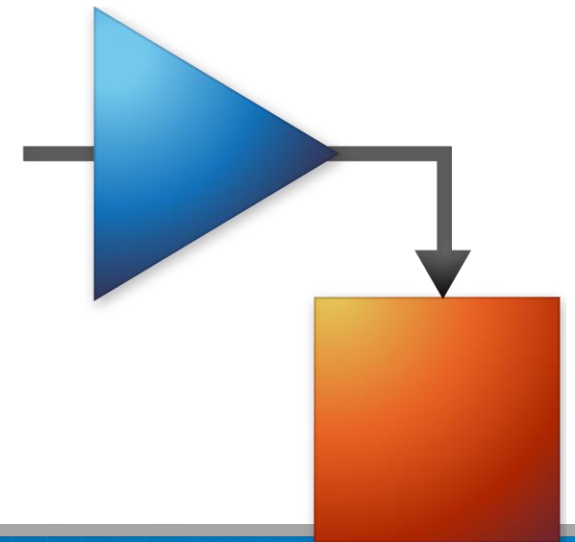
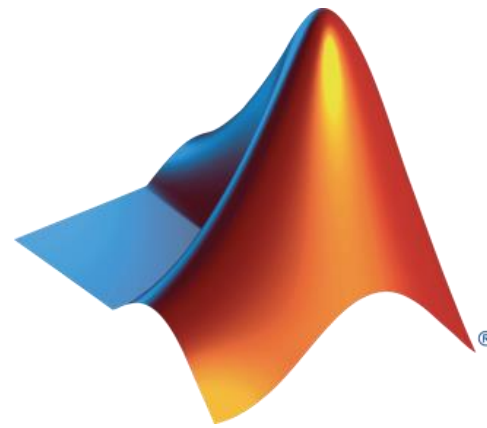


MATLAB & Simulink for Cyber Physical Systems



Sumit Tandon – Senior Customer Success Manager, MathWorks

Agenda

- Intro to MATLAB and Simulink
 - What, where, who, how, quick demos

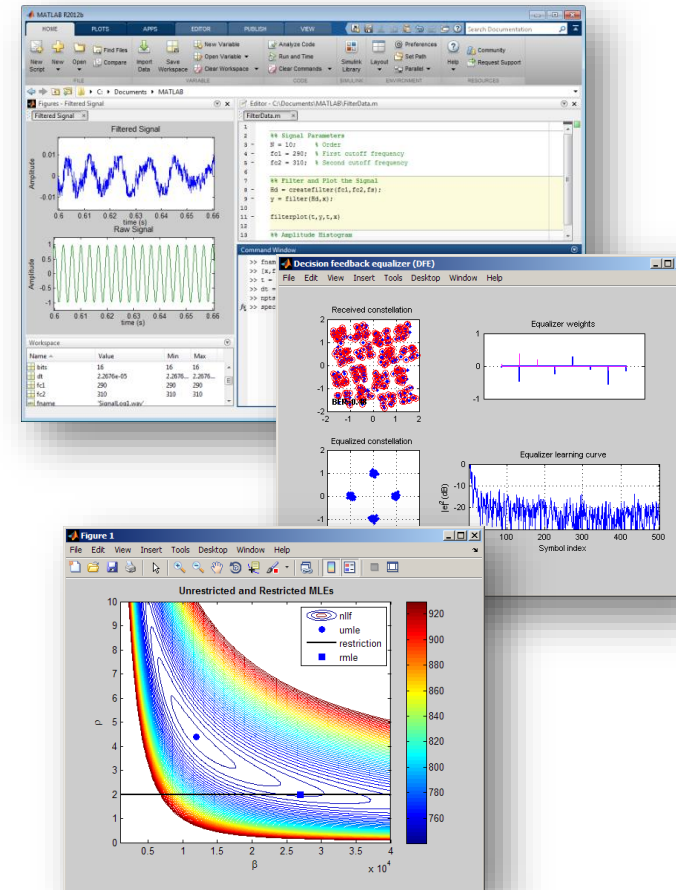
- Intro to Automated Driving System Toolbox
 - What, where, why, quick demos

- Resources

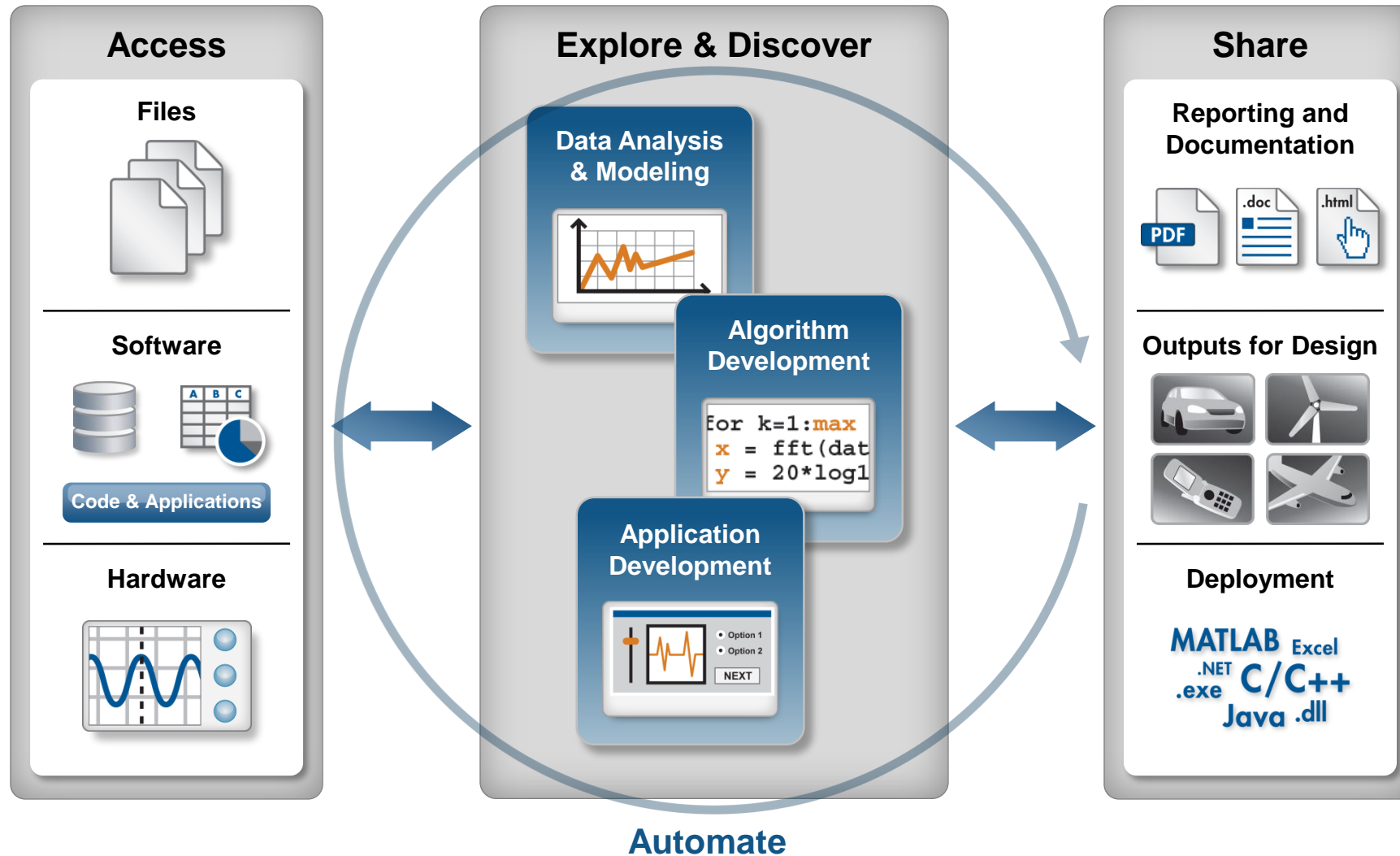
- Q & A

What is MATLAB?

- High-level language
- Interactive development environment
- Used for:
 - Numerical computation
 - Data analysis and visualization
 - Algorithm development and programming
 - Application development and deployment



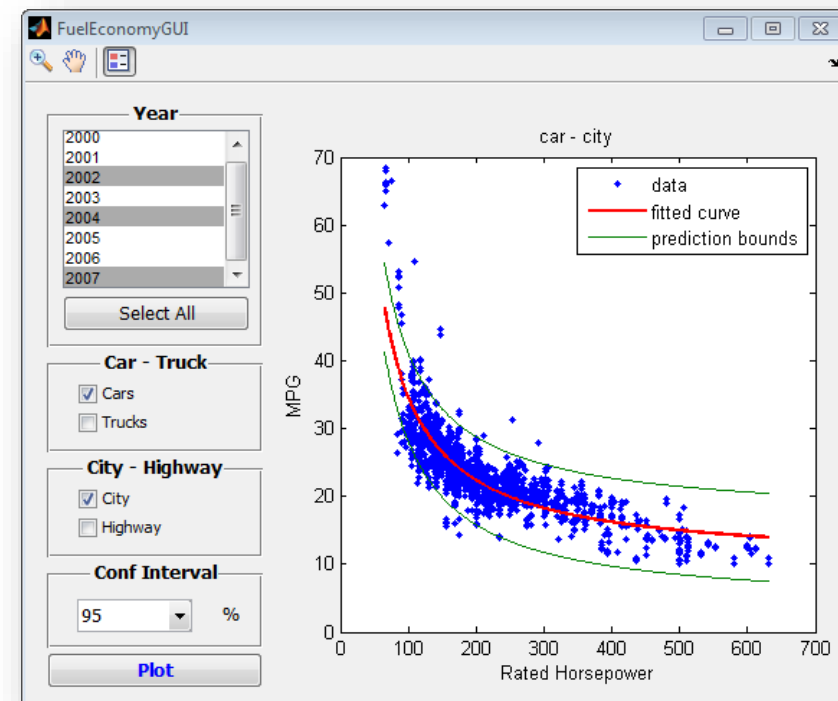
Data Analysis Workflow



Demo: Fuel Economy Analysis

- Goal:
 - Study the relationships between fuel economy, horsepower, and type of vehicle

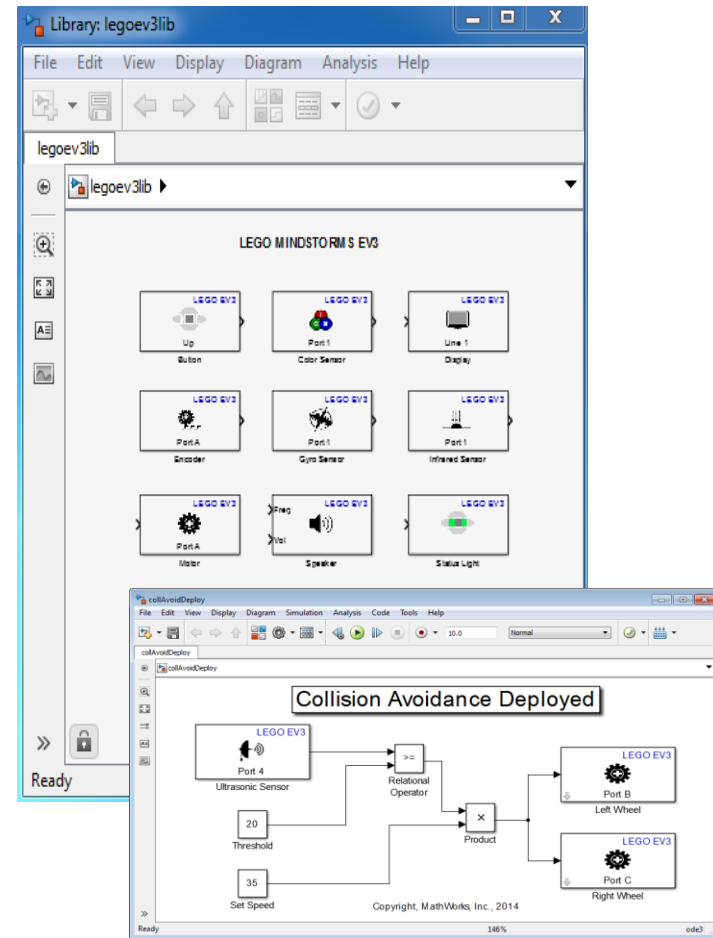
- Approach:
 - Import data from spreadsheet
 - Interactively visualize and explore trends
 - Create a model
 - Document results



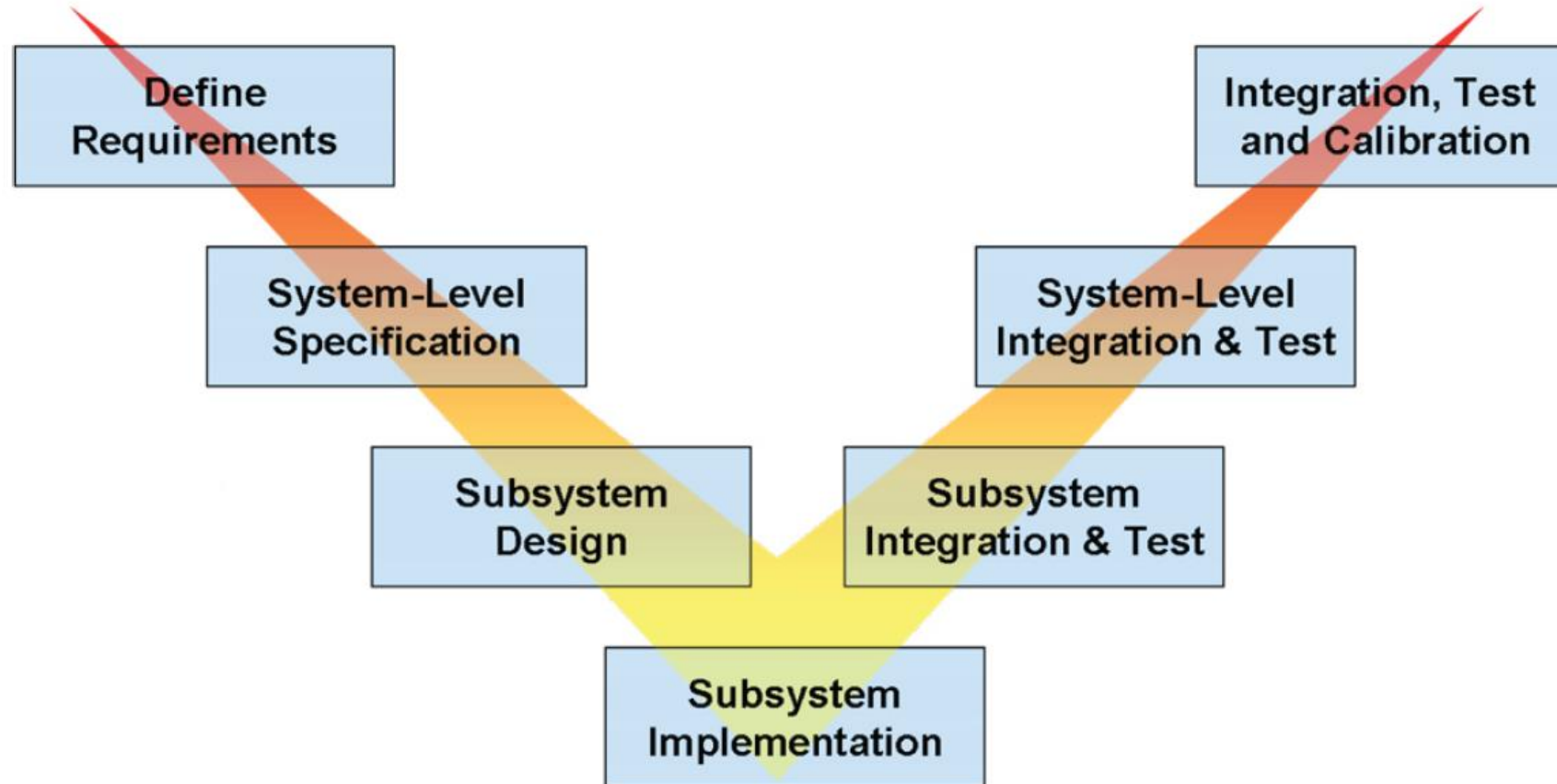
Simulink

The leading environment for modeling, simulating, and implementing dynamic and embedded systems

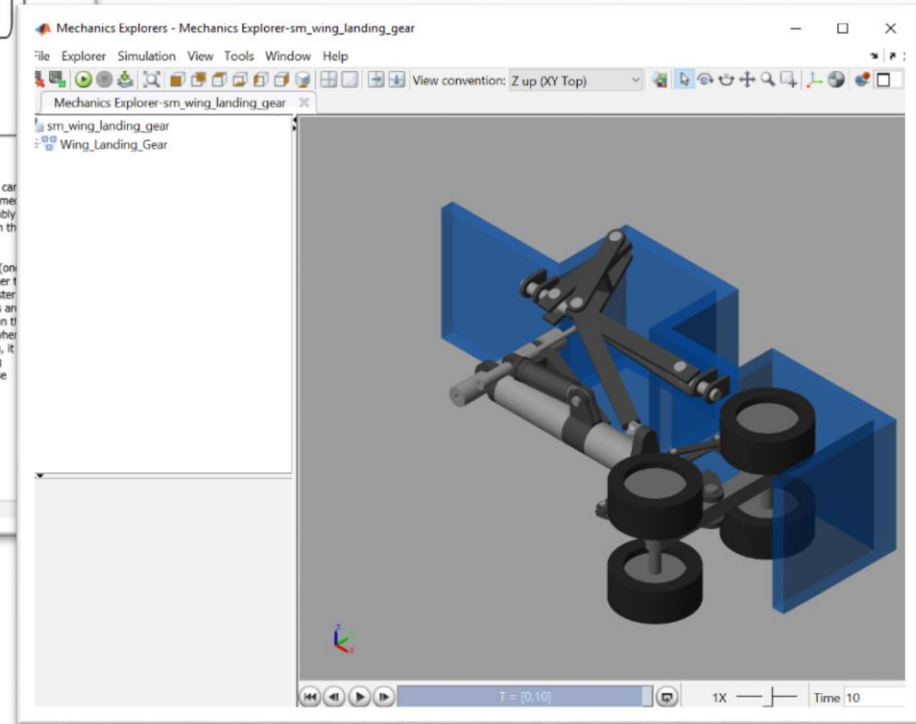
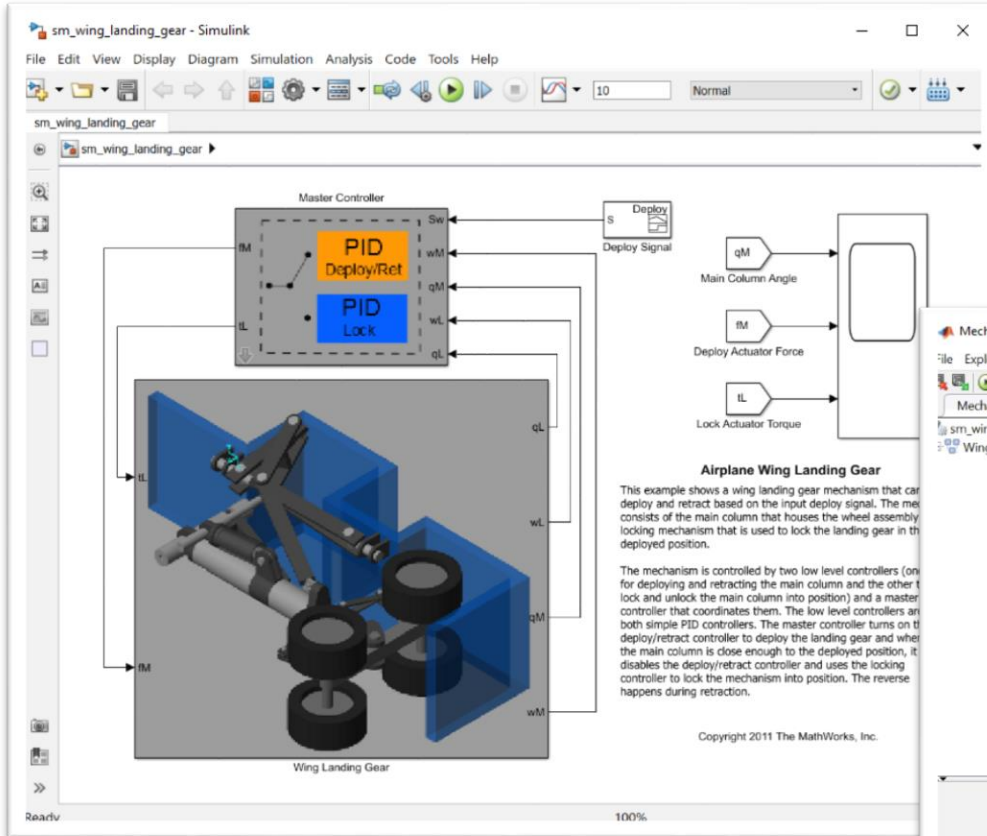
- **Block-diagram** environment
- Model, simulate and analyze **multidomain** systems
- Accurately design, implement, and test:
 - Control systems
 - Signal processing systems
 - Communications systems
 - And other **dynamic** systems
- Platform for **Model-Based Design**



System Design Process



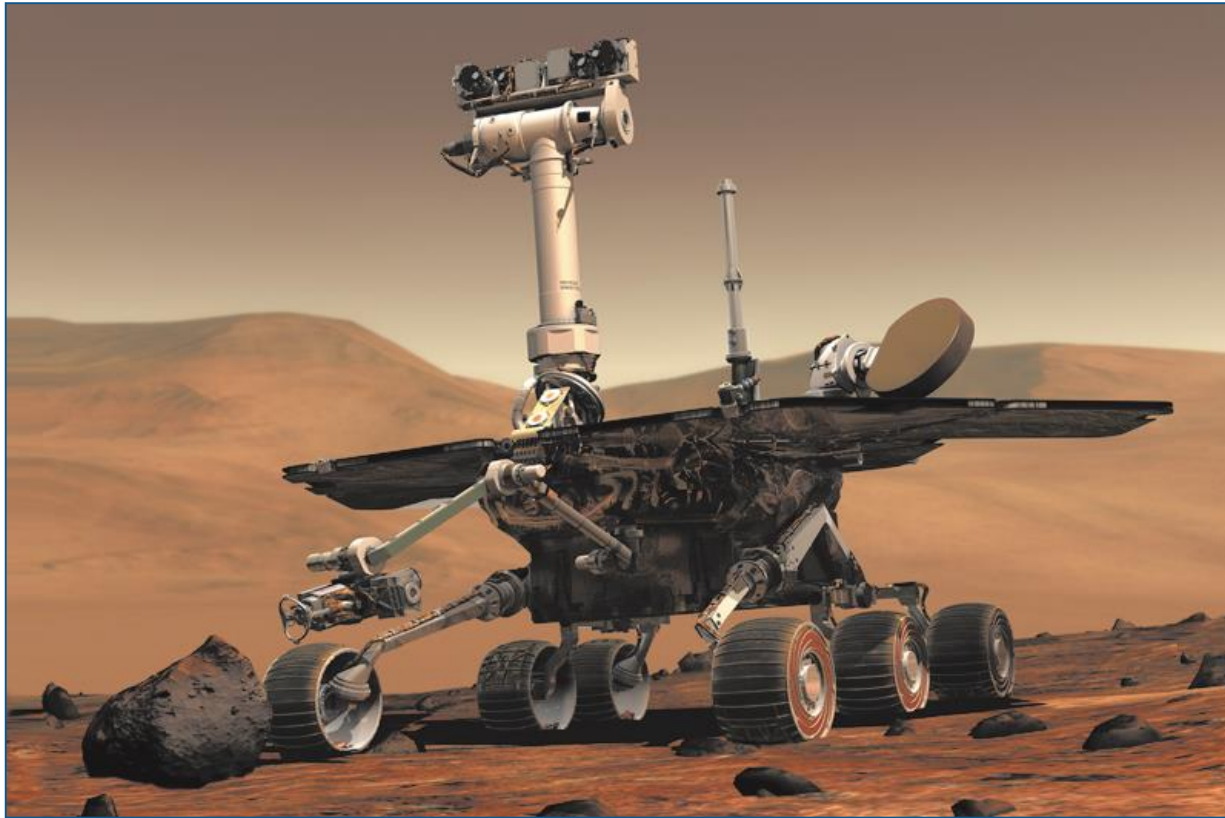
Demo: Wing Landing Gear System



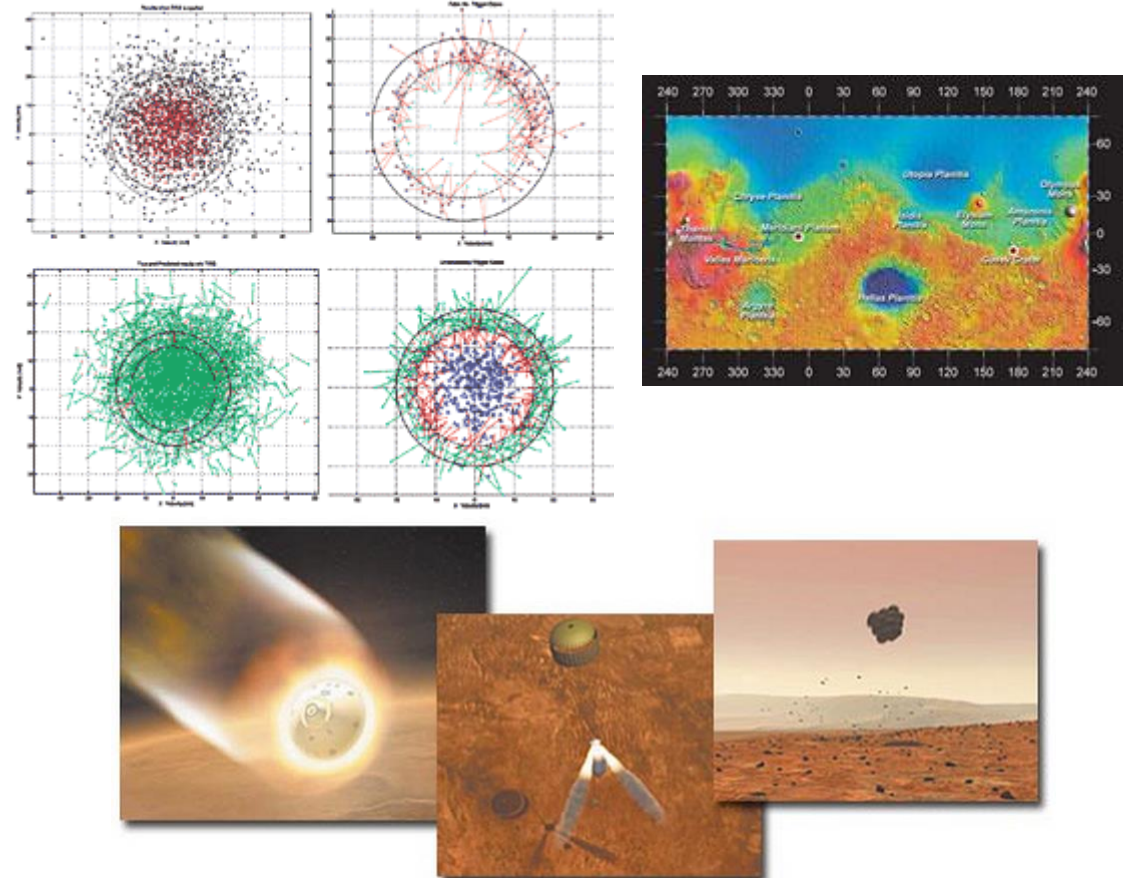
What people do in industry: Mars Rovers – NASA Jet Propulsion Lab

MATLAB is used for:

Entry, Descent, and Landing System Design, Navigation, and Data Analysis...



Artist's rendition of Mars rover.
Graphics courtesy of NASA/JPL/Cornell

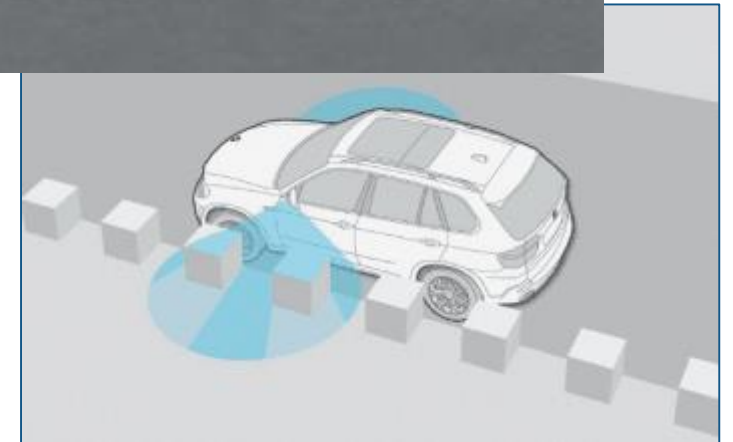


What people do in industry: Motion-Stereo Parking – BMW

**MATLAB is use for:
Motion-Stereo Systems, Object Detection, Computer Vision, Real-Time Control...**



Vehicle equipped with side-view camera. As the vehicle moves, the side-view camera acquires images that are used to measure depth.



What people do in industry:

Prosthetic Arm – Applied Physics Lab

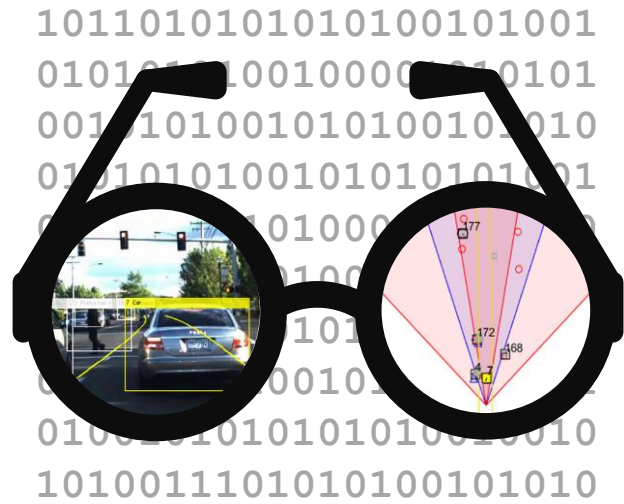
MATLAB is use for:

**Simulation in Virtual Environment, Machine Learning, Real-Time Controller Design,
and Clinical Application...**

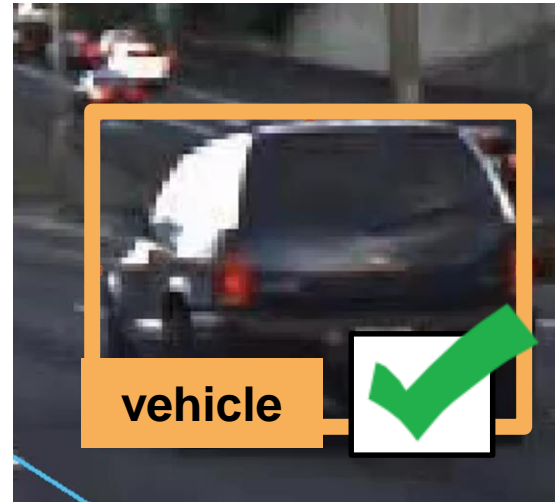


Automated Driving System Toolbox

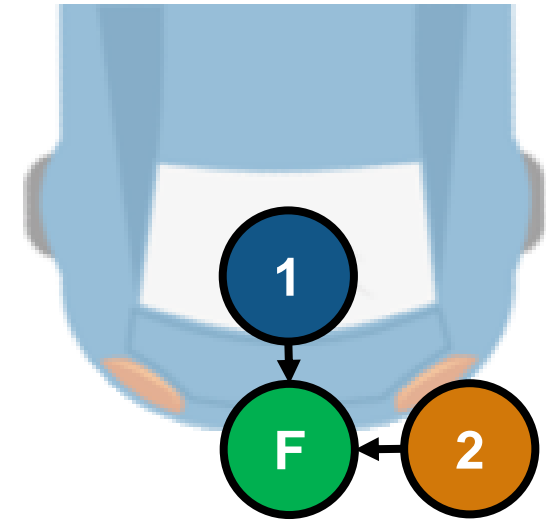
Some common questions from automated driving engineers



How can I visualize vehicle data?

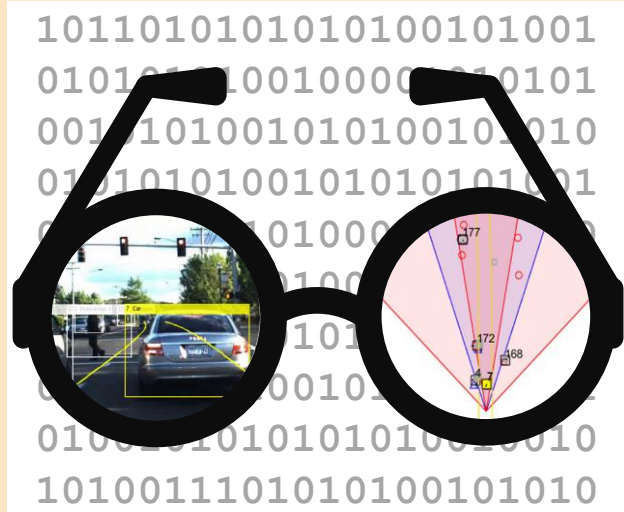


How can I detect objects in images?

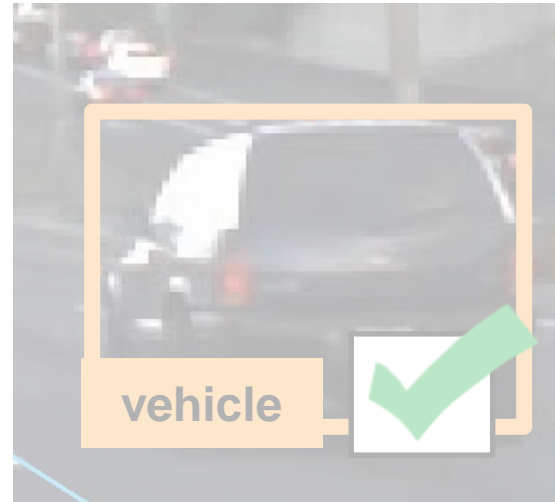


How can I fuse multiple detections?

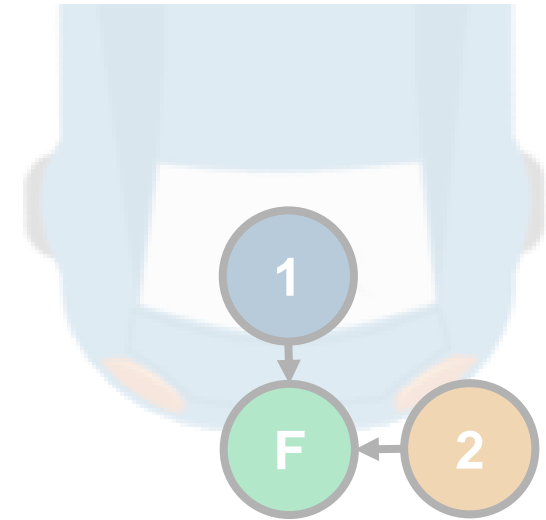
Some common questions from automated driving engineers



**How can I
visualize vehicle
data?**



**How can I
detect objects in
images?**



**How can I
fuse multiple
detections?**

Visualize sensor data

Image Coordinates

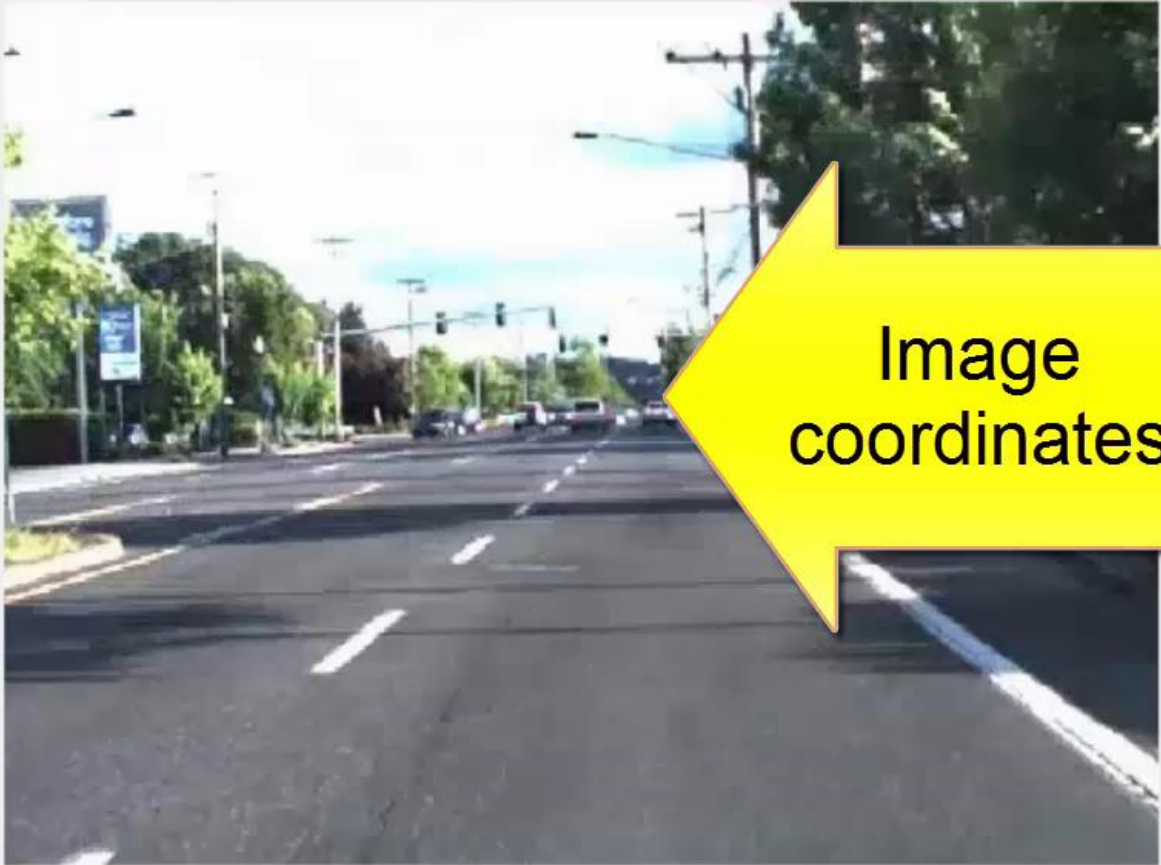
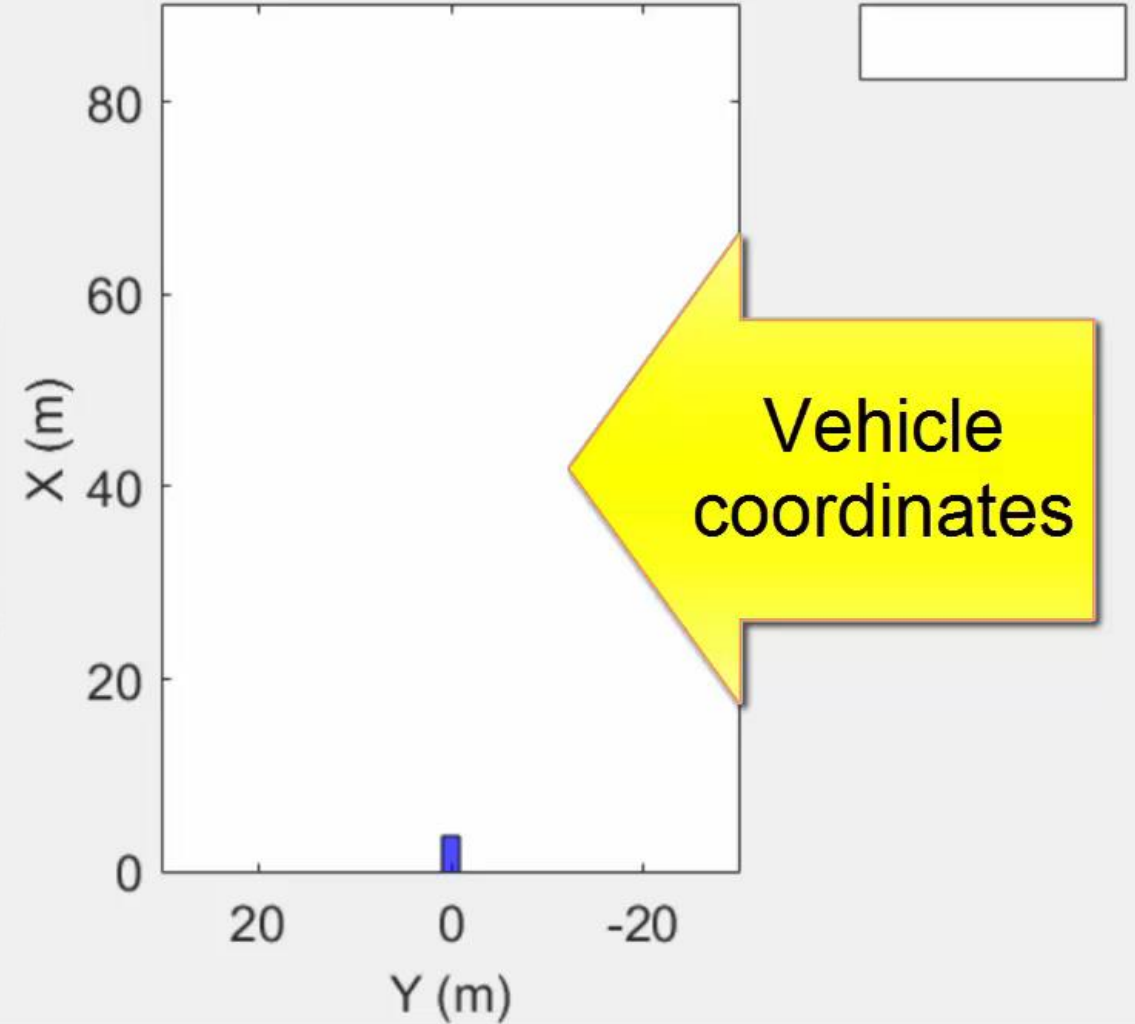


Image
coordinates

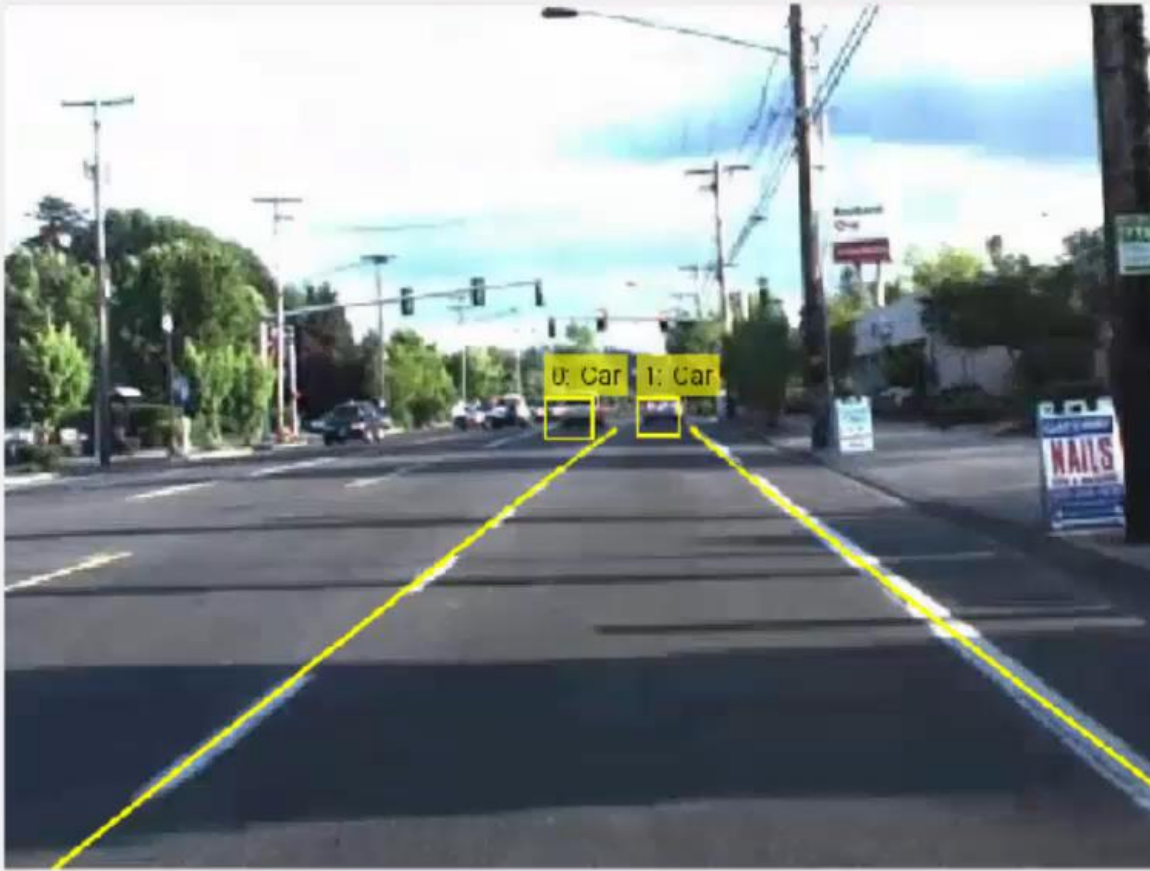
Vehicle Coordinates



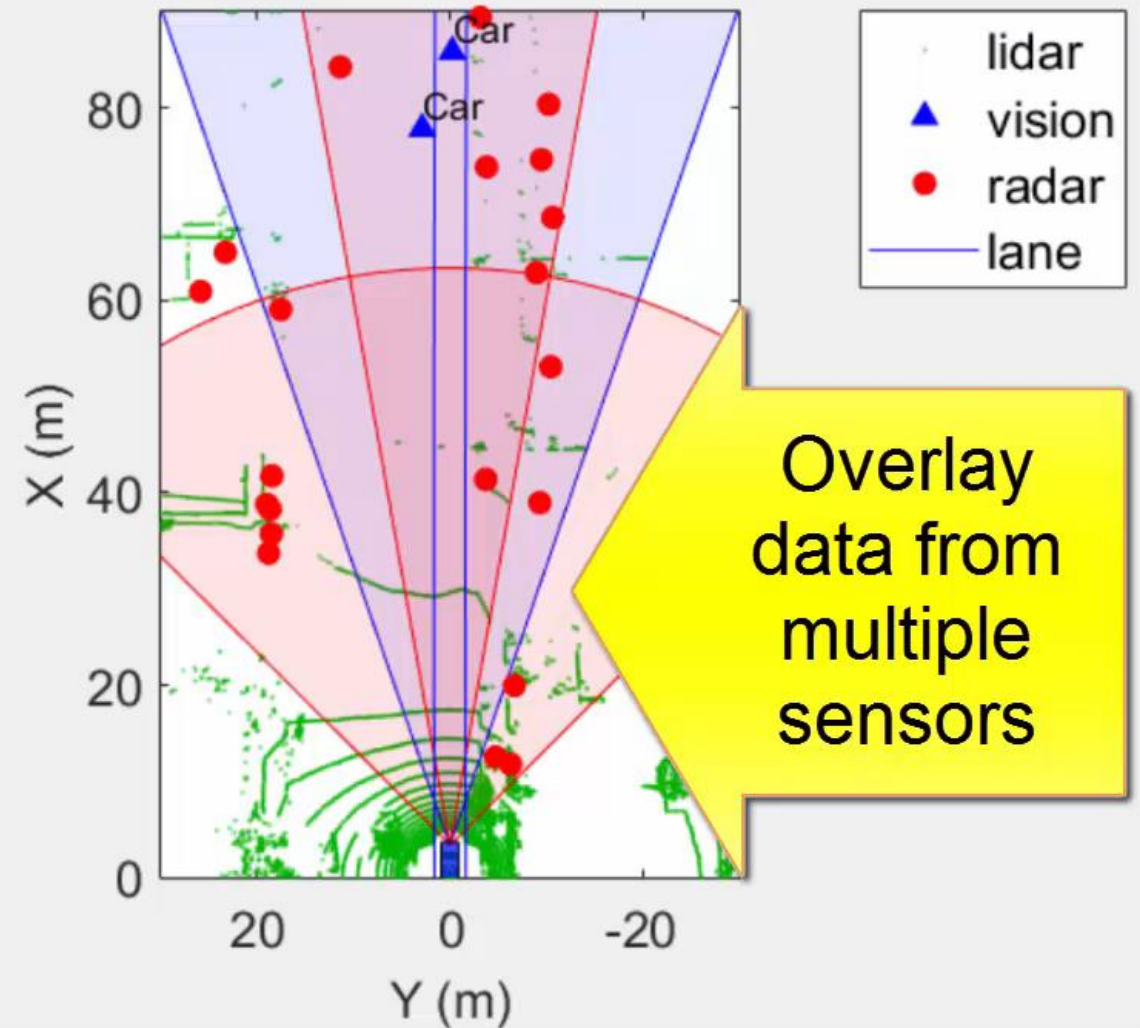
Vehicle
coordinates

Visualize differences in sensor detections

Image Coordinates

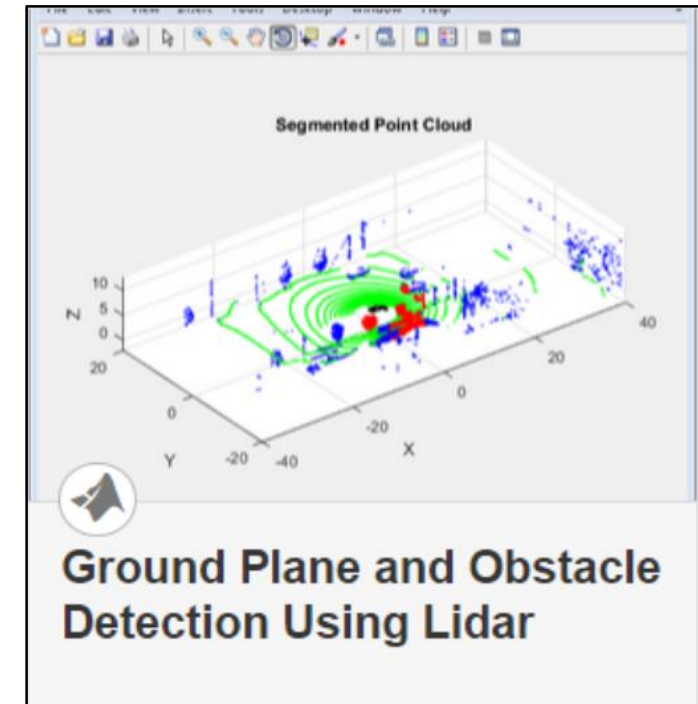
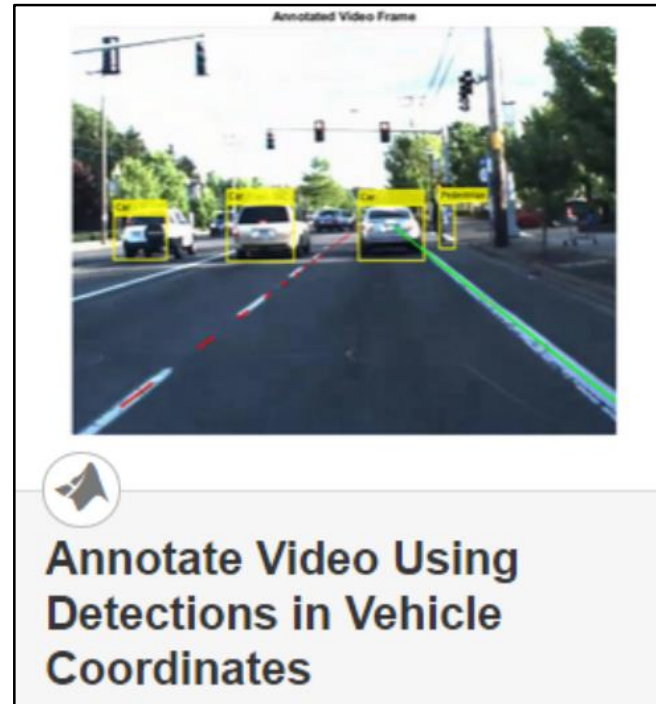
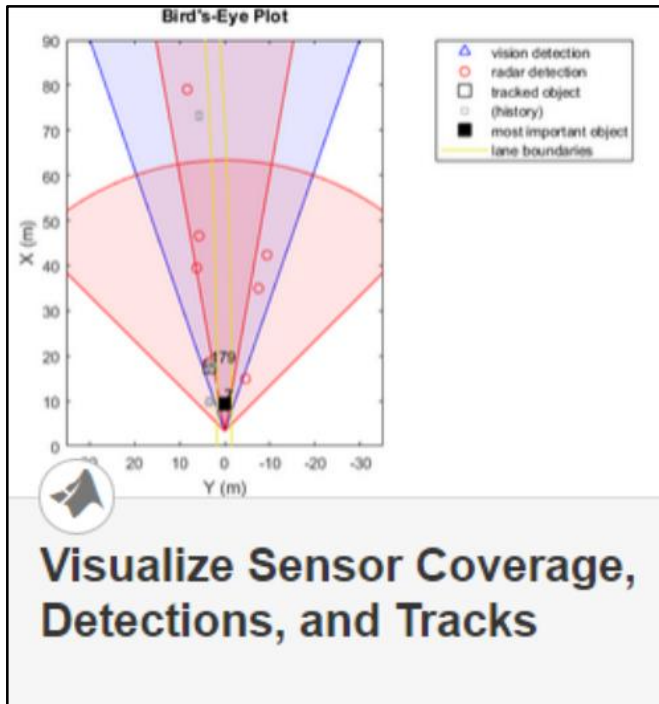


Vehicle Coordinates



Learn more about visualizing vehicle data

by exploring examples in the Automated Driving System Toolbox

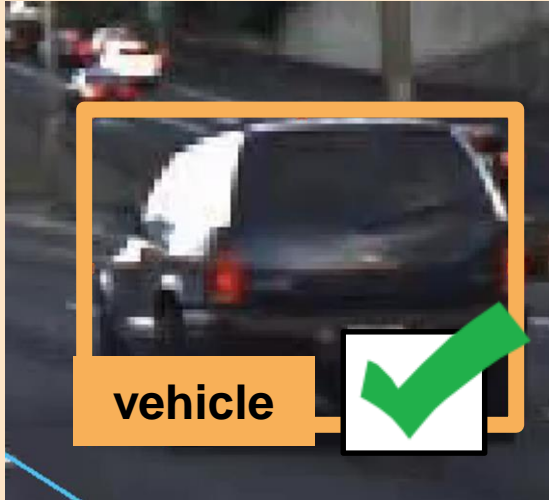


- **Plot object detectors in vehicle coordinates**
 - Vision & radar detector
 - Lane detectors
 - Detector coverage areas
- **Transform between vehicle and image coordinates**
- **Plot lidar point cloud**

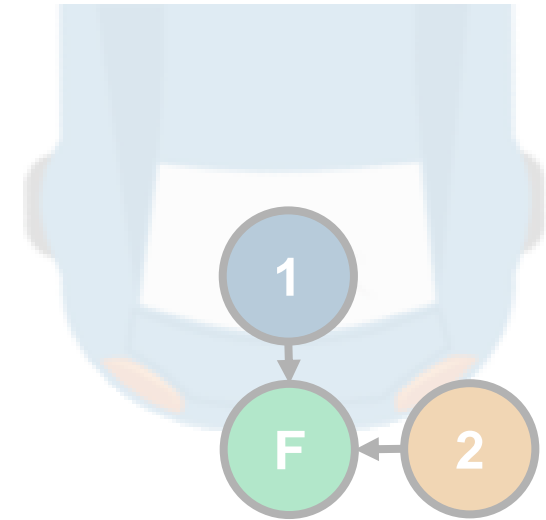
Some common questions from automated driving engineers



How can I
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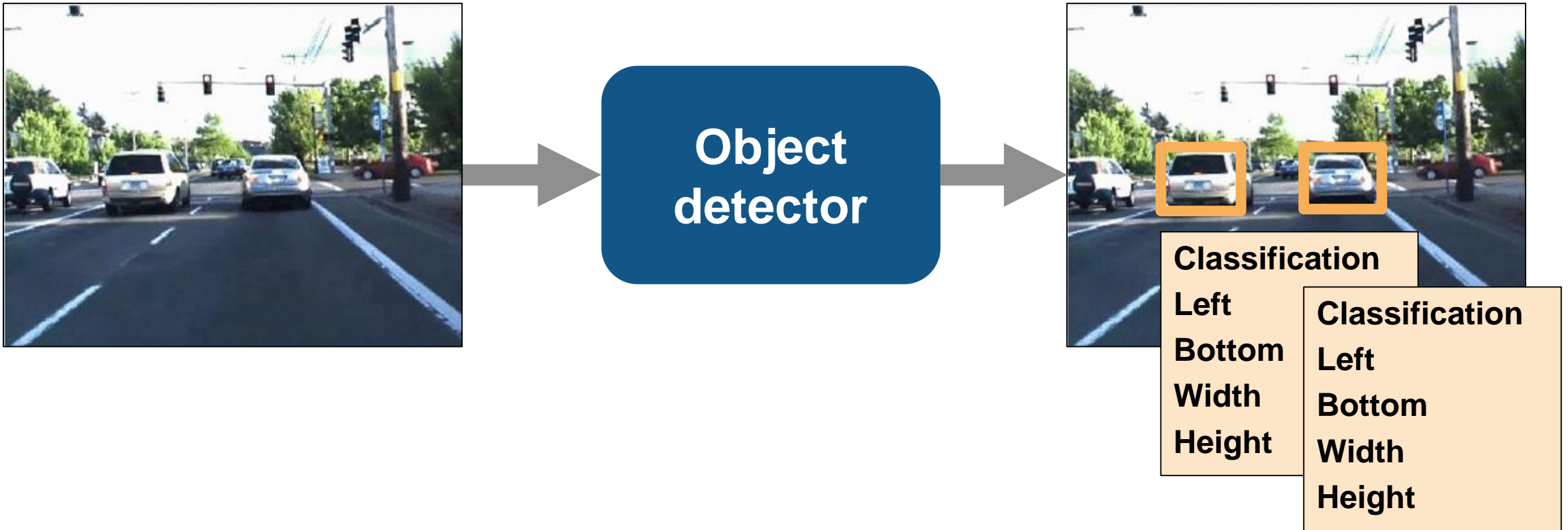


How can I
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images?

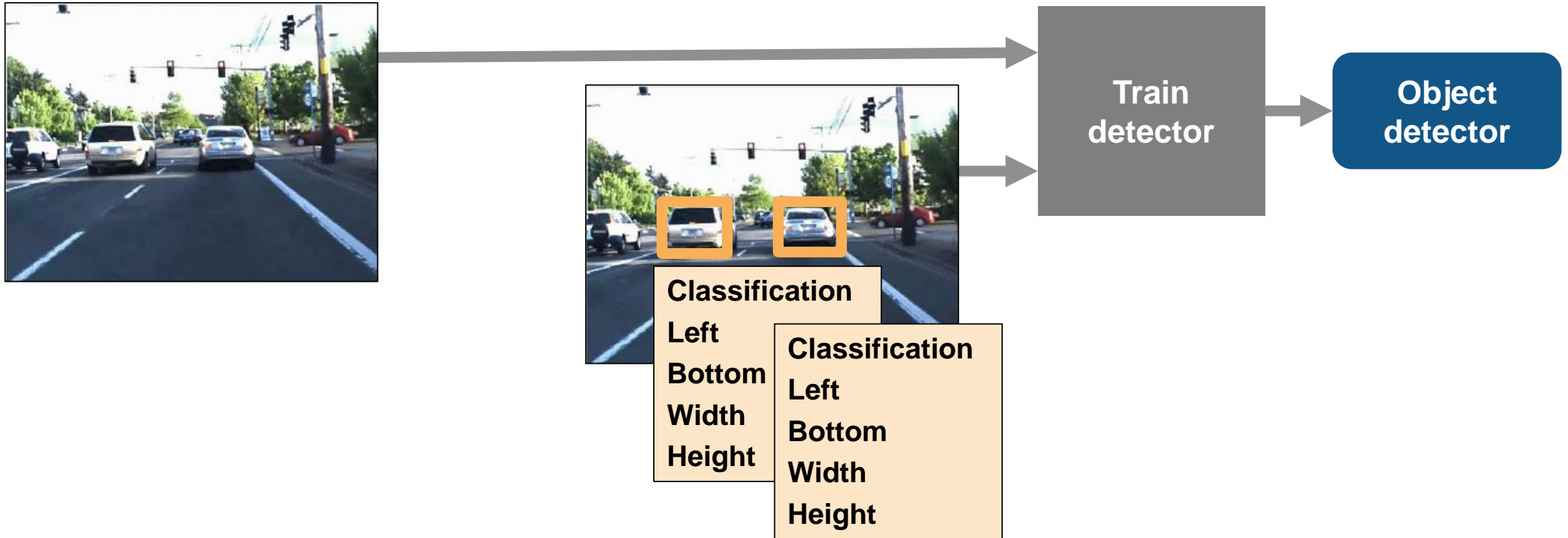


How can I
fuse multiple
detections?

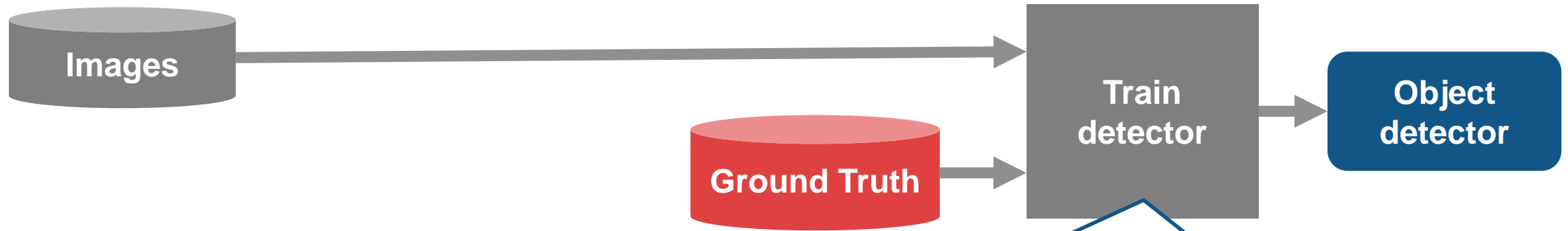
How can I detect objects in images?



Train object detectors based on ground truth



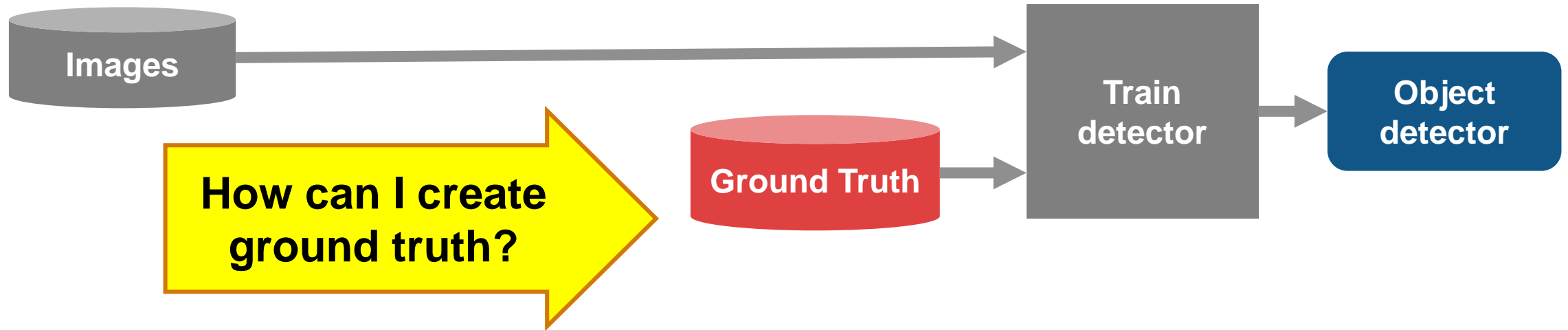
Train object detectors based on ground truth



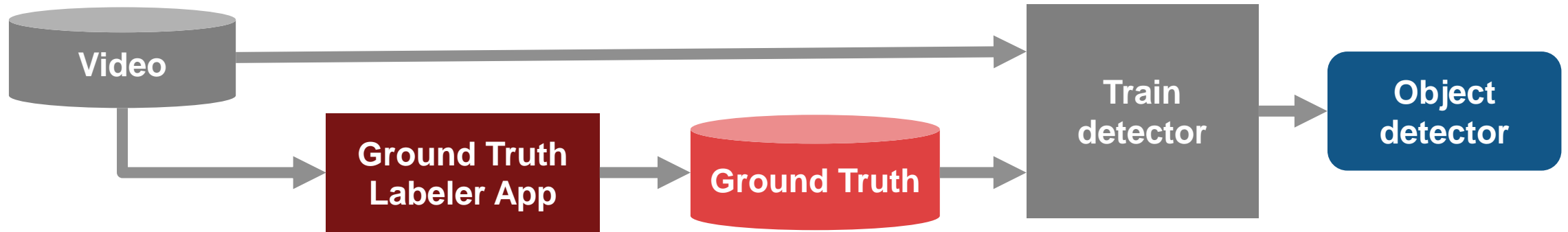
Design object detectors with the Computer Vision System Toolbox

Machine Learning	Aggregate Channel Feature	<code>trainACFObjectDetector</code>
	Cascade	<code>trainCascadeObjectDetector</code>
Deep Learning	R-CNN (Regions with Convolutional Neural Networks)	<code>trainRCNNObjectDetector</code>
	Fast R-CNN	<code>trainFastRCNNObjectDetector</code>
	Faster R-CNN	<code>trainFasterRCNNObjectDetector</code>

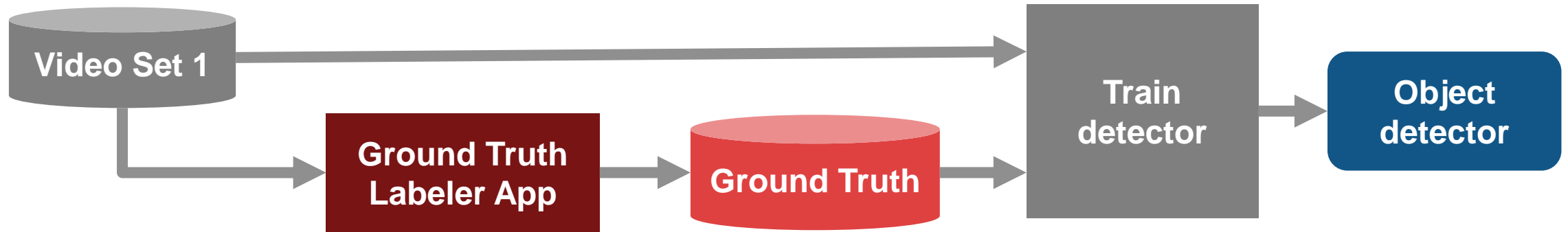
Specify ground truth to train detector



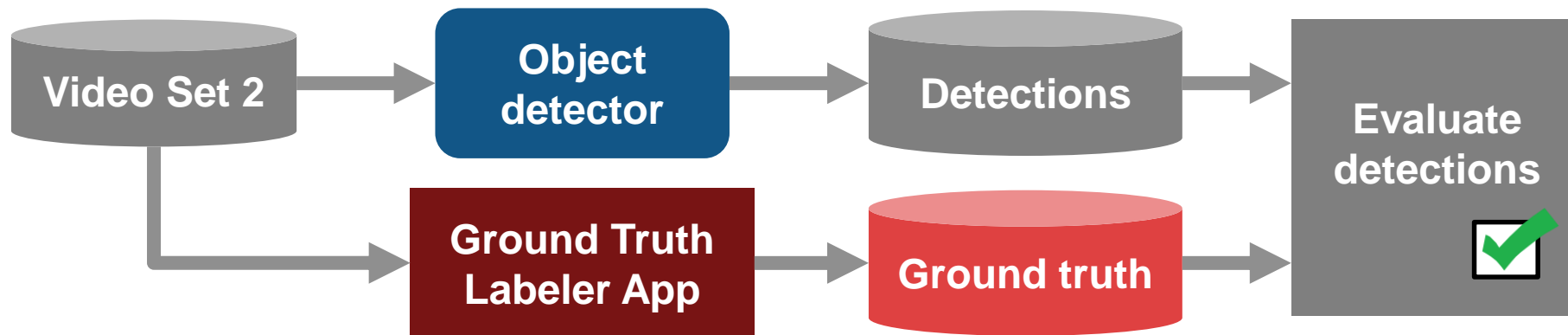
Specify ground truth to train detector



Specify ground truth to train detectors



Specify ground truth to evaluate detectors



Learn more about detecting objects in images by exploring examples in the Automated Driving System Toolbox

The screenshot shows the Ground Truth Labeler App interface. On the left, there are tabs for 'DATA SOURCE' (Video, Image Sequence, Custom Reader), 'LABEL DEFINITIONS' (Label Definitions), and 'SESSION'. The main area is divided into 'ROI Label Definition' and 'Scene Label Definition' sections. The 'ROI Label Definition' section includes a 'Define New ROI Label' button and a list of labels like 'cars' and 'streetLights'. The 'Scene Label Definition' section includes a 'Define New Scene Label' button and options for 'Current Frame' (Add Label, Remove Label) and 'Time Interval'. A video preview window shows a street scene with labeled objects. At the bottom, there are four steps: 'LOAD Video, Image Sequence, or Custom Reader', 'DEFINE ROIs and Scene Label Definitions', 'SET Interval and Controls', and 'LABEL Rectangles & Lines'.

Define Ground Truth Data for Video or Image Sequences

- **Label detections** with Ground Truth Labeler App

The screenshot shows the Automated Driving System Toolbox interface. The main window displays a video of a road with lane boundaries highlighted in cyan and yellow. The interface includes a toolbar with 'Zoom In', 'Zoom Out', 'Default Layout', 'Settings', 'Run', 'Stop', 'Undo Run', 'Accept', and 'Cancel'. Below the video, there are 'ROI Label Definition' and 'Scene Label Definition' panels. The 'ROI Label Definition' panel shows a 'LaneBound...' label. The 'Scene Label Definition' panel shows 'Current Fra...' and 'Time Interval' options. A timeline at the bottom shows 'Start Time', 'Current', 'End Time', and 'Max Time' values. A circular icon with a road sign is positioned below the screenshot.

Automate Ground Truth Labeling of Lane Boundaries

- **Add automation algorithm** for lane tracking

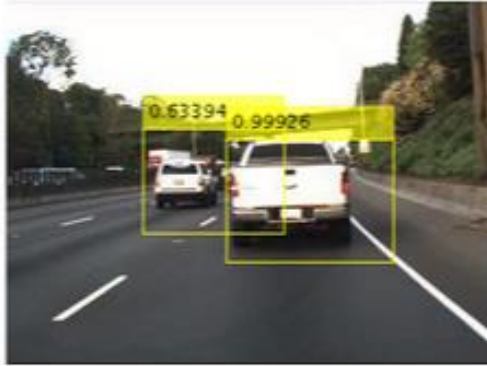
The screenshot shows the Ground Truth Labeler App interface. The main window displays a video of a road with lane boundaries highlighted in cyan and yellow. The interface includes a toolbar with 'Zoom In', 'Zoom Out', 'Default Layout', 'Settings', 'Run', 'Stop', 'Undo Run', 'Accept', and 'Cancel'. Below the video, there are 'ROI Label Definition' and 'Scene Label Definition' panels. The 'ROI Label Definition' panel shows a 'LaneBound...' label. The 'Scene Label Definition' panel shows 'Current Fra...' and 'Time Interval' options. A timeline at the bottom shows 'Start Time', 'Current', 'End Time', and 'Max Time' values. A circular icon with a road sign is positioned below the screenshot.

driving.connector.Connector class
Connect Lidar Display to Ground Truth Labeler

- **Extend connectivity** of Ground Truth Labeler App

Learn more about detecting objects in images

by exploring examples in the Automated Driving System Toolbox



Train a Deep Learning Vehicle Detector

- **Train object detector** using deep learning and machine learning techniques



Track Pedestrians from a Moving Car

- **Explore pre-trained pedestrian detector**



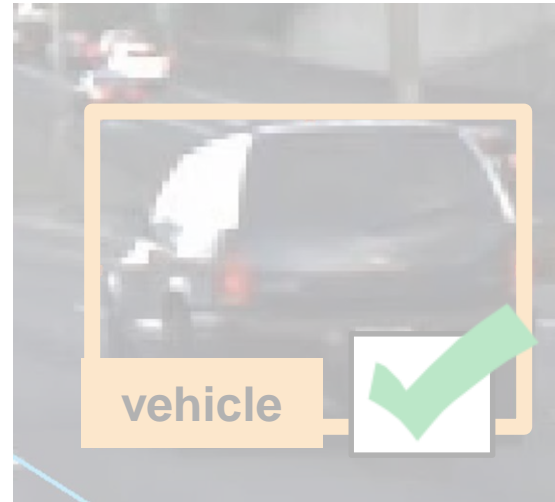
Visual Perception Using Monocular Camera

- **Explore lane detector** using coordinate transforms for mono-camera sensor model

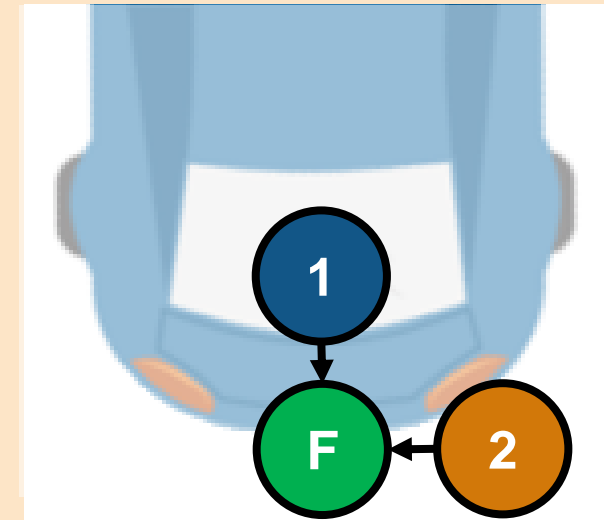
Some common questions from automated driving engineers



How can I
visualize vehicle
data?



How can I
detect objects in
images?



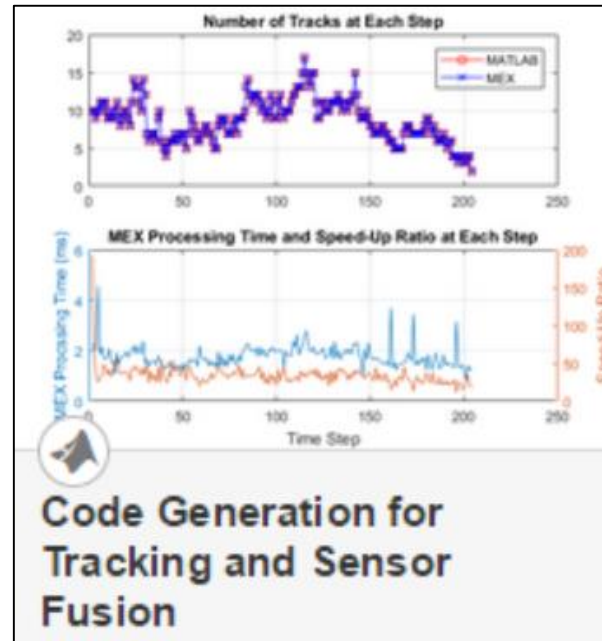
How can I
fuse multiple
detections?

Learn more about sensor fusion

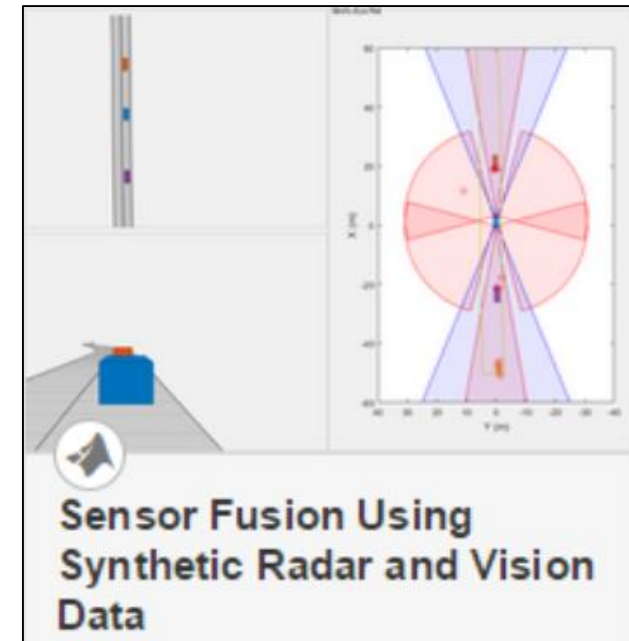
by exploring examples in the Automated Driving System Toolbox



- **Design** multi-object tracker based on logged vehicle data



- **Generate C/C++** code from algorithm which includes a multi-object tracker



- **Synthesize driving scenario** to test multi-object tracker

Upcoming Webinar: Introduction to Automated Driving System Toolbox

Date	Time
25 Jan 2018	1:30 AM PST
25 Jan 2018	6:00 AM PST
25 Jan 2018	11:00 AM PST

www.mathworks.com > Events > Upcoming Webinars

<https://www.mathworks.com/company/events/webinars/upcoming/introduction-to-automated-driving-system-toolbox-2355969.html>

Resources

Q & A