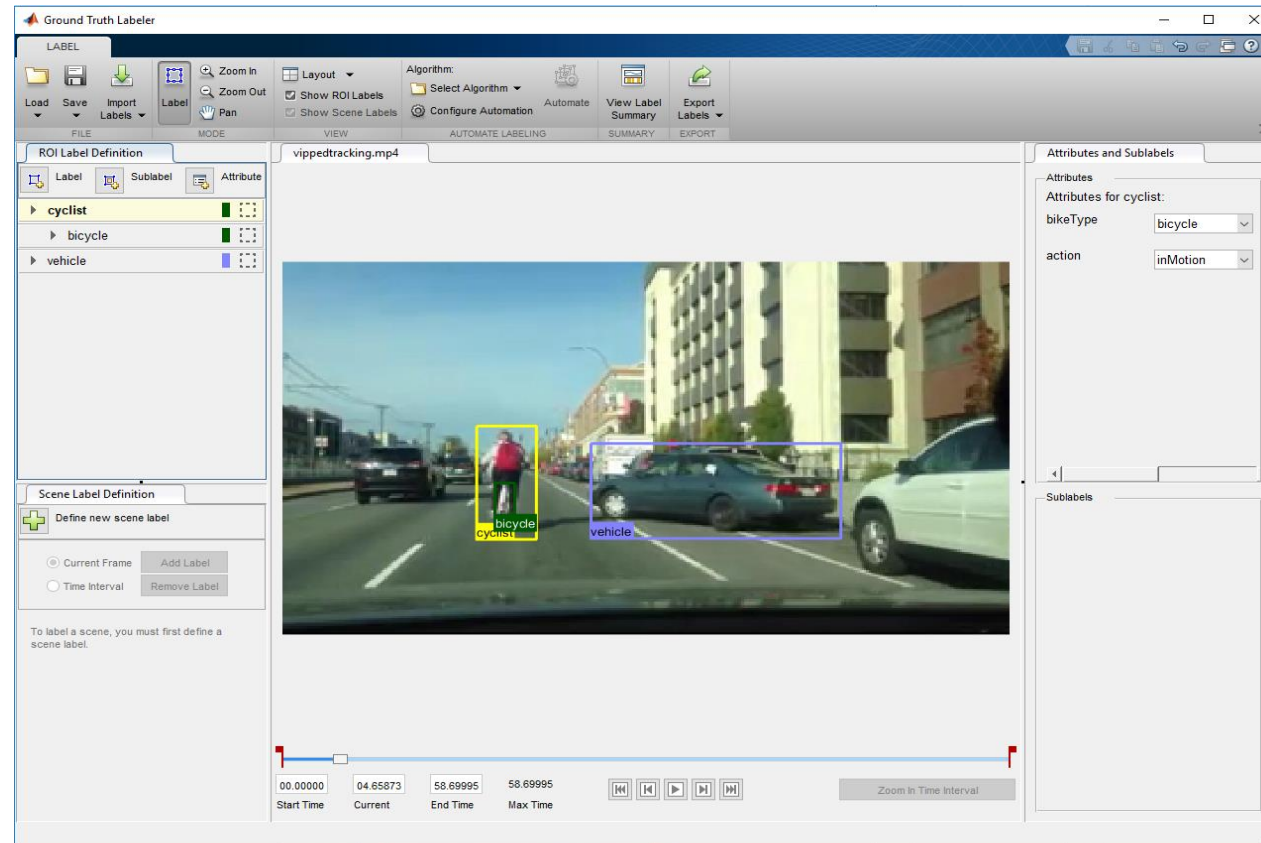


Making **deep learning** easy and accessible for Engineers

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

Making **deep learning** easy and accessible for Engineers

R2017a



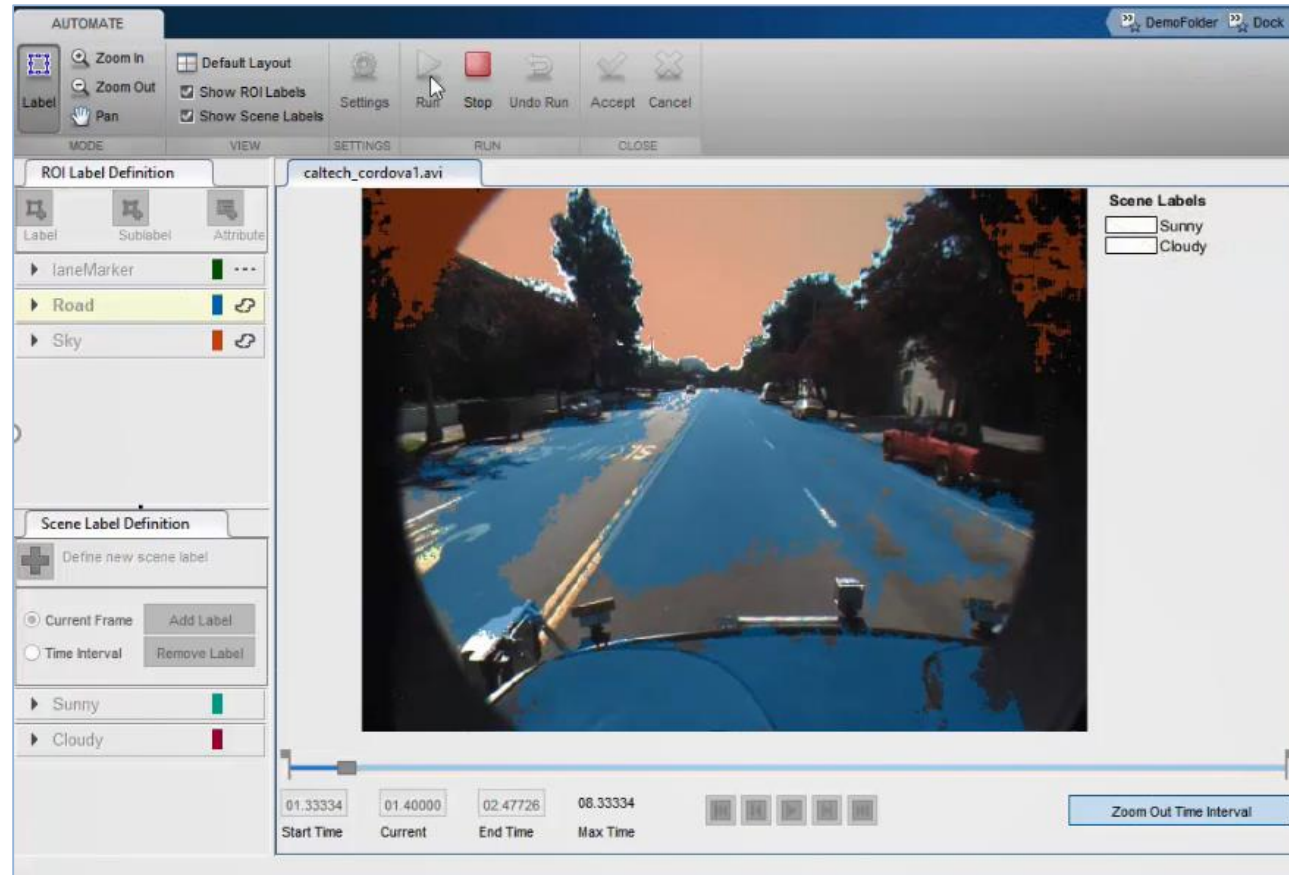
Automate ground truth labeling using deep learning

Sometimes you need more than object detection ...



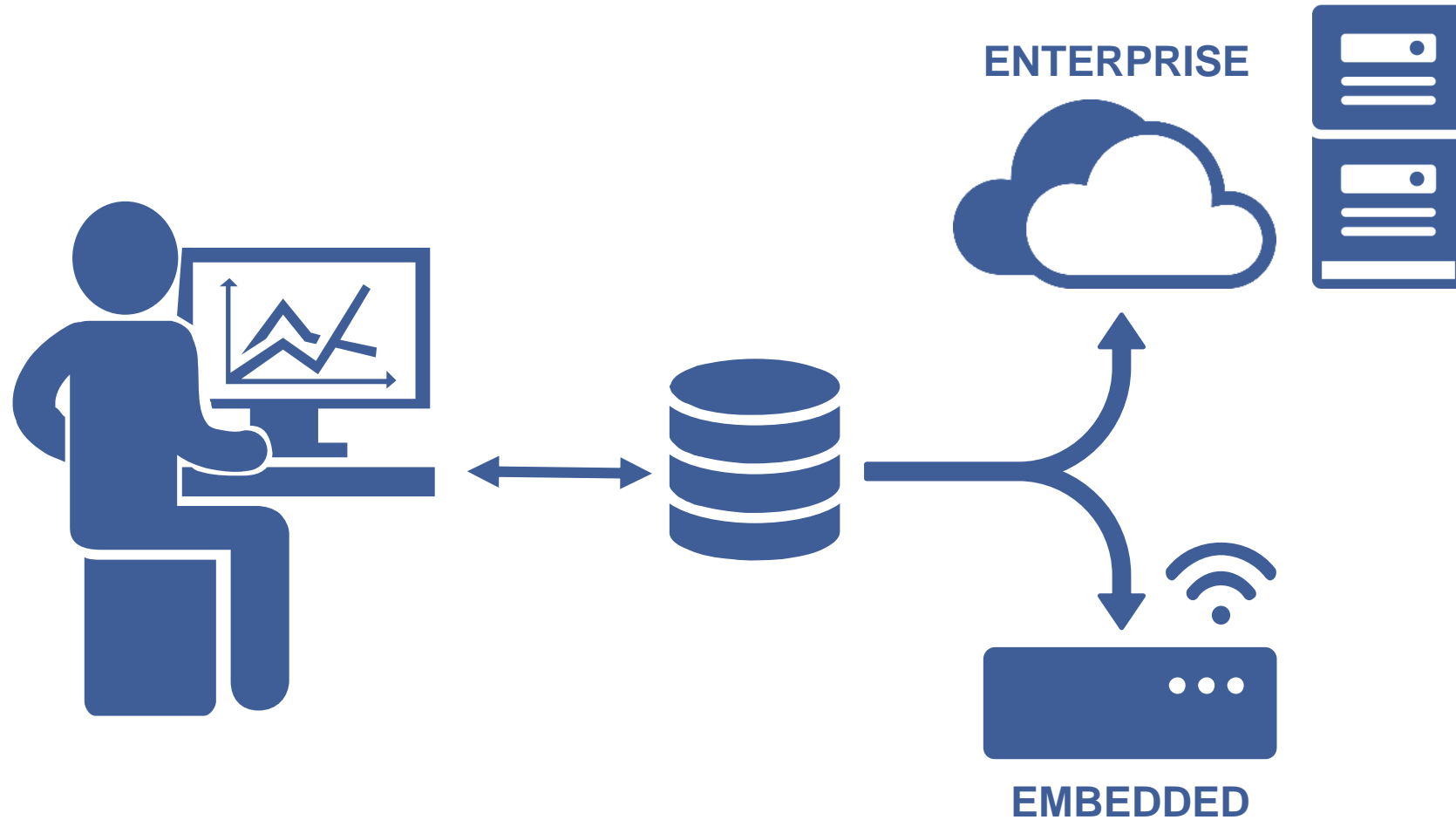
Making **deep learning** easy and accessible for Engineers

R2018a



Labeling everything through semantic segmentation

Delivering analytics to both **embedded** and **enterprise** systems



Making **deep learning** easy and accessible for Engineers

R2017b



Automatically generate CUDA code and TensorRT to deploy trained deep learning networks to NVIDIA GPUs

Making **deep learning** easy and accessible for Engineers



R2018a

Embedded GPU code finding drivable path

Each release makes **AI easy and accessible**

R2016b

JSON	Hyperparameter Optimization
Mobile Sensors Cloud Logging	Spark
Timetable	Machine Learning Code Gen
Missing Data Functions	MATLAB Production Server
Tall Arrays	RESTful Interface
Deep Learning	AlexNet

R2017a

MATLAB Drive	CAFFE Model Zoo
Heatmap Charts	Tall timetable
Regression Learner app	Add-On Explorer Categories
Classification Code Gen	Categorical Plotting
Deep Learning on CPU	Bayesian Statistics
VGG-16, VGG-19	Symbolic Variable Units

R2017b

GPU Coder	Tall Visualization
DAG Networks	Text Analytics Toolbox
LSTM	Change Point Detection
Semantic Image Segmentation	Twitter Datafeed
Image Denoising	MQTT
Deep Learning Training	Geographic Bubble Chart
Visualization	Parallel Bayesian Optimization

R2018a

Live Functions	Image Segmenter App
Web Apps	Deep Learning Layer
App Testing Framework	Validation
uidatepicker	More Tall Array Statistics
Faster Startup	Modal Analysis
Faster Image and Video	Predictive Maintenance
Reading	Toolbox

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®

