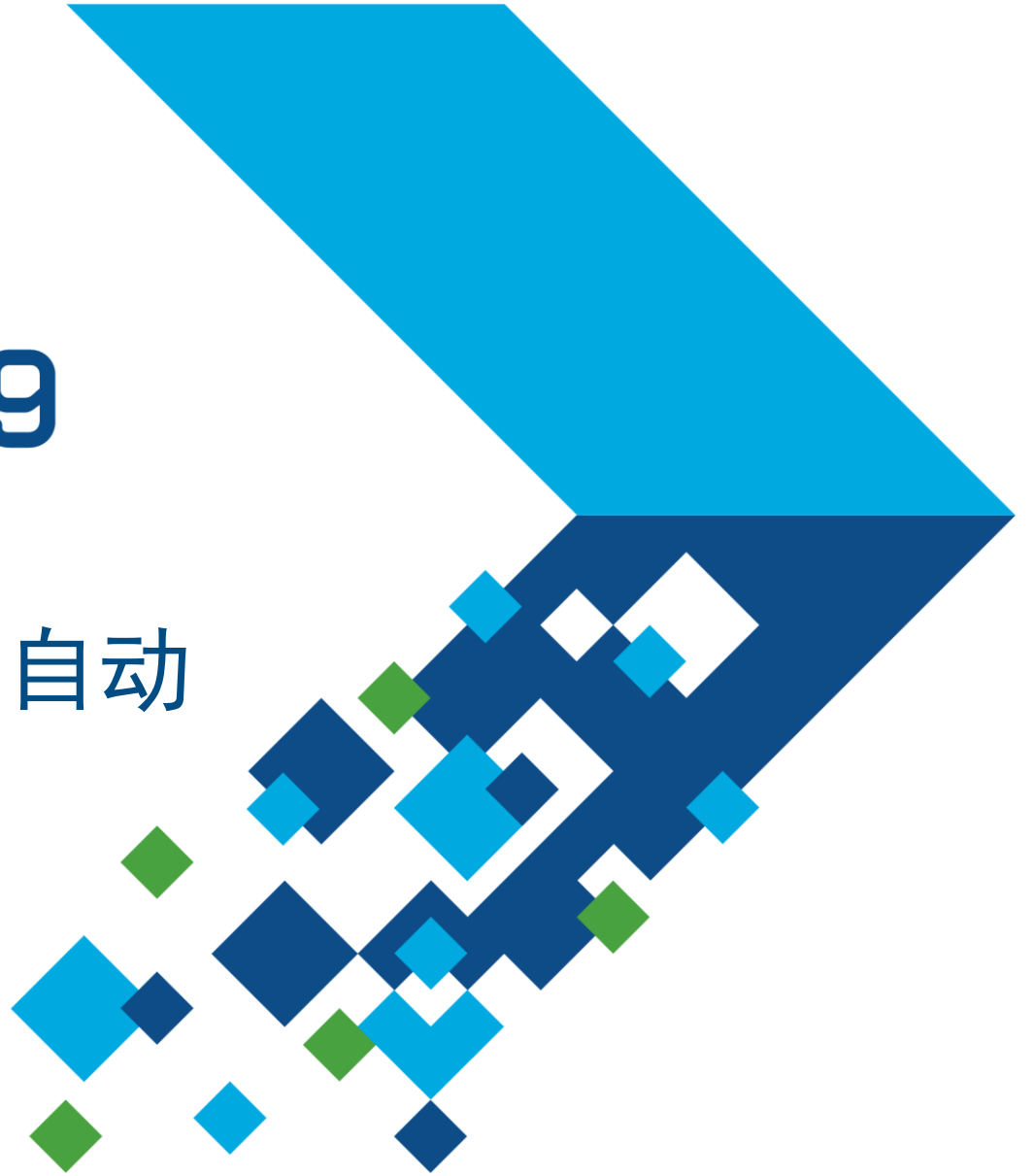


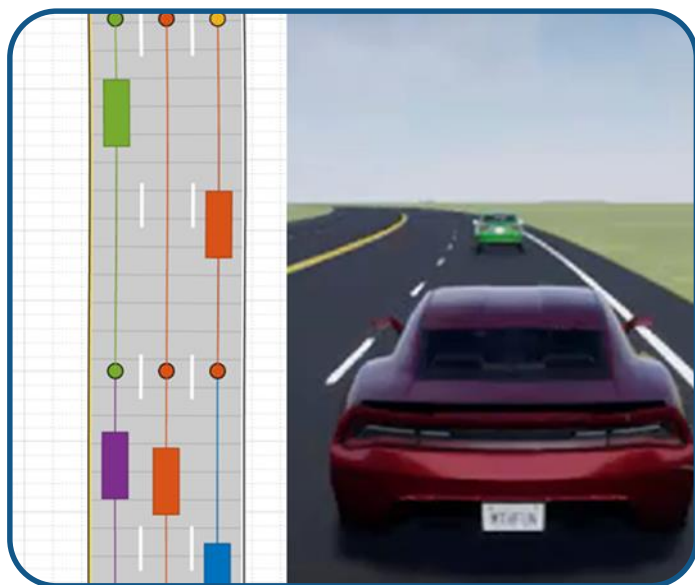
MATLAB EXPO 2019

MATLAB和Simulink用于开发自动驾驶的新特性

王鸿钧, MathWorks 中国



自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？

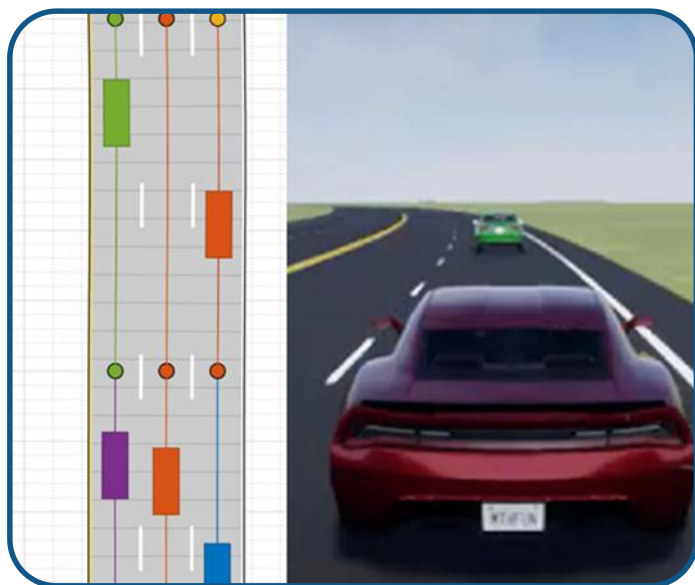


如何串联和加速多个专业
的算法开发？

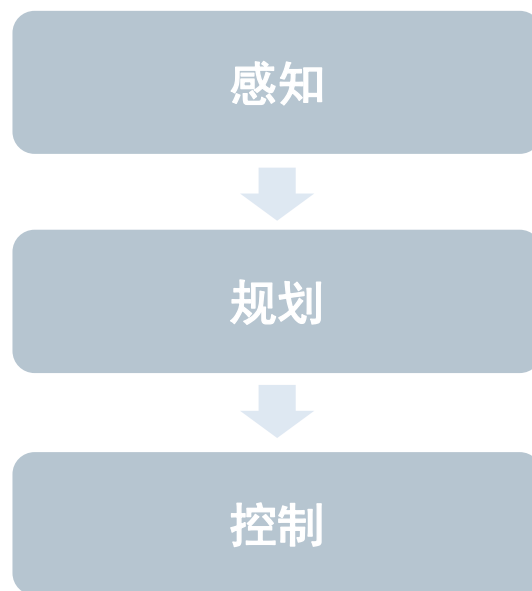


如何将其他资源集成到我们的
仿真环境？

自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
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仿真环境？

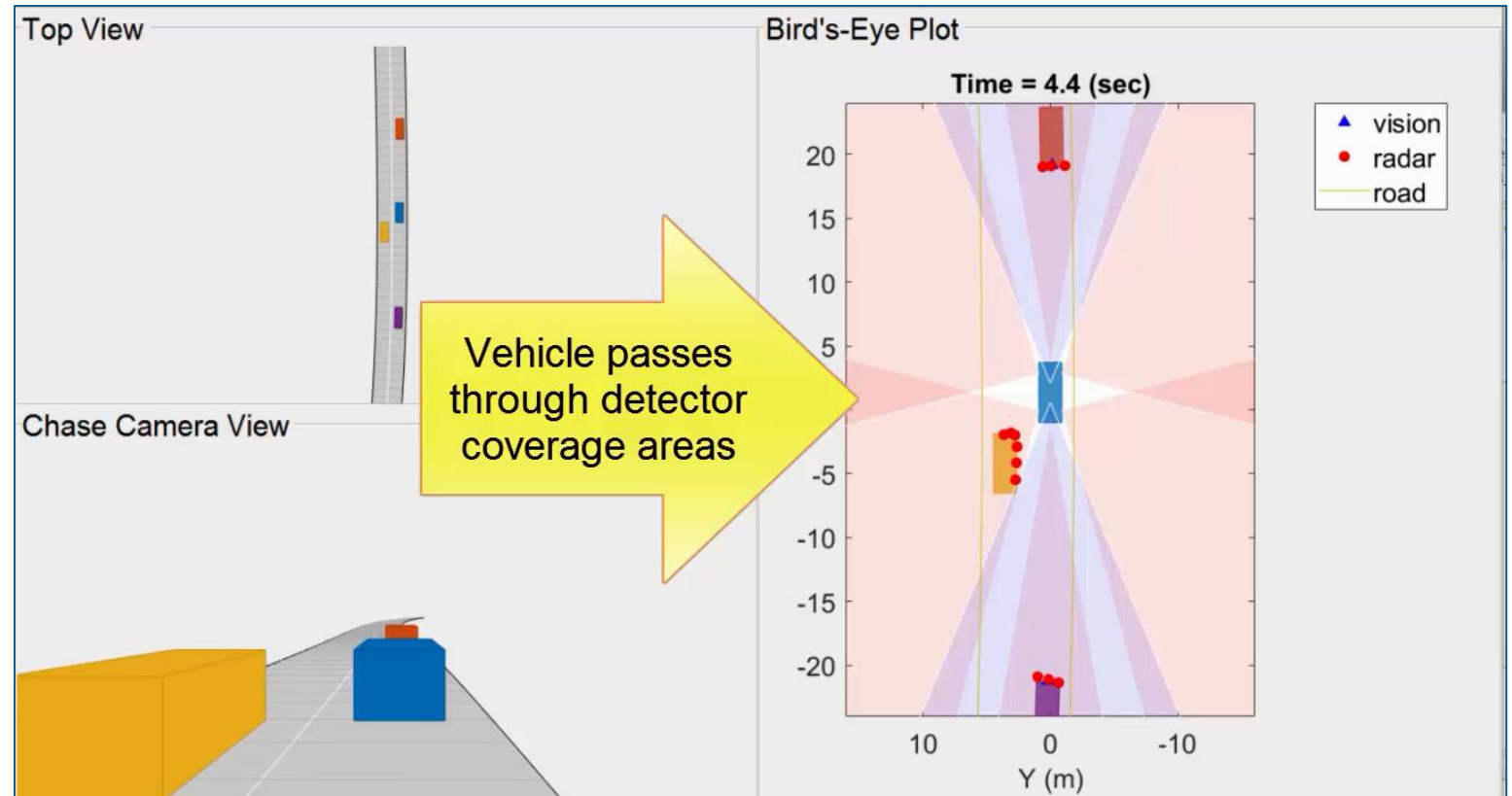
创建虚拟驾驶场景

Sensor Fusion Using Synthetic Radar and Vision Data

- 模拟道路和车辆
- 添加基于统计概率的视觉与雷达传感器
- 测试传感器融合与目标跟踪
- 可视化传感器覆盖区域, 检测列表, 目标跟踪列表

Automated Driving Toolbox™

R2017a



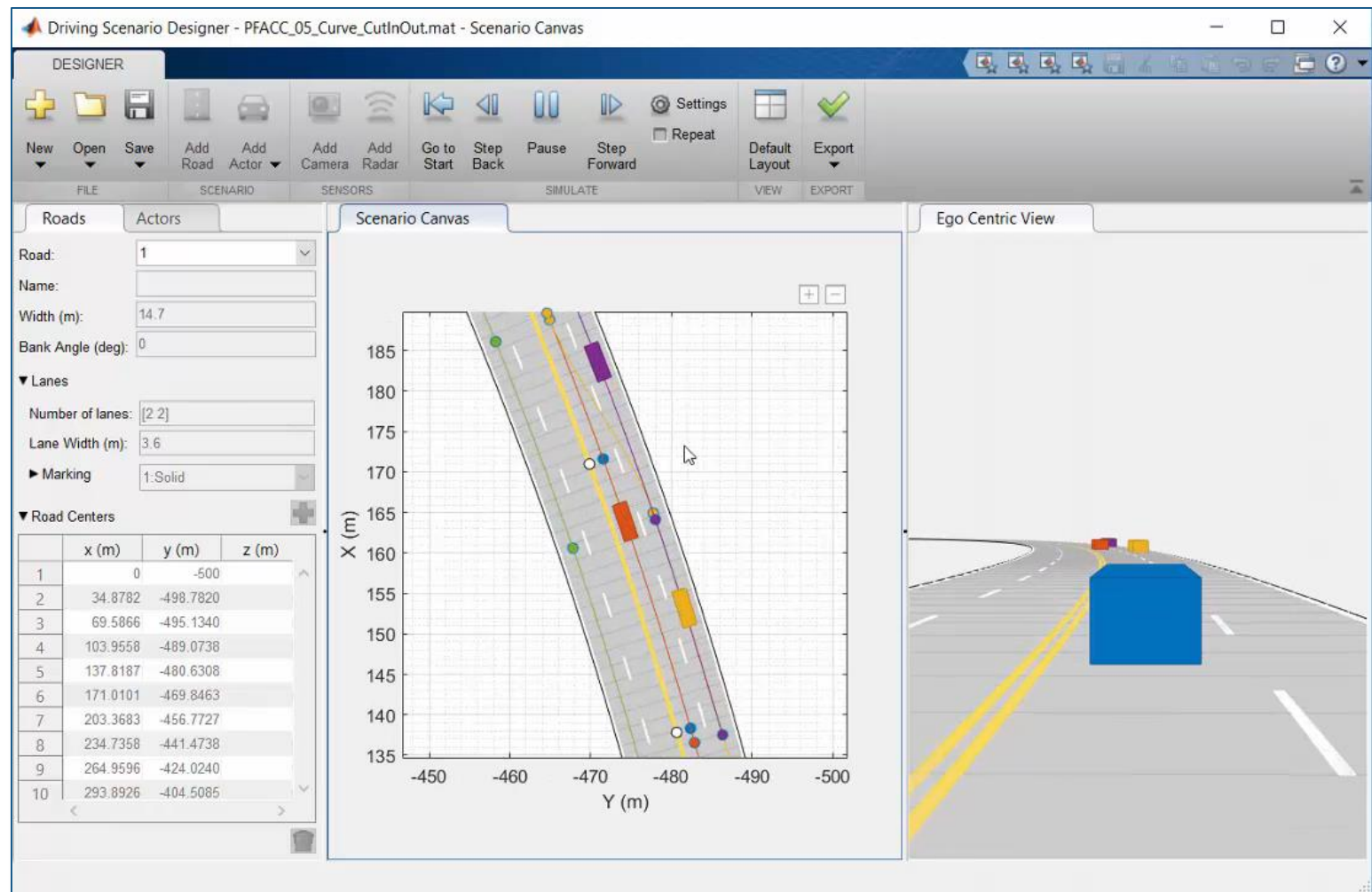
图形化的驾驶场景设计器

Driving Scenario Designer

- 创建道路与车道线标记
- 添加车辆与行驶轨迹
- 设置车辆尺寸与雷达截面积 (RCS)
- 提供预定义的ADAS场景
- 支持导入OpenDRIVE格式路网文件

Automated Driving Toolbox™

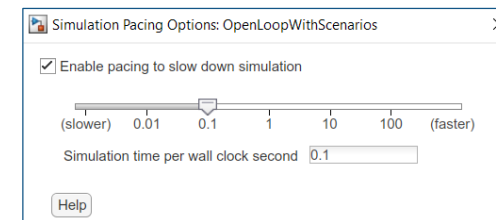
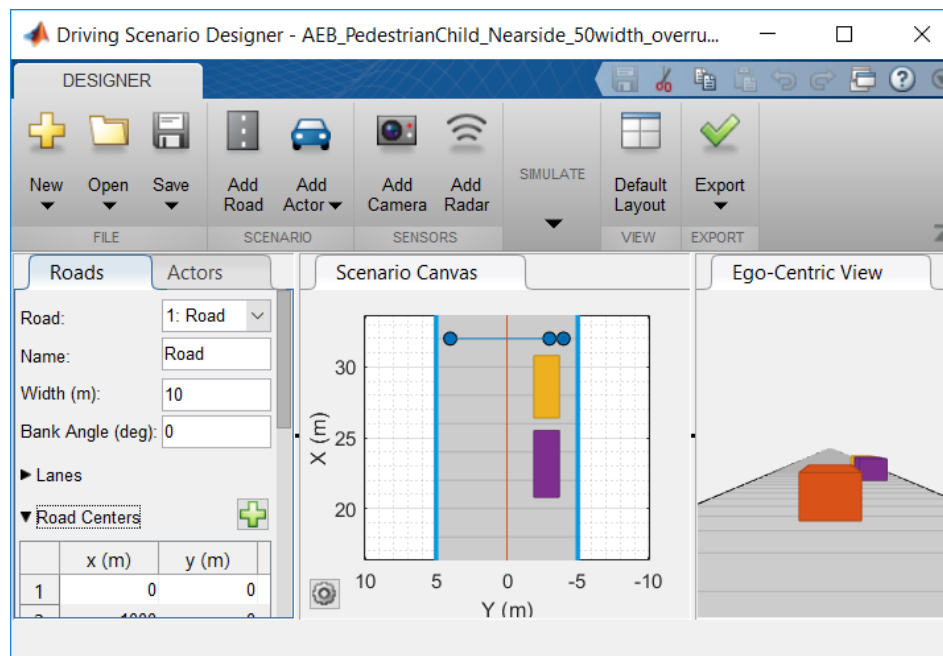
R2018a



在Simulink中仿真驾驶场景

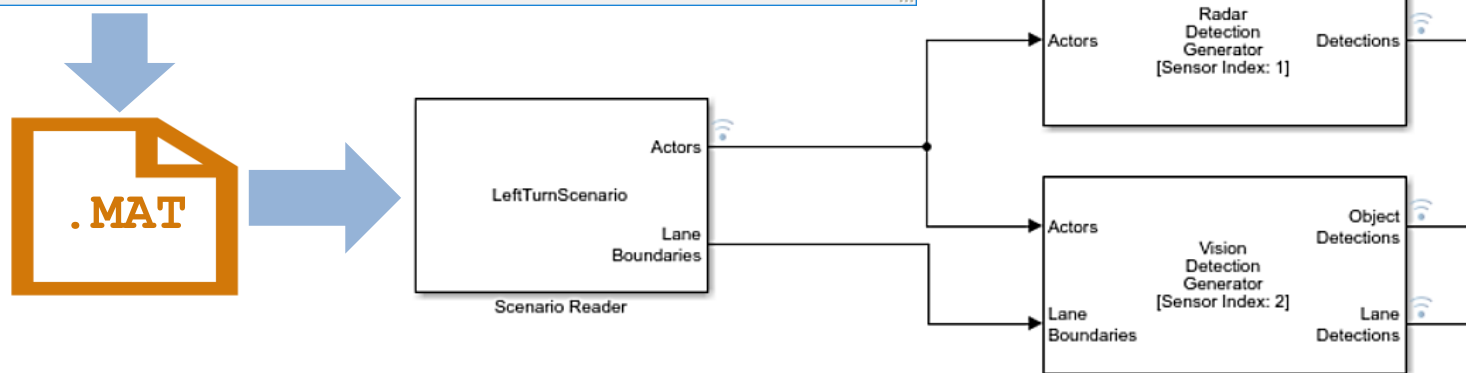
Test Open-Loop ADAS Algorithm Using Driving Scenario

- 编辑驾驶场景
- 在Simulink中读取场景
- 添加传感器模型
- 可视化传感器输出
- 调节仿真速度



Automated Driving Toolbox™

R2019a



在Simulink中仿真驾驶场景

Lane Following Control with Sensor Fusion

- 将场景集成到Simulink
- 设计横向（车道保持）与纵向（间距管理）模型预测控制器
- 设计传感器融合
- 生成C/C++代码
- 软件在环 (SIL) 测试

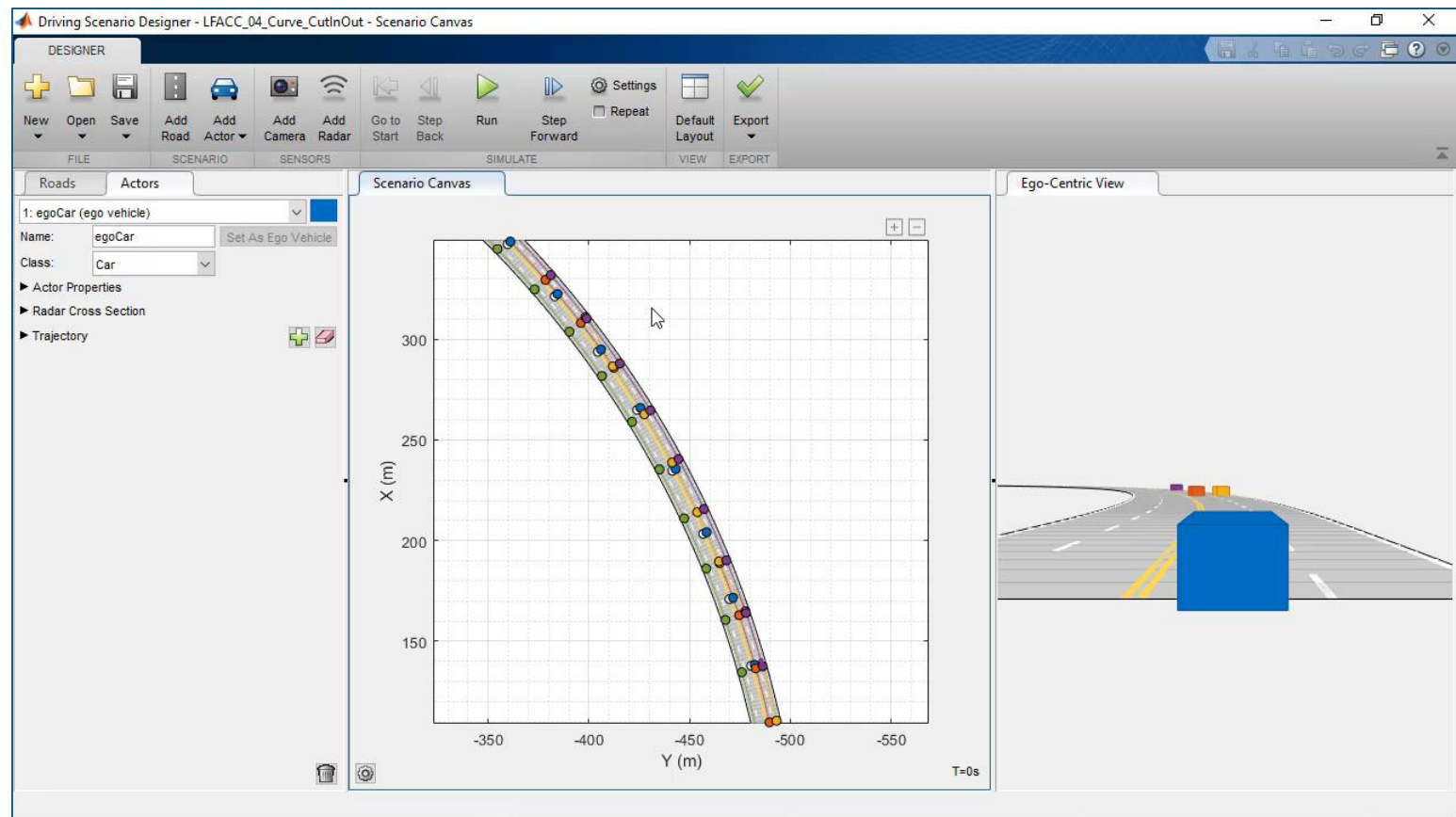
Model Predictive Control Toolbox™

Automated Driving Toolbox™

Embedded Coder®

R2018b

MATLAB EXPO 2019



设计车辆的横向与纵向控制

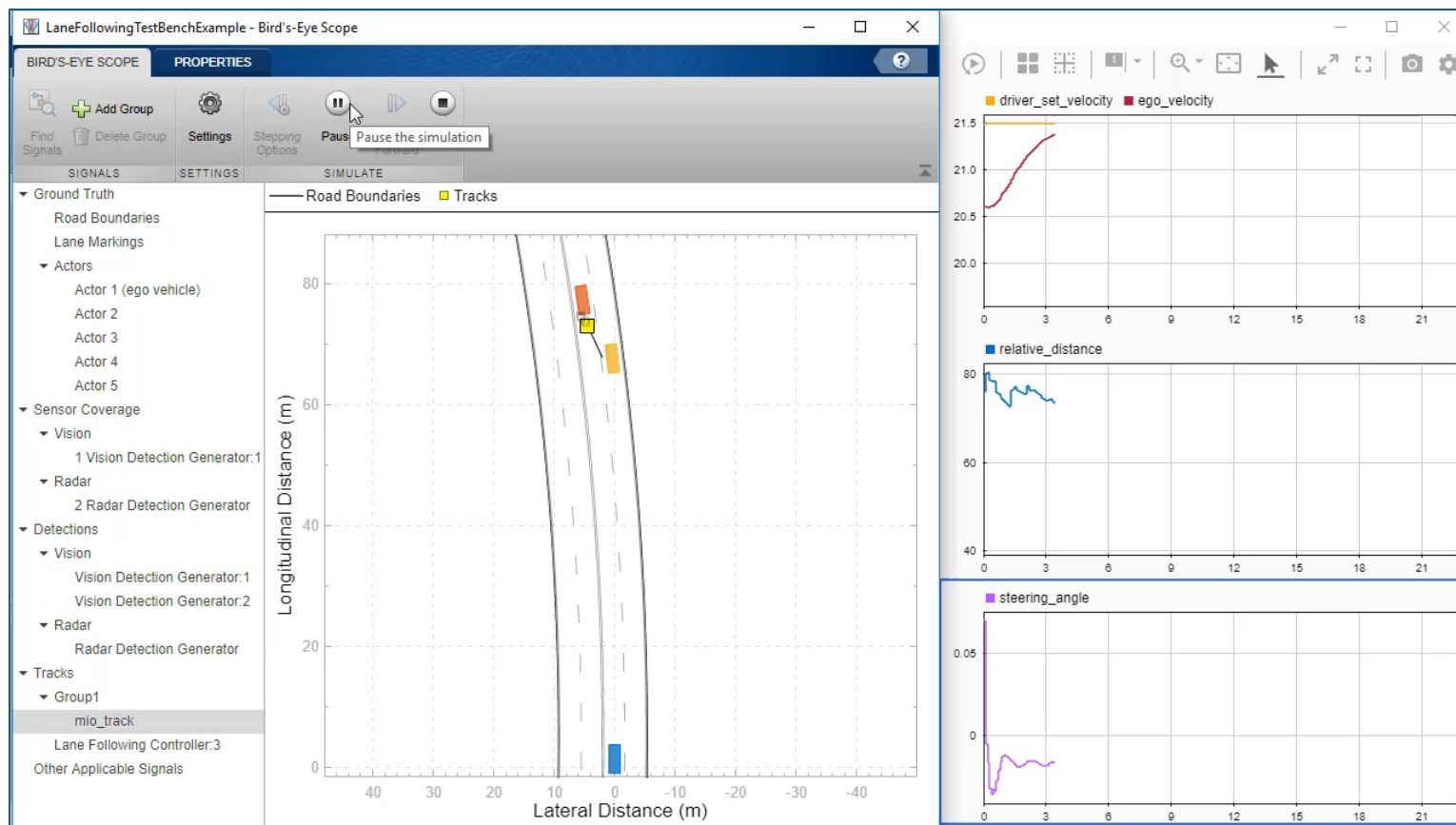
Lane Following Control with Sensor Fusion

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Model Predictive Control Toolbox™
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R2018b

MATLAB EXPO 2019



可视化传感器检测列表与目标跟踪列表

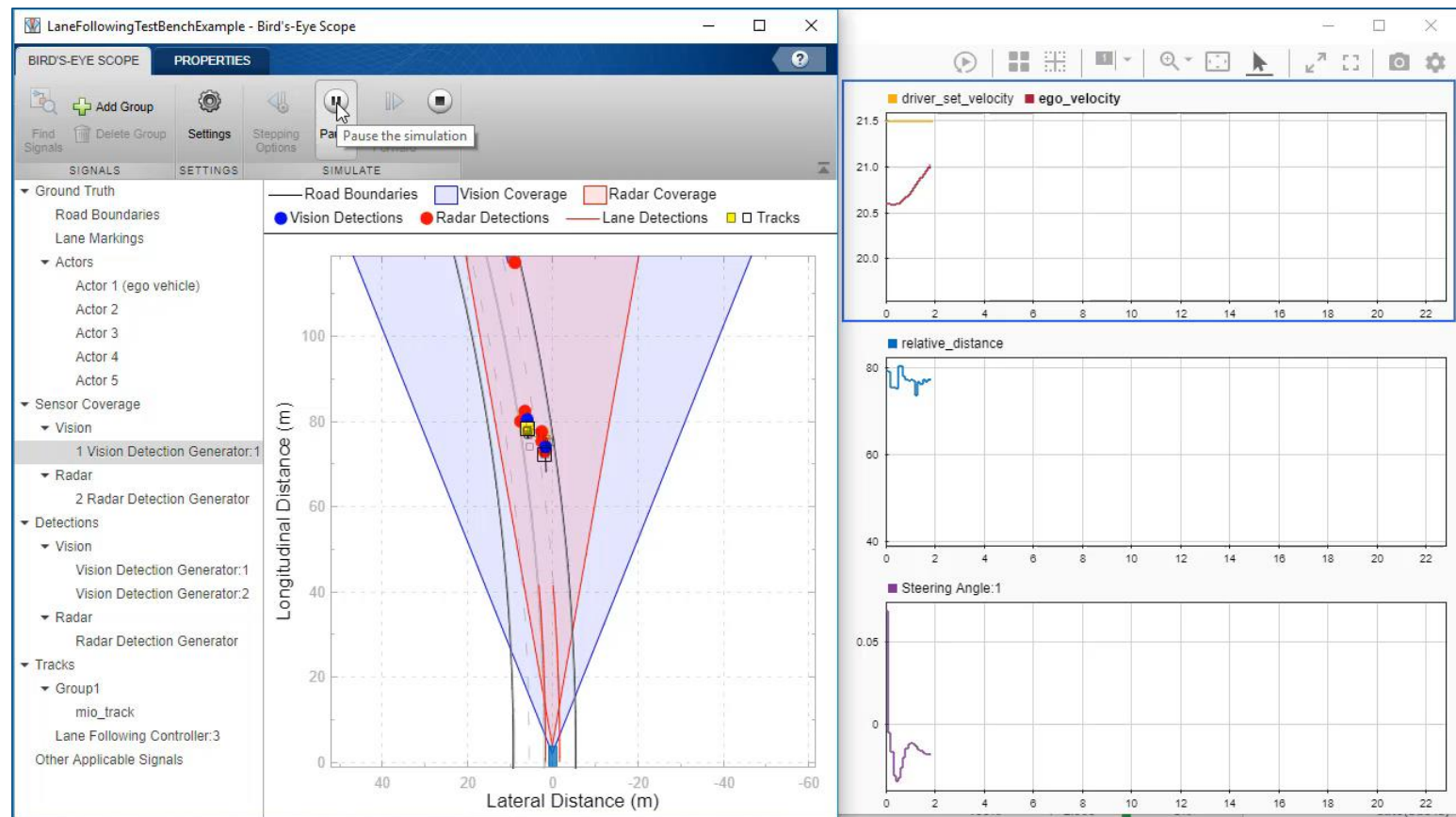
Lane Following Control with Sensor Fusion

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Model Predictive Control Toolbox™
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控制算法的自动化测试

Testing a Lane Following Controller with Simulink Test

- 指定测试需求与被测模型
- 指定测试通过判据
- 测试结果绘图与报告生成
- 自动化整个测试过程

Simulink Test™

Automated Driving Toolbox™

Model Predictive Control Toolbox™

R2018b

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Test Manager

TESTS

Run

Test Browser

Filter tests by name or tags, e.g. tags: test

LaneFollowingTestScenarios

Scenarios

- ACC_ISO_TargetDiscriminationTest
- ACC_ISO_AutoRetargetTest
- ACC_ISO_CurveTest
- ACC_StopnGo
- LFACC_DoubleCurve_DecelTarget
- LFACC_DoubleCurve_AutoRetarget
- LFACC_DoubleCurve_StopnGo
- LFACC_Curve_CutInOut
- LFACC_Curve_CutInOut_TooClose

ACC_ISO_TargetDiscriminationT...

DESCRIPTION*

REQUIREMENTS*

scenarioId #1: ACC_ISO_TargetDiscriminationTest (LaneFollowingTestRequirements#1)

SYSTEM UNDER TEST*

Model: LaneFollowingTestBenchExample

TEST HARNESS

SIMULATION SETTINGS OVERRIDES*

PARAMETER OVERRIDES ?

CALLBACKS*

PRE-LOAD ▶

POST-LOAD* ▶

Runs after the model loads and the model PostLoadFcn callback

```
1 scenarioId = 1;
2 helperLFSetUp;
```

CLEANUP* ▶

Runs after simulations and all model callbacks

```
1 plotLFResults(slttest_simout.logout);
```

需求链接

被测模型

驾驶场景

定义场景ID与初始化数据

测试结果绘图

PROPERTY	VALUE
Name	ACC_ISO_TargetDiscri...
Type	Simulation Test
Model	LaneFollowingTestBenchEx...
Simulation Mode	Normal
Location	C:\02_ADST2018b\Demos...
Enabled	✓
Hierarchy	LaneFollowingTestScenario...
Tags	Type comma or space separa...

从录制的实车数据生成驾驶场景

Scenario Generation from Recorded Vehicle Data

- 回放录制的视频
- 导入OpenDRIVE路网
- 导入GPS数据（本车位置）
- 导入传感器目标列表（其他车辆位置）

Automated Driving Toolbox™

R2019a

Simulate synthesized scenario

Summary
This example shows how to automatically generate a virtual driving scenario from vehicle data recorded using the GPS and lidar sensors.

Helper Functions

helperGetEgoData
This function reads the ego vehicle data from a text file and converts into a structure.

```

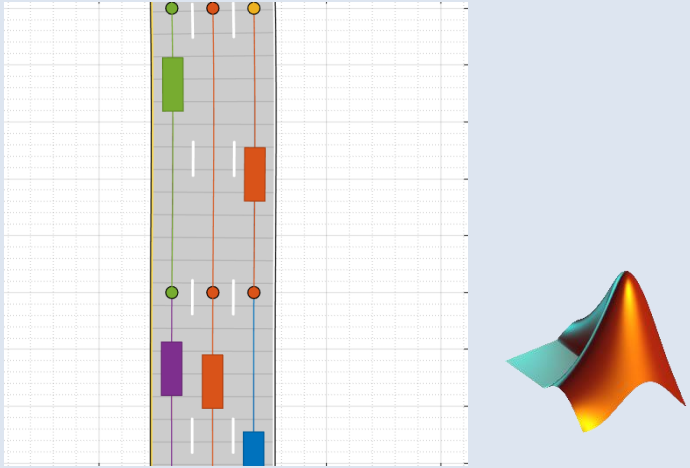
108 function [egoData] = helperGetEgoData(egoFile)
109 %Read the ego vehicle data from text file
110 fileID = fopen(egoFile);
111 content = textscan(fileID, '%f %f %f');
112 fields = {'lat', 'lon', 'Time'};
113 egoData = cell2struct(content, fields, 2);
114 fclose(fileID);
115 end

```

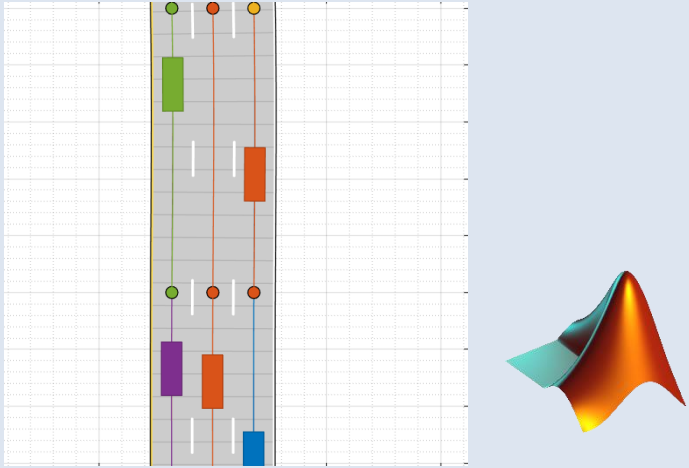

helperGetNonEgoData
This function reads the processed lidar data from a text file and converts into a structure. The processed lidar data contains information about the

The 3D visualization shows a road scene with a blue car and other vehicles. The X-axis is labeled 'X (m)' and ranges from 270 to 320. The Y-axis is labeled 'Y (m)' and ranges from 80 to 120.

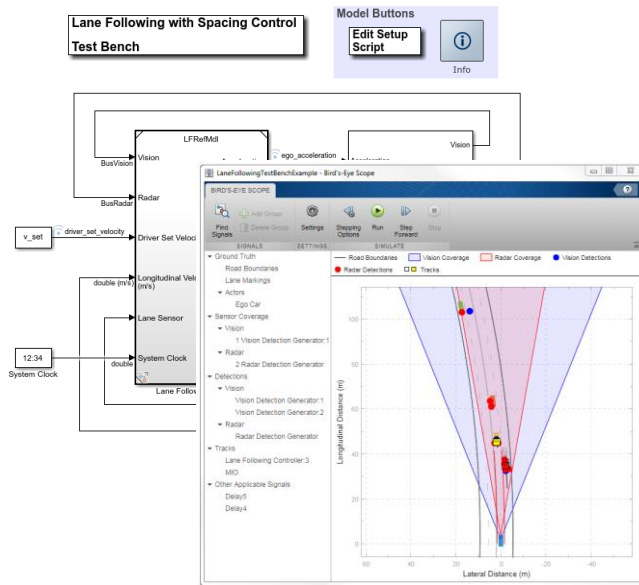
虚拟驾驶场景的两种表达方式

场景表达	<p>“方块式” 驾驶场景</p> 
可测试算法	控制 控制 + 传感器融合
编辑器	MATLAB提供的驾驶场景设计器及编程接口
传感器模型	基于概率的雷达目标列表 基于概率的视觉目标列表 基于概率的车道线检测列表

虚拟驾驶场景的两种表达方式

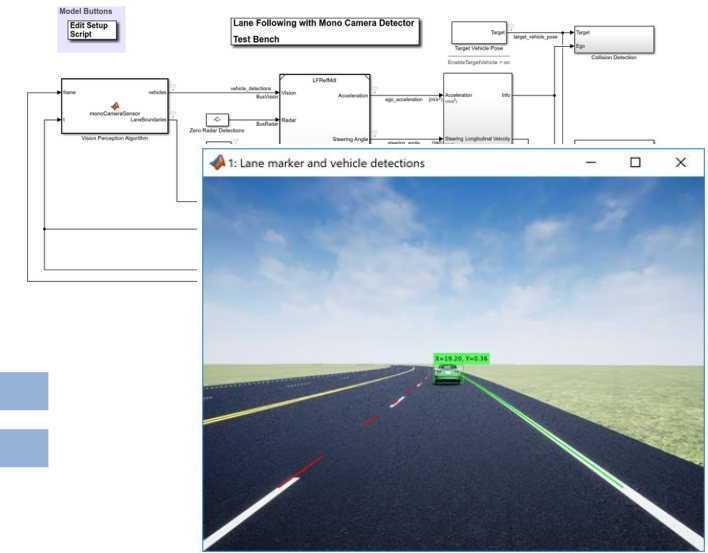
<p>场景表达</p>	<p>“方块式” 驾驶场景</p> 	<p>“虚幻” 引擎 (Unreal Engine)</p> 
<p>可测试算法</p>	<p>控制 控制 + 传感器融合</p>	<p>控制 控制 + 视觉</p>
<p>编辑器</p>	<p>MATLAB提供的驾驶场景设计器及编程接口</p>	<p>“虚幻” 编辑器 (Unreal Editor)</p>
<p>传感器模型</p>	<p>基于概率的雷达目标列表 基于概率的视觉目标列表 基于概率的车道线检测列表</p>	<p>理想图像传感器</p>

控制与感知系统的集成仿真



```

40
41 classdef helperMonoSensor < handle
42
43 properties
44     % Sensitivity for the lane segmentation
45     LaneSegmentationSensitivity = 0.25;
46
47
48
49
50
51
    
```



Lane Following Control with Sensor Fusion

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 Embedded Coder®

R2018b
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Visual Perception Using Monocular Camera

Automated Driving Toolbox™

R2017a

Lane-Following Control with Monocular Camera Perception

Model Predictive Control Toolbox™
 Automated Driving Toolbox™
 Vehicle Dynamics Blockset™

R2018b

车道跟随控制器与视觉算法的集成仿真

Lane-Following Control with Monocular Camera Perception

- 集成Simulink控制器模块
 - 车道跟随
 - 间距控制
- 集成MATLAB图像算法
 - 车道边界检测
 - 车辆检测
- 通过“虚幻”引擎合成理想视觉传感器图像

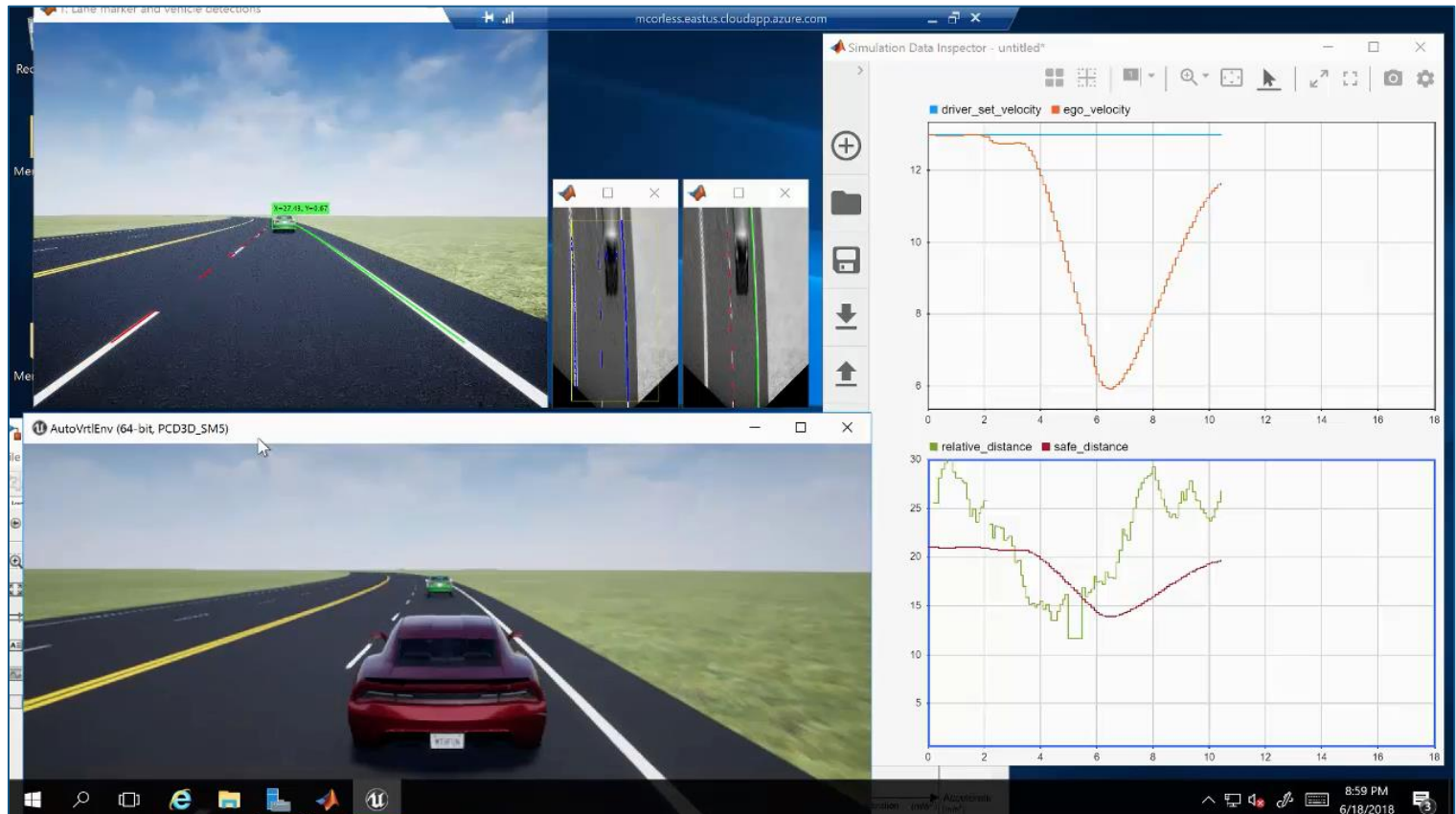
Model Predictive Control Toolbox™

Automated Driving Toolbox™

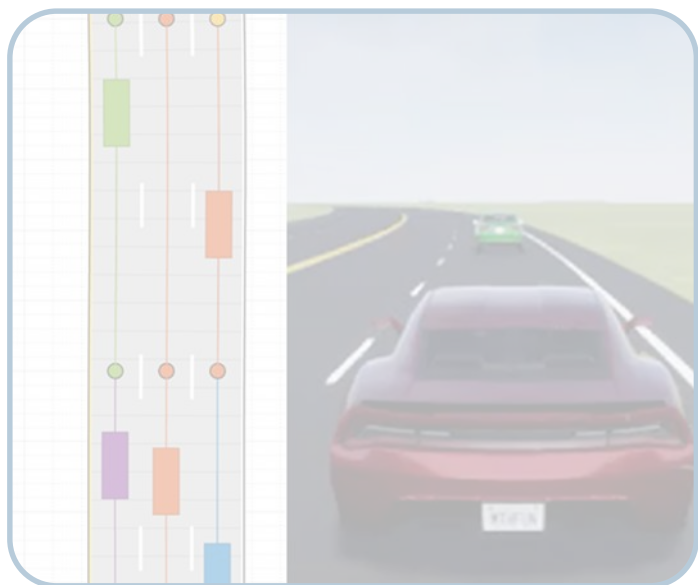
Vehicle Dynamics Blockset™

R2018b

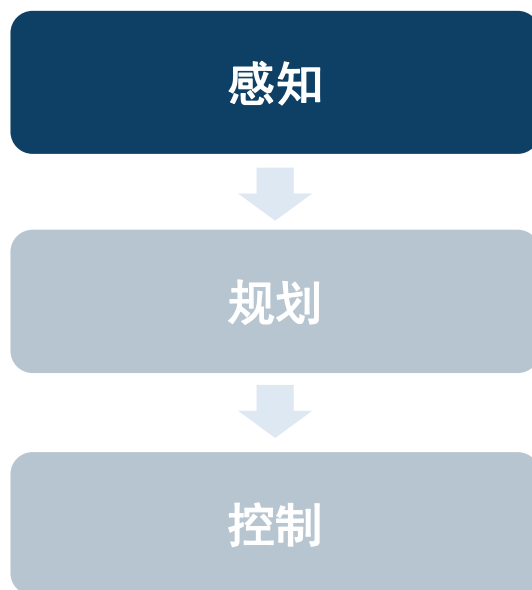
MATLAB EXPO 2019



自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？

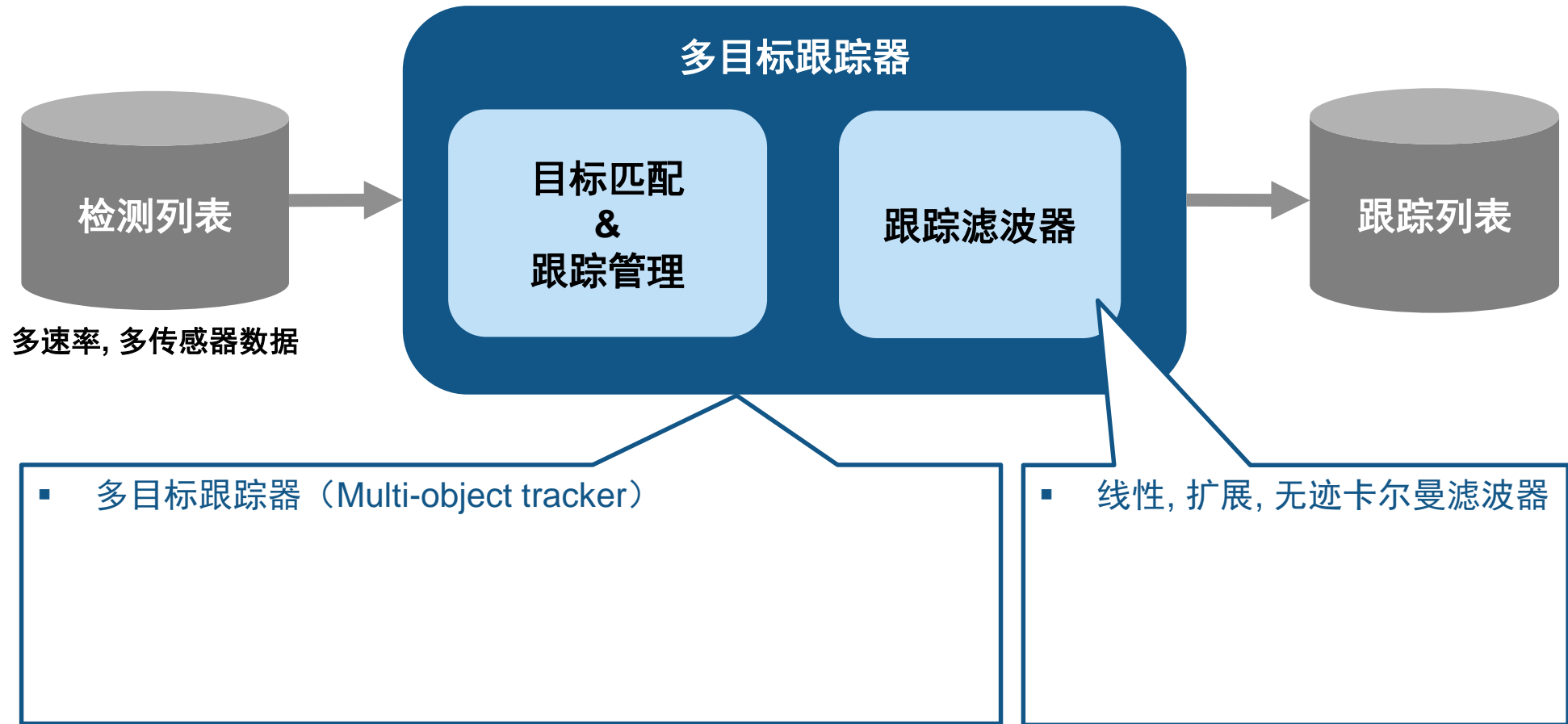


如何串联和加速多个专业
的算法开发？

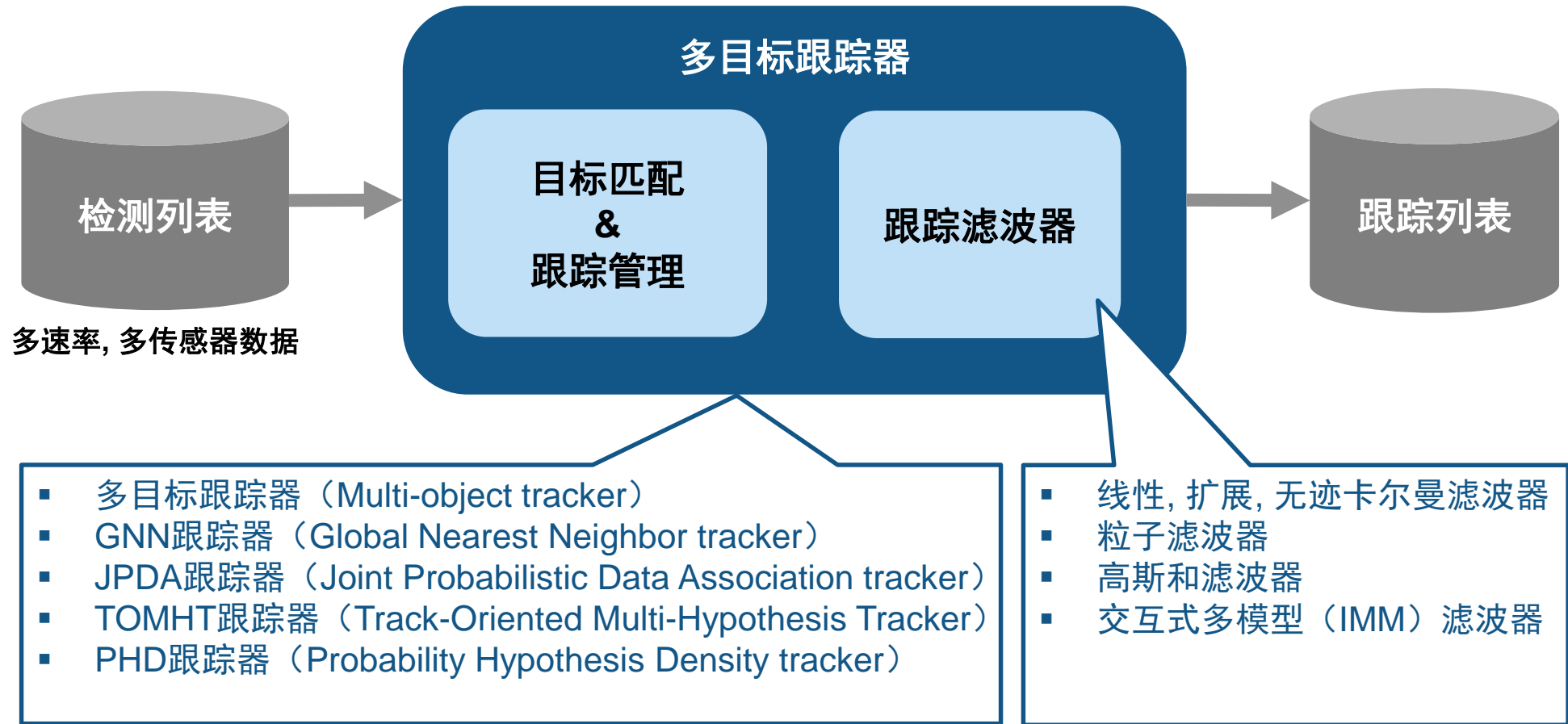


如何将其他资源集成到我们的
仿真环境？

传感器融合与目标跟踪



传感器融合与目标跟踪



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Sensor Fusion and Tracking Toolbox™

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R2019a

点目标跟踪与扩展目标跟踪：点目标跟踪

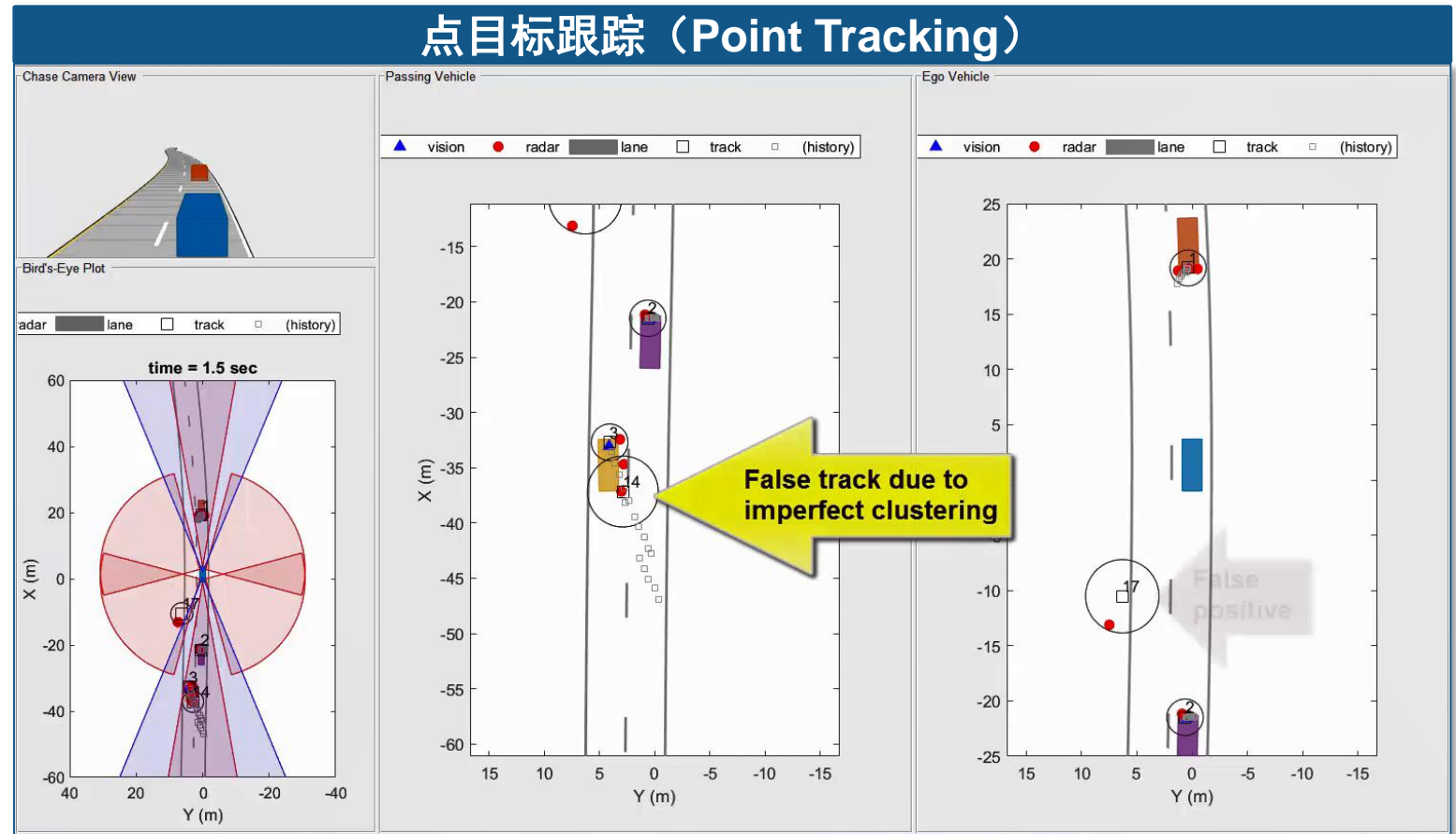
Extended Object Tracking

- 点目标跟踪器 multiObjectTracker
- 传感器对单个目标生成单个检测或经过聚类后形成单个检测
- 将目标简化为一个点进行跟踪

Sensor Fusion and Tracking
Toolbox™

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Updated **R2019a**



点目标跟踪与扩展目标跟踪：扩展目标跟踪

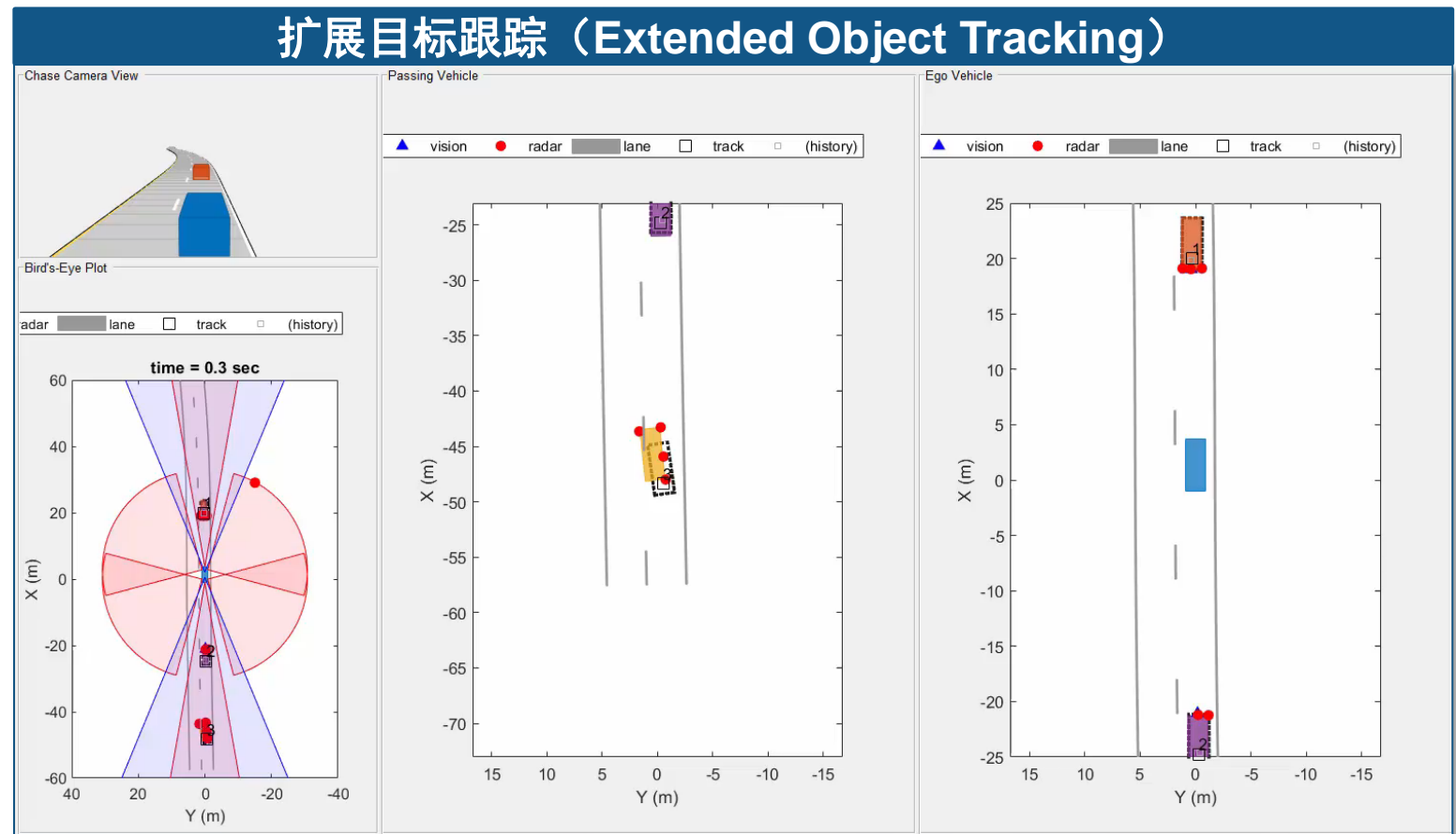
Extended Object Tracking

- 自定义的扩展目标跟踪器
- 利用高精度传感器对单个目标生成的多个检测
- 可获取更多目标属性：大小、形状、方向等

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Toolbox™*

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Updated **R2019a**



点目标跟踪与扩展目标跟踪：评估跟踪性能

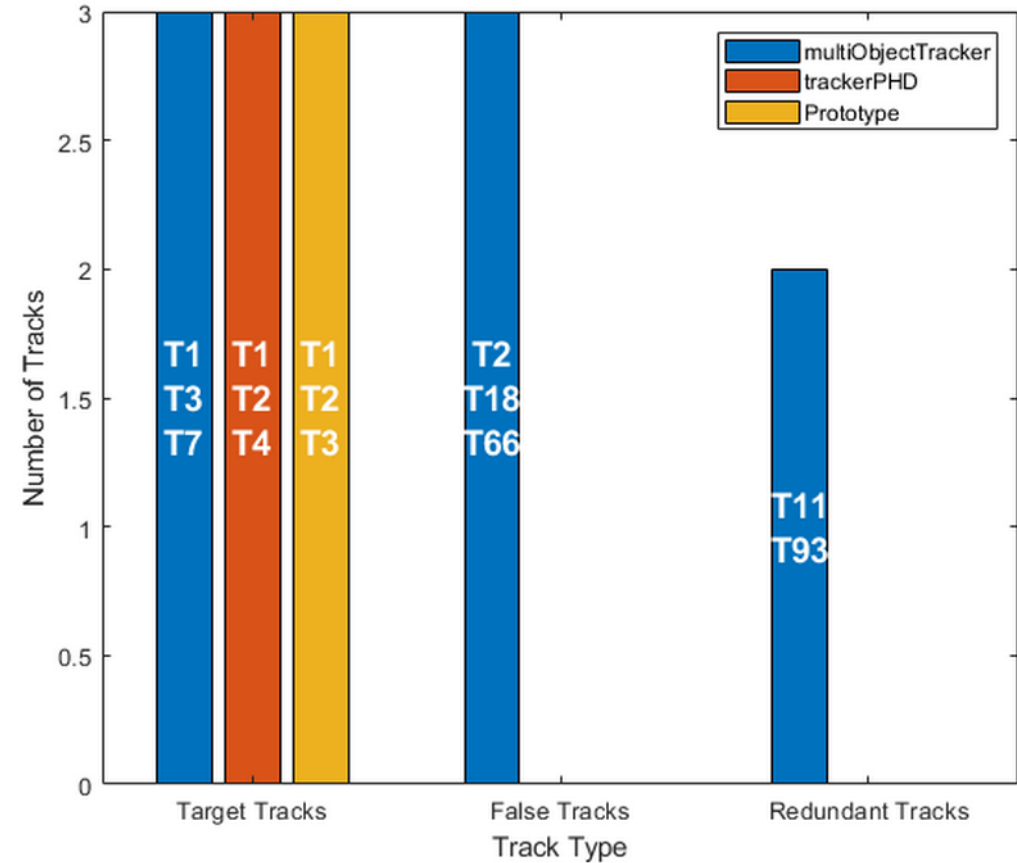
Extended Object Tracking

- 评估跟踪性能和误差指标
- 评估算法在桌面的执行时间

Sensor Fusion and Tracking Toolbox™

Automated Driving Toolbox™

Updated **R2019a**



- Multi-object tracker
- Probability Hypothesis Density tracker
- Extended object (size and orientation) tracker

点目标跟踪与扩展目标跟踪：评估误差指标

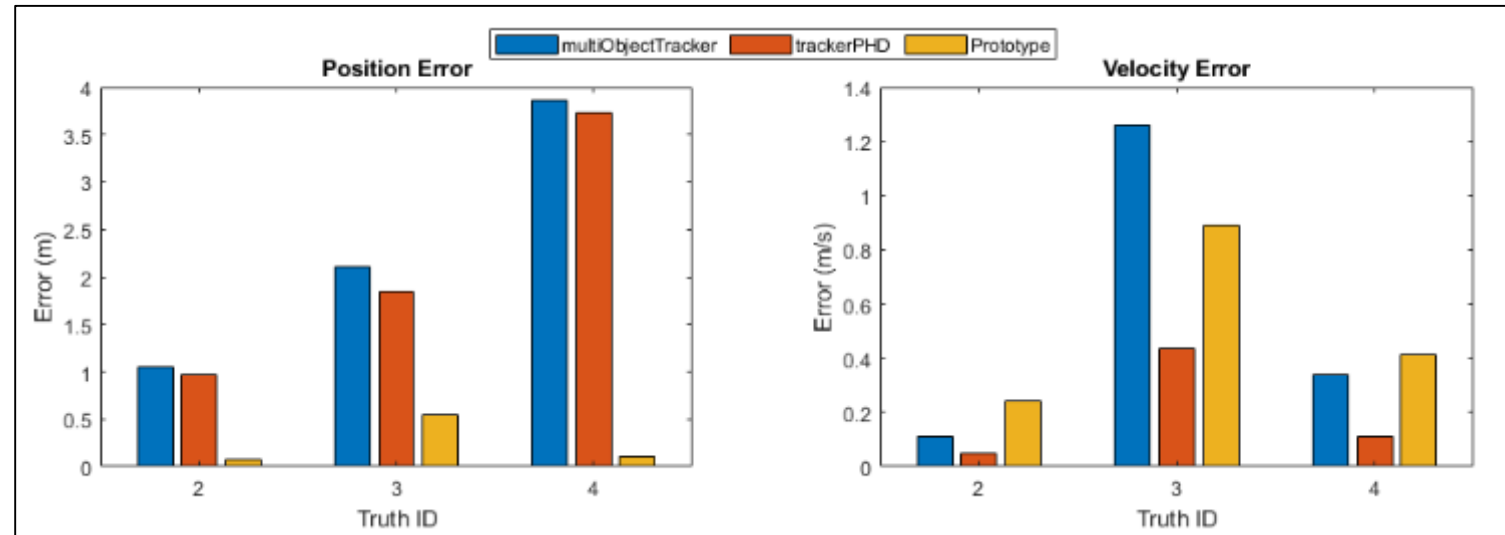
Extended Object Tracking

- 评估跟踪性能和误差指标
- 评估算法在桌面的执行时间

*Sensor Fusion and Tracking
Toolbox™*

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Updated **R2019a**



- Multi-object tracker
- Probability Hypothesis Density tracker
- Extended object (size and orientation) tracker

点目标跟踪与扩展目标跟踪：比较算法的相对执行时间

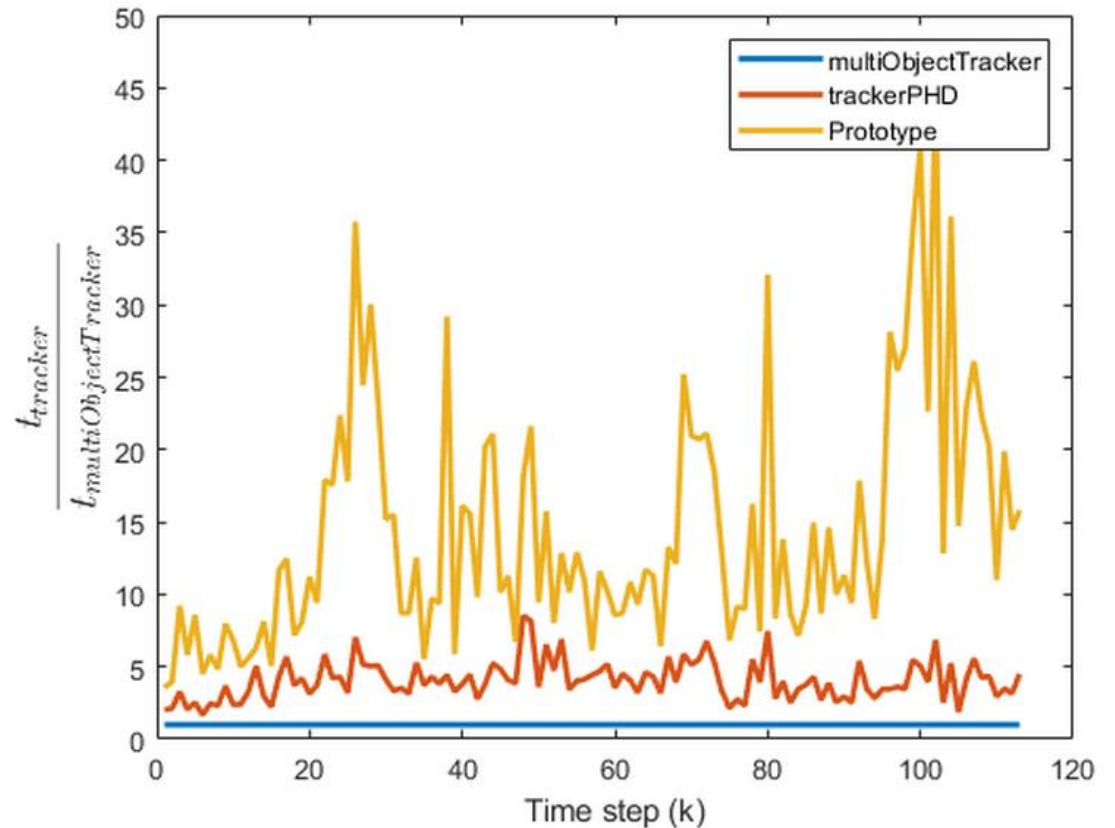
Extended Object Tracking

- 评估跟踪性能和误差指标
- 评估算法在桌面的执行时间

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Toolbox™*

Automated Driving Toolbox™

Updated **R2019a**



- Multi-object tracker
- Probability Hypothesis Density tracker
- Extended object (size and orientation) tracker

将激光雷达点云转换为目标列表：设计检测器

Track Vehicles Using Lidar: From Point Cloud to Track List

- 设计3-D边框检测器
- 设计目标跟踪器
- 生成C/C++代码

*Sensor Fusion and Tracking
Toolbox™*

Computer Vision Toolbox™

R2019a

The screenshot shows the MATLAB R2019a environment. The Editor window displays the code for the 'HelperBoundingBoxDetector.m' function. The Command Window shows the execution of 'pcshow(pcObstacles)' and the output of the 'detBBboxes' function. A yellow callout box highlights the output matrix columns: X-Center, Y-Center, Z-Center, Length, Width, and Height.

```

methods (Access = protected)
function [bboxDets, obstacleI] = HelperBoundingBoxDetector(pcObstacles, obstacleI)
% Crop point cloud
[pcSurvived, survivedIndices] = cropPointCloud(pcObstacles, obstacleI);
% Remove ground plane
[pcObstacles, obstacleI] = removeGroundPlane(pcSurvived, survivedIndices);
% Form clusters and get bounding boxes
detBBboxes = getBoundingBoxes(pcObstacles, obstacleI);
% Assemble bounding boxes
bboxDets = [detBBboxes; obstacleI];
end
end
end

```

Command Window:

```

K>> pcshow(pcObstacles)
fx K>>
<
| 2 usages of "bboxDets" found

```

Output of 'detBBboxes':

```

detBBboxes: 6x10 single matrix =
Columns 1 through 4
12.8921  -22.6758  -46.8280  -21.1414
-3.9148  -3.7233  -3.5872   0.0260
0.7299   0.6966  -0.6705   0.7558
2.8747   2.6390   0.0816   2.2517
1.7510   1.7391   0.8562   1.6446
1.0838   0.5916   0.0068   0.5503

```

Yellow callout box labels:

- X-Center
- Y-Center
- Z-Center
- Length
- Width
- Height

将激光雷达点云转换为目标列表：设计跟踪器

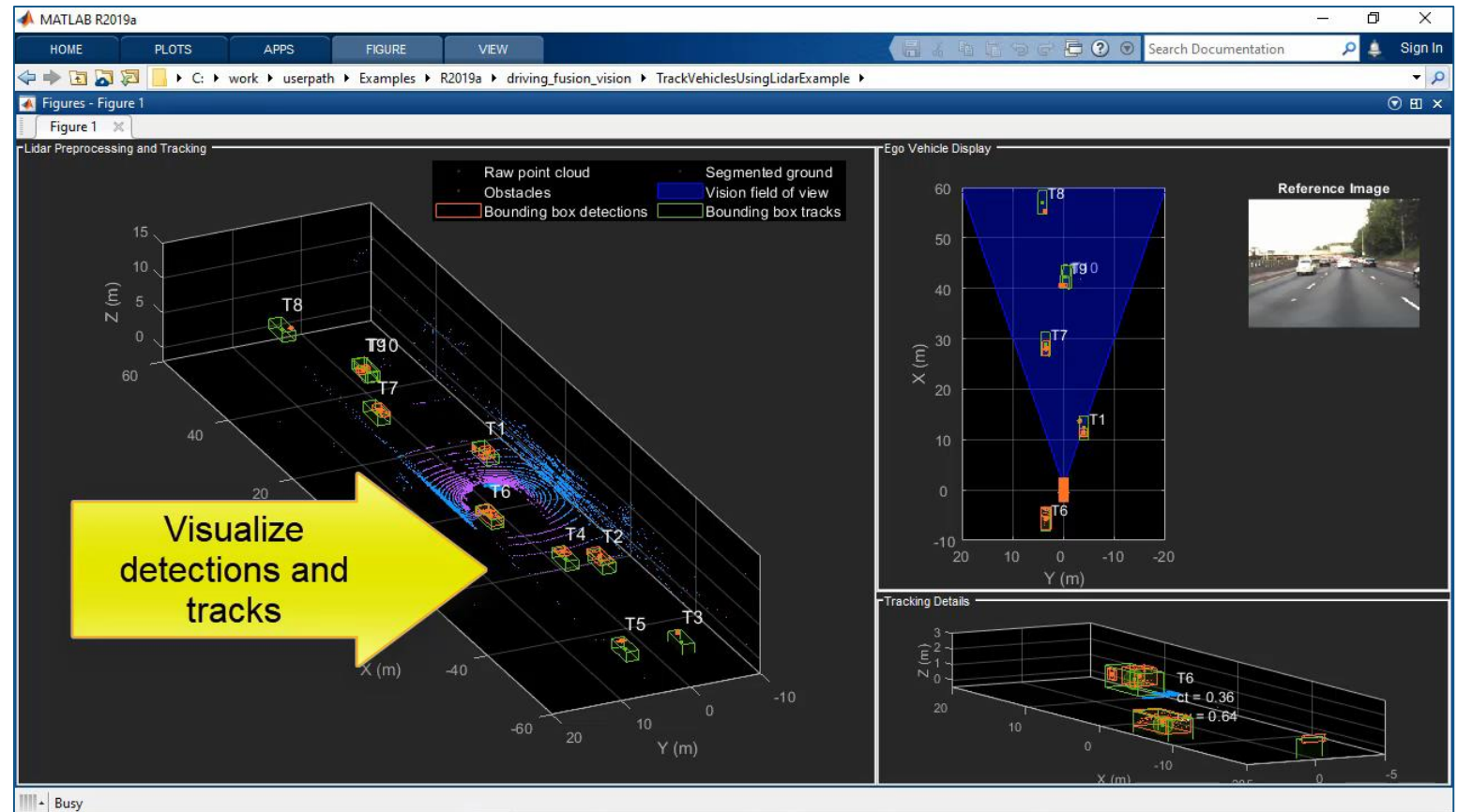
[Track Vehicles Using Lidar: From Point Cloud to Track List](#)

- 设计3-D边框检测器
- 设计目标跟踪器
- 生成C/C++代码

*Sensor Fusion and Tracking
Toolbox™*

Computer Vision Toolbox™

R2019a



将激光雷达点云转换为目标列表：生成代码

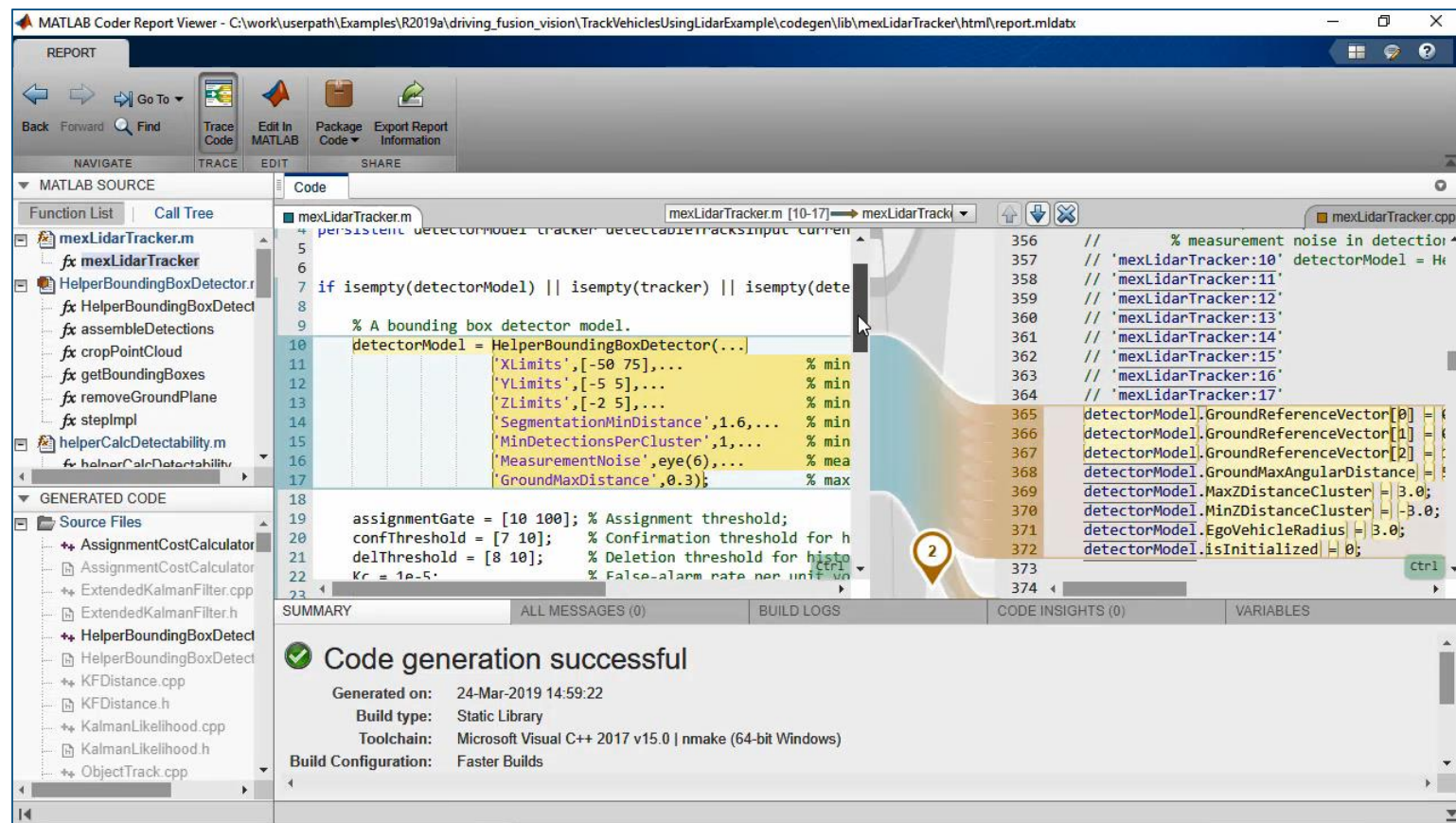
Track Vehicles Using Lidar: From Point Cloud to Track List

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- 设计目标跟踪器
- 生成C/C++代码

*Sensor Fusion and Tracking
Toolbox™*

Computer Vision Toolbox™

R2019a



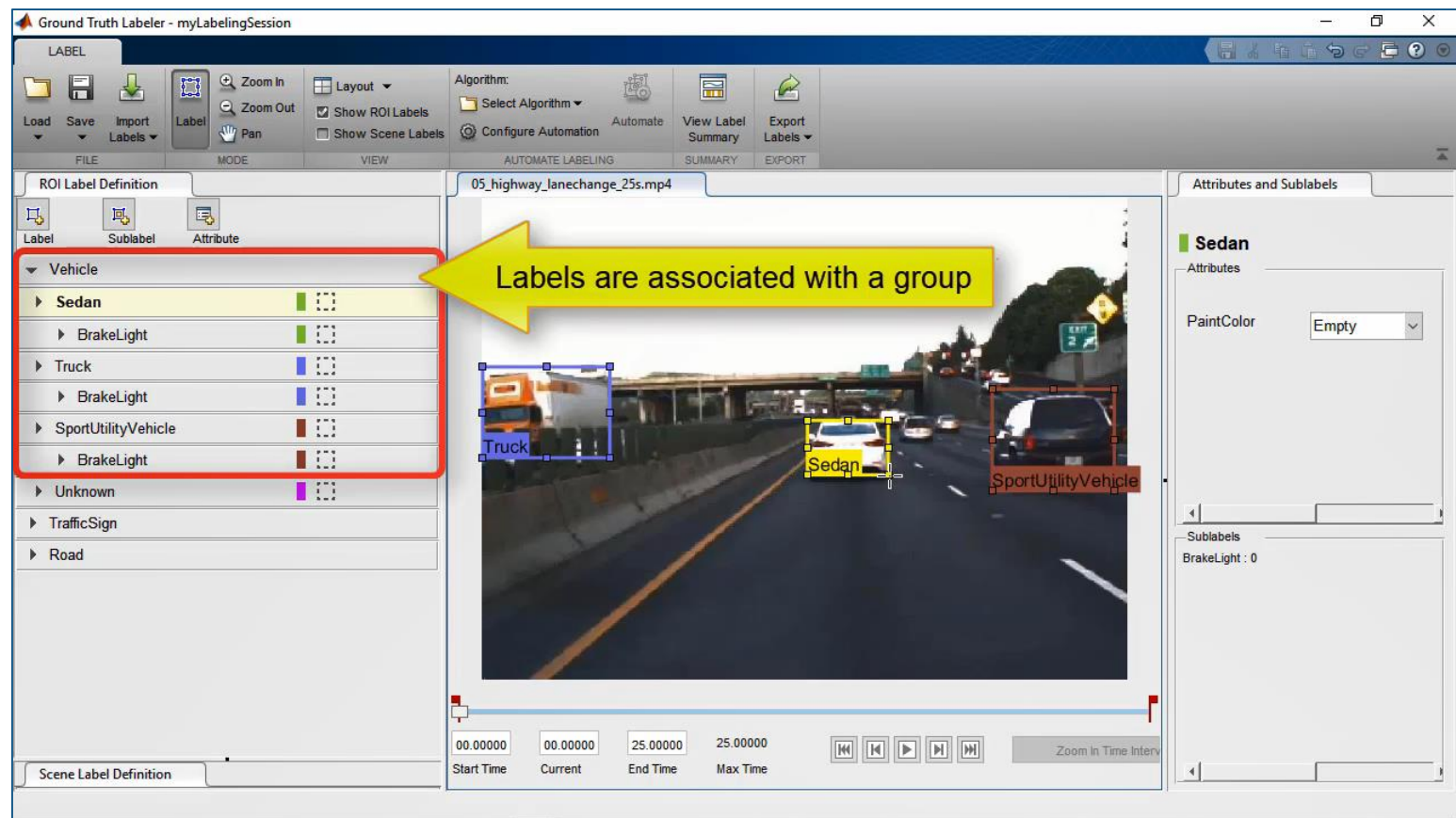
真值标签工具：创建选区标签与分组

Get Started with the Ground Truth Labeler

- 矩形框标签
- 多段线标签
- 像素标签
- 场景标签
- 创建标签分组
- 创建子标签
- 添加标签属性

Automated Driving Toolbox™

Updated **R2019a**



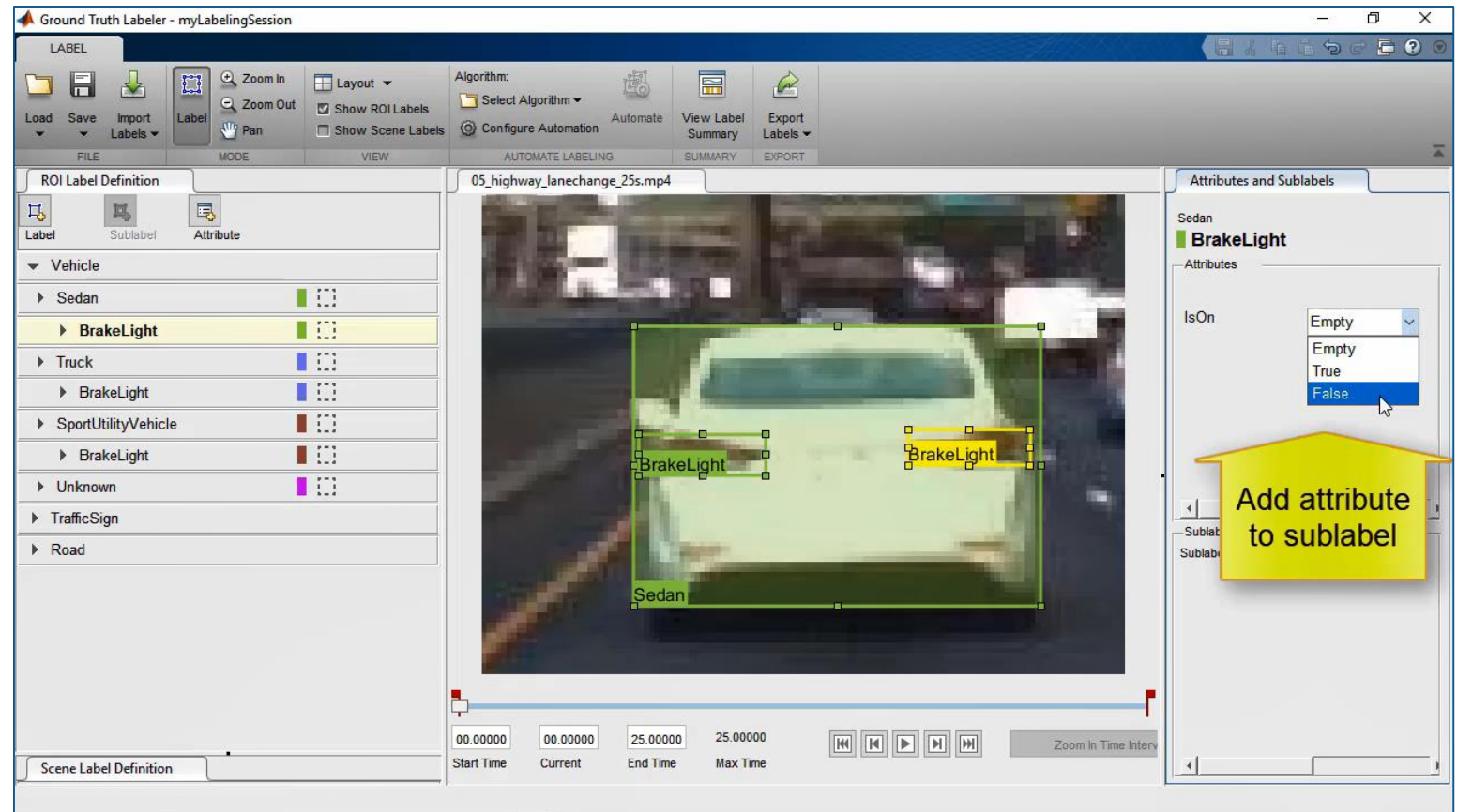
真值标签工具：创建子标签并添加属性

Get Started with the Ground Truth Labeler

- 矩形框标签
- 多段线标签
- 像素标签
- 场景标签
- 创建标签分组
- 创建子标签
- 添加标签属性

Automated Driving Toolbox™

Updated **R2019a**

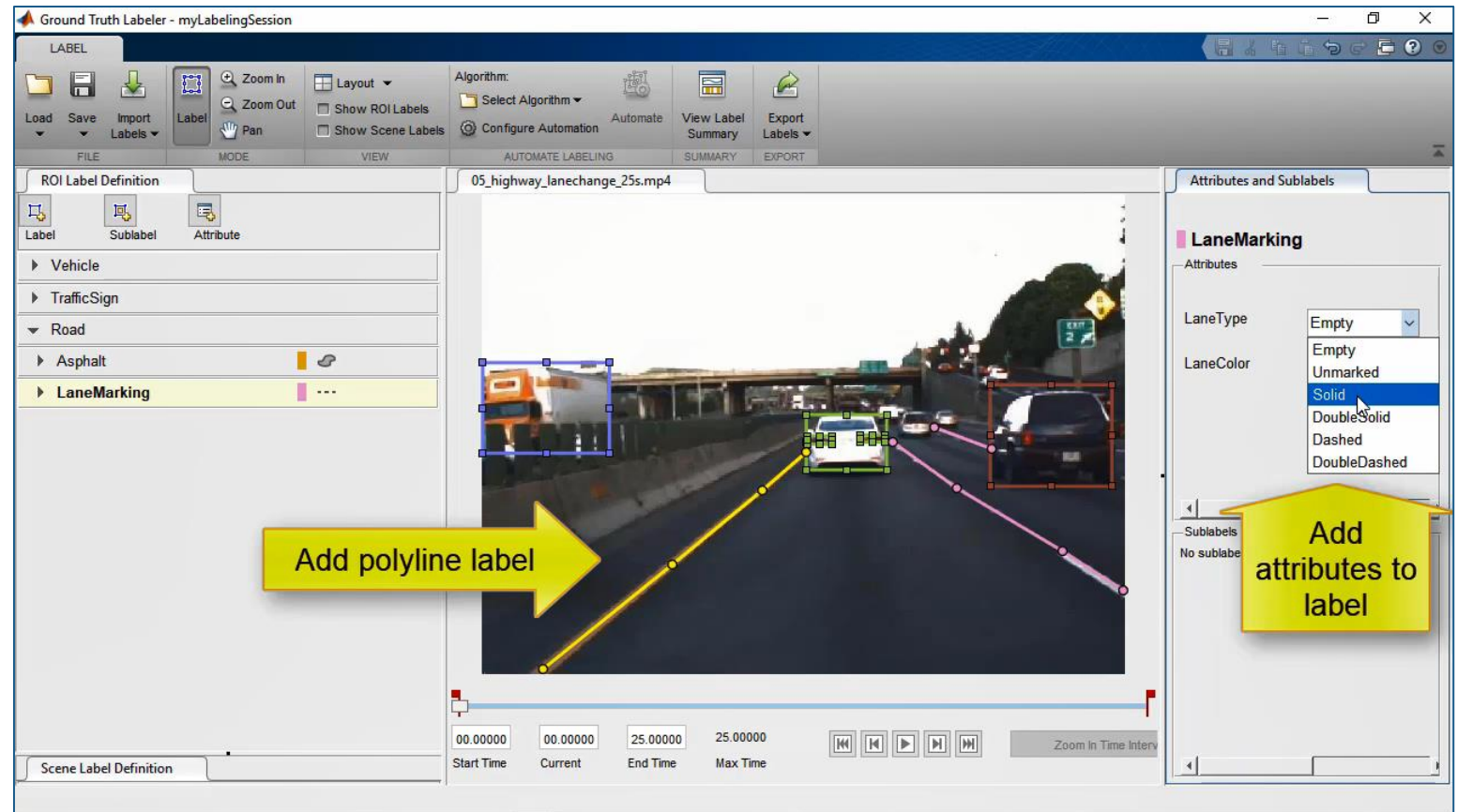


真值标签工具：创建多段线标签并添加属性

Get Started with the Ground Truth Labeler

- 矩形框标签
- 多段线标签
- 像素标签
- 场景标签
- 创建标签分组
- 创建子标签
- 添加标签属性

Automated Driving Toolbox™
Updated **R2019a**



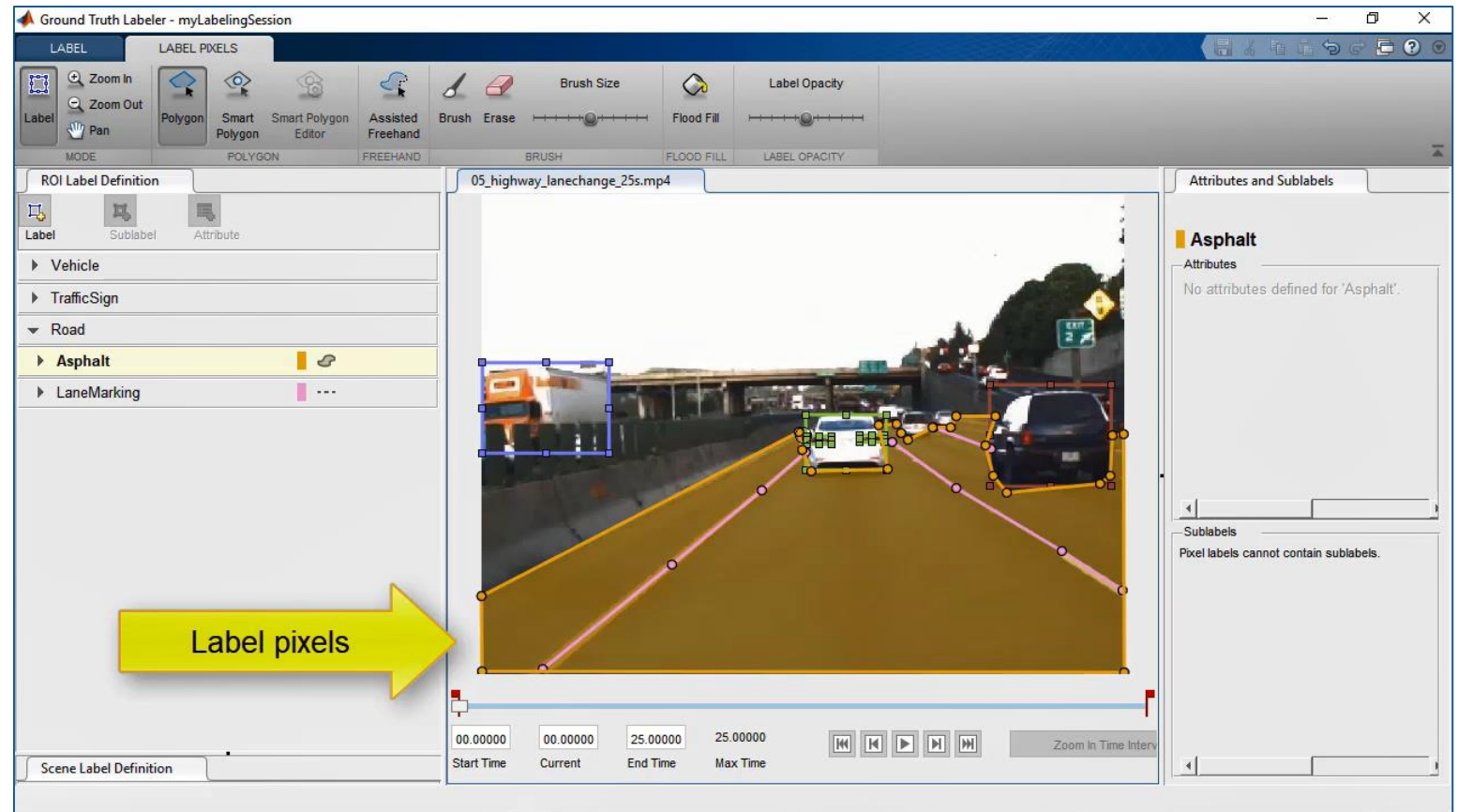
真值标签工具：创建像素标签

Get Started with the Ground Truth Labeler

- 矩形框标签
- 多段线标签
- 像素标签
- 场景标签
- 创建标签分组
- 创建子标签
- 添加标签属性

Automated Driving Toolbox™

Updated **R2019a**

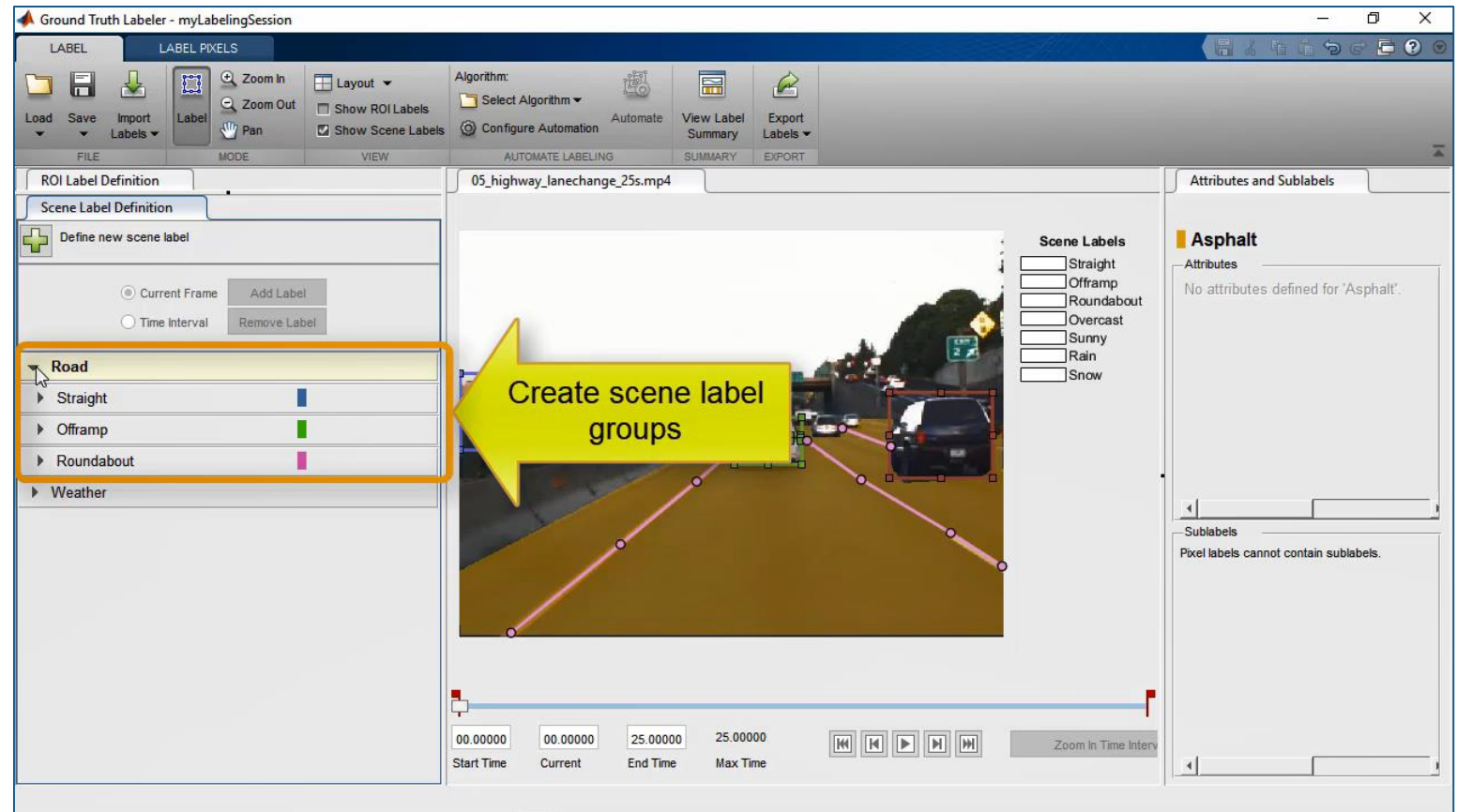


真值标签工具：创建场景标签与分组

Get Started with the Ground Truth Labeler

- 矩形框标签
- 多段线标签
- 像素标签
- 场景标签
- 创建标签分组
- 创建子标签
- 添加标签属性

Automated Driving Toolbox™
Updated **R2019a**



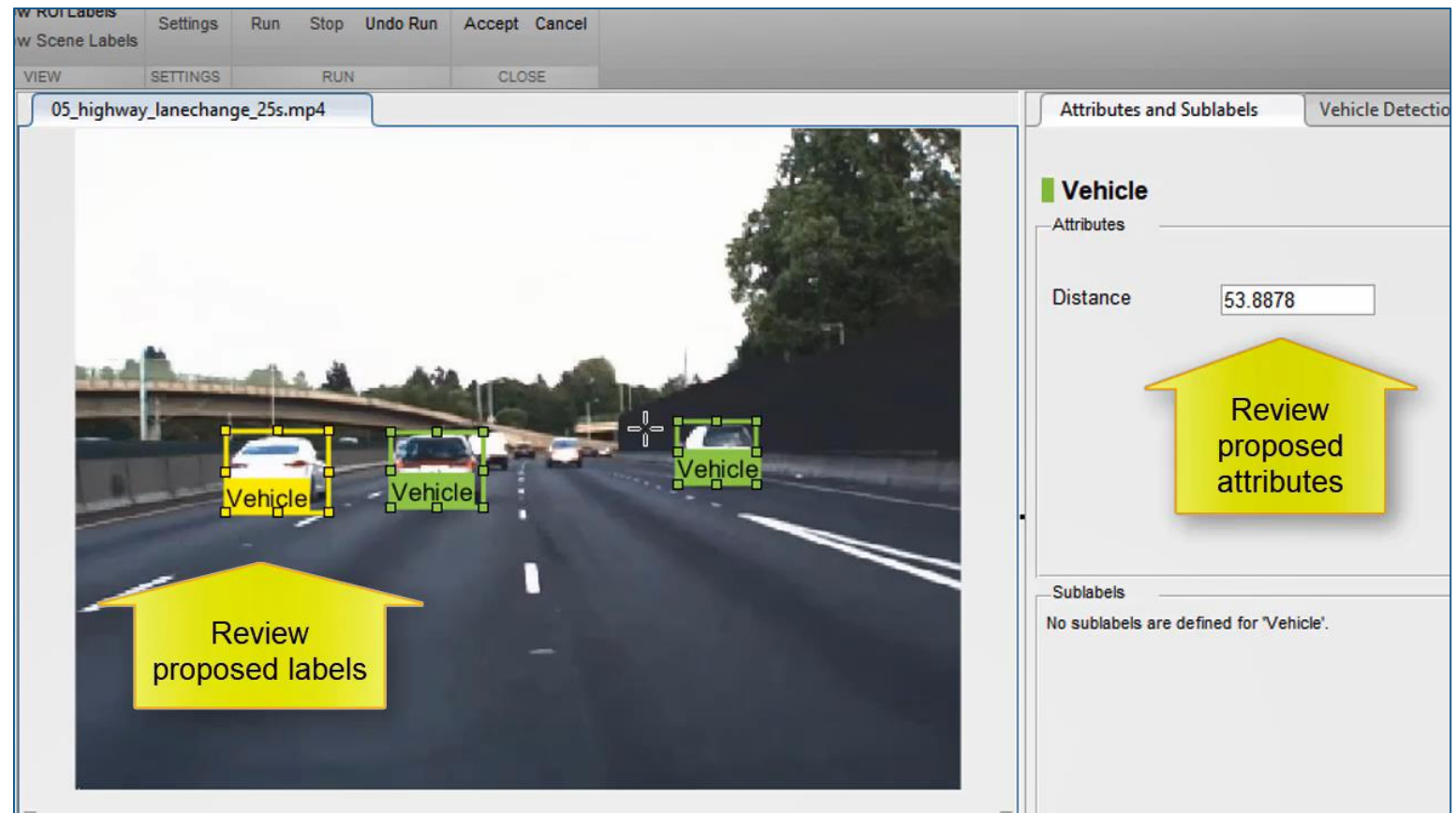
真值标签工具：导入自定义的自动标注算法

Automate Attributes of Labeled Objects

- 在真值标签工具中导入自动标注算法
- 在单目摄像机视图中检测车辆
- 估计检测到车辆的距离
- 运行自动标注算法并确认标签和属性

Automated Driving Toolbox™

R2018b



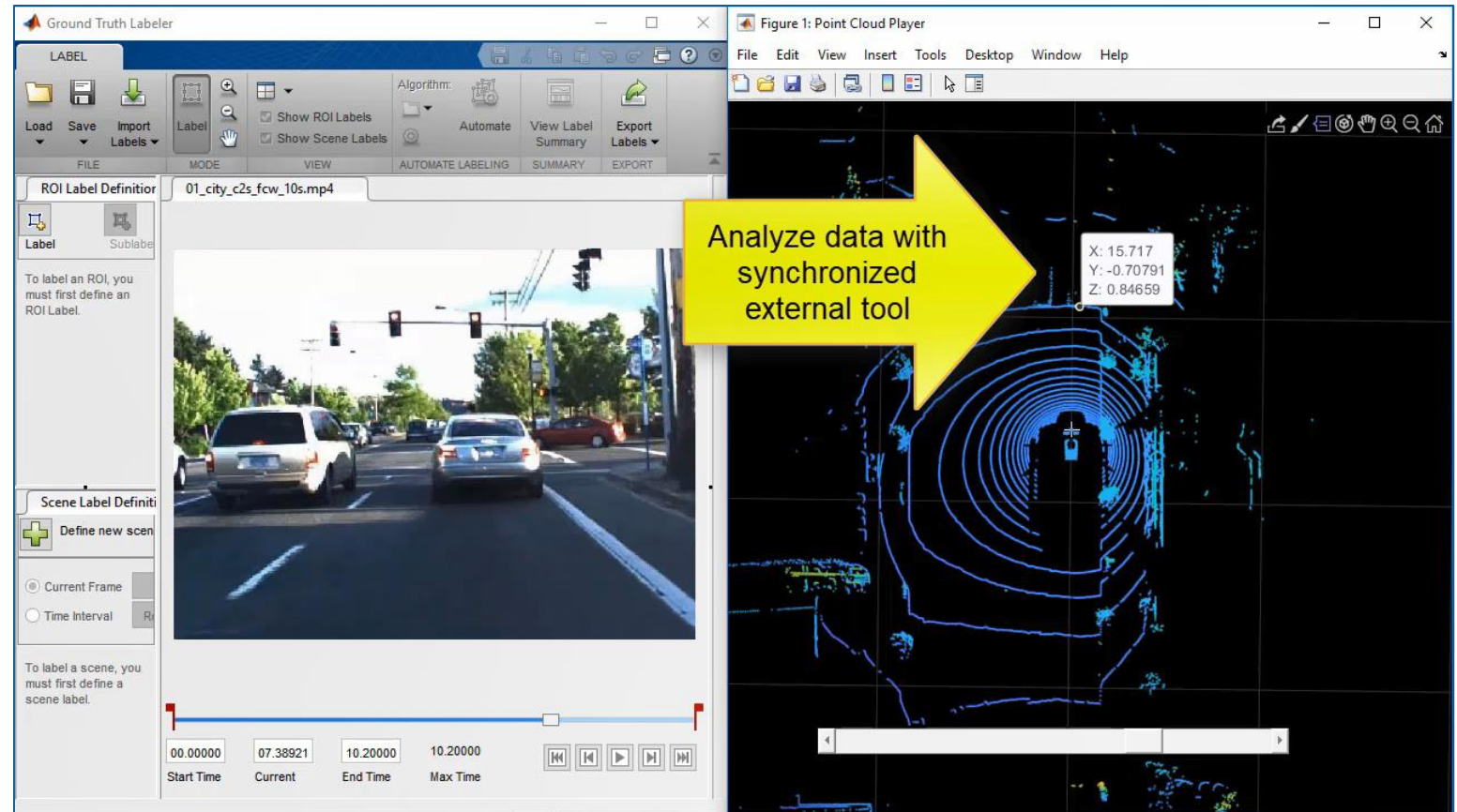
真值标签工具：添加自定义的多传感器视图

Connect Lidar Display to Ground Truth Labeler

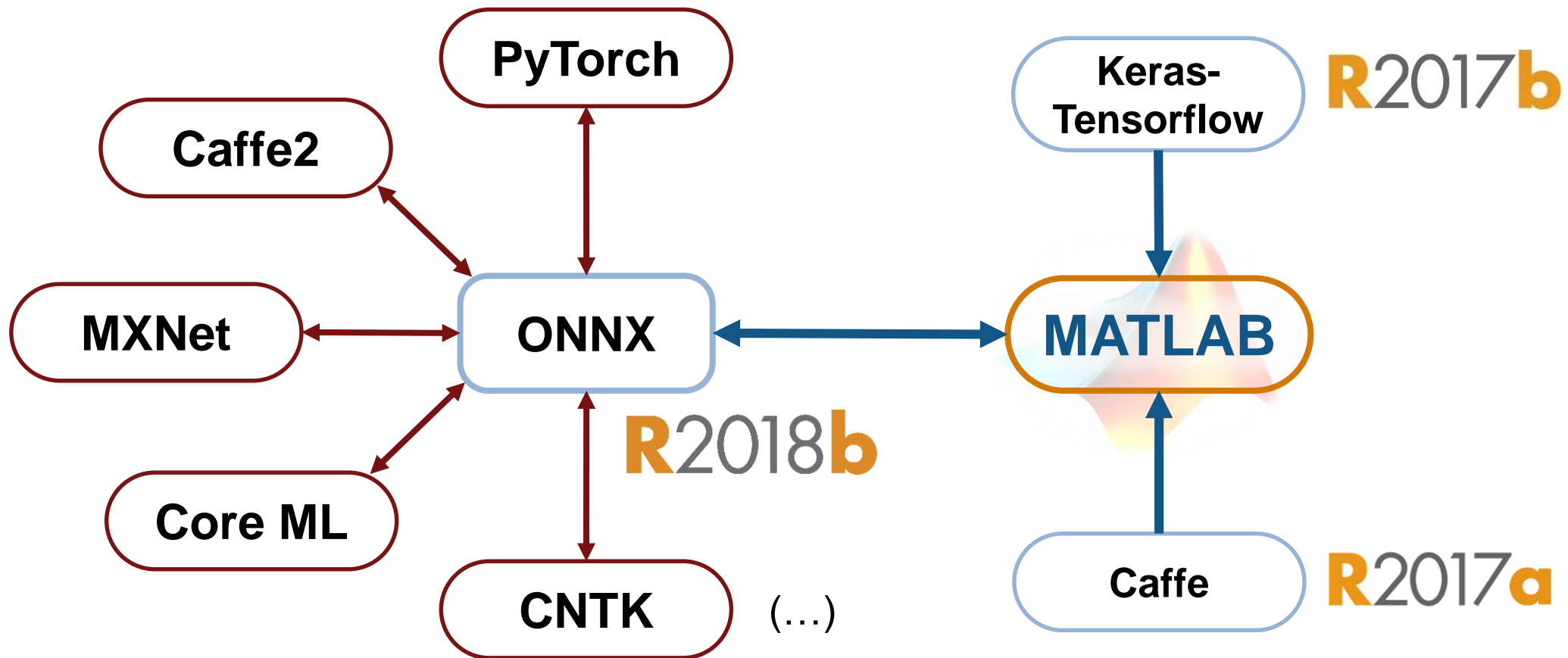
- 同步显示每一个数据帧
- 回放控制与数据分析

Automated Driving Toolbox™

R2017a



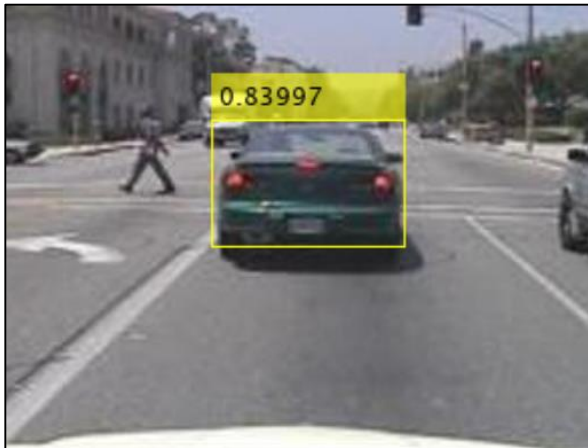
通过ONNX与各种深度学习框架交互



Open Neural Network Exchange

设计摄像机/雷达/激光雷达感知算法

采用摄像机检测车辆



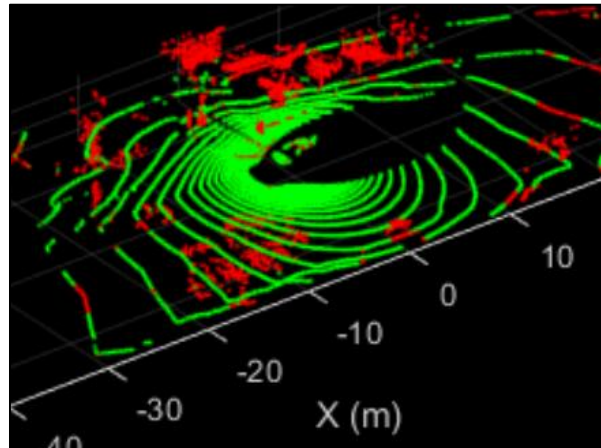
[Object Detection Using YOLO v2 Deep Learning](#)

Computer Vision Toolbox™
Deep Learning Toolbox™

R2019a

MATLAB EXPO 2019

采用激光雷达检测地面

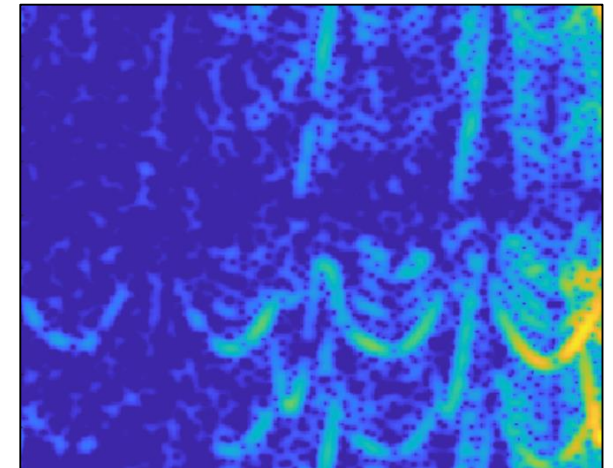


[Segment Ground Points from Organized Lidar Data](#)

Computer Vision Toolbox™

R2018b

采用雷达检测行人



[Introduction to Micro-Doppler Effects](#)

Phased Array System Toolbox™

R2019a

自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？



如何串联和加速多个专业
的算法开发？



如何将其他资源集成到我们的
仿真环境？

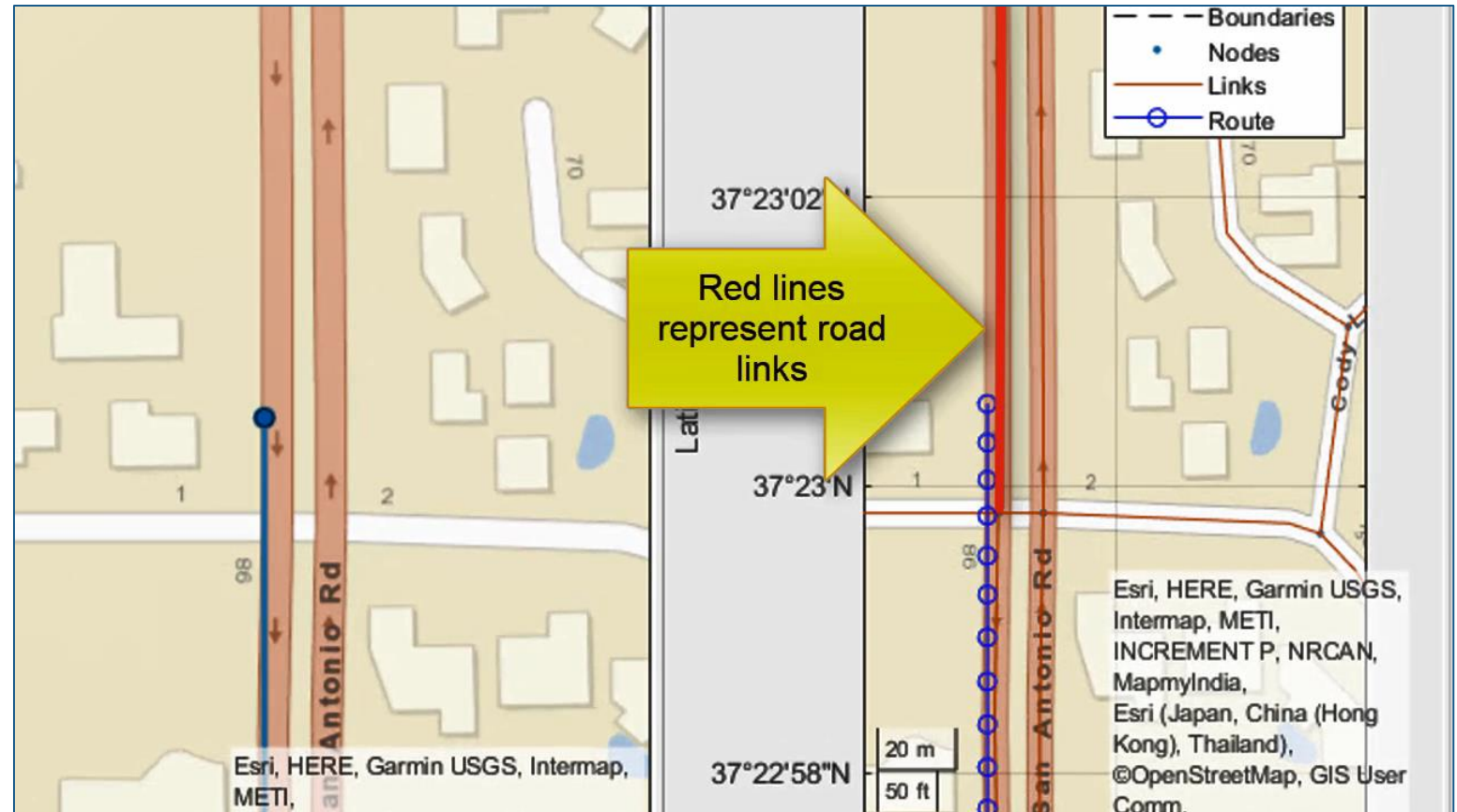
连接HERE高精度实时地图：读取道路和限速属性

Use HERE HD Live Map Data to Verify Lane Configurations

- 载入摄像机与GPS数据
- 读取道路限速
- 读取车道配置
- 可视化组合数据

Automated Driving Toolbox™

R2019a



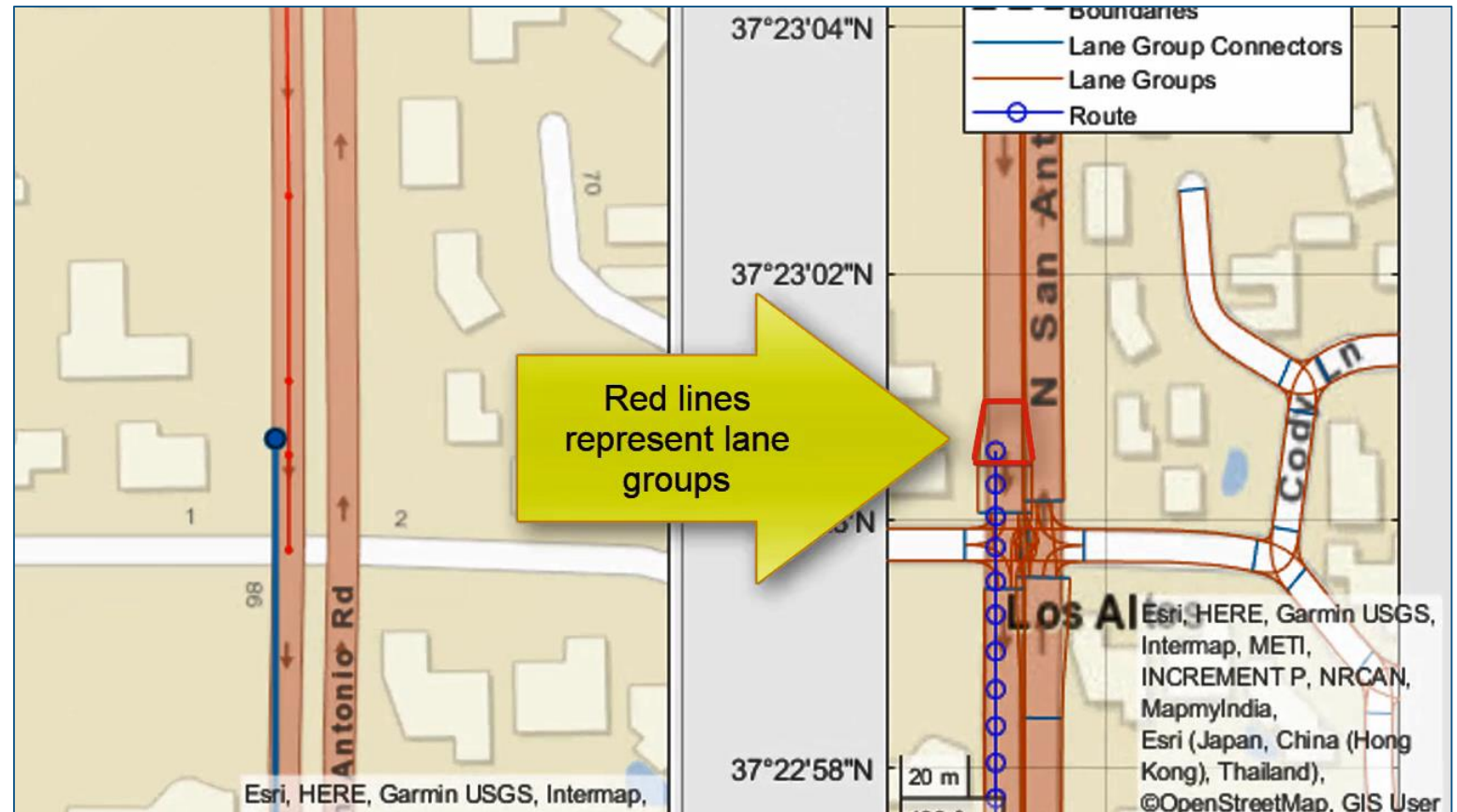
连接HERE高精度实时地图：读取车道属性

Use HERE HD Live Map Data to Verify Lane Configurations

- 载入摄像机与GPS数据
- 读取道路限速
- 读取车道配置
- 可视化组合数据

Automated Driving Toolbox™

R2019a



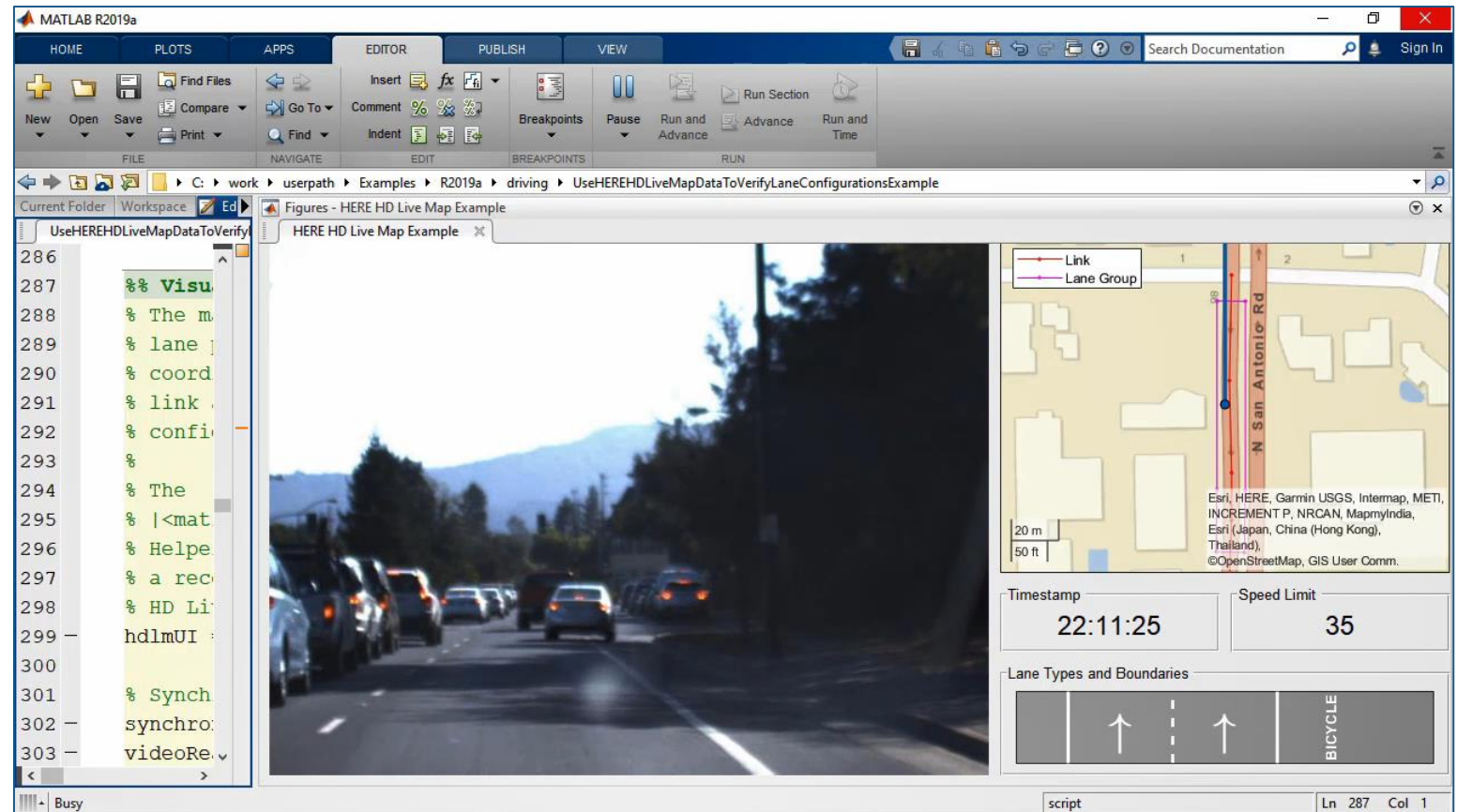
连接HERE高精度实时地图：可视化记录的数据

Use HERE HD Live Map Data to Verify Lane Configurations

- 载入摄像机与GPS数据
- 读取道路限速
- 读取车道配置
- 可视化组合数据

Automated Driving Toolbox™

R2019a



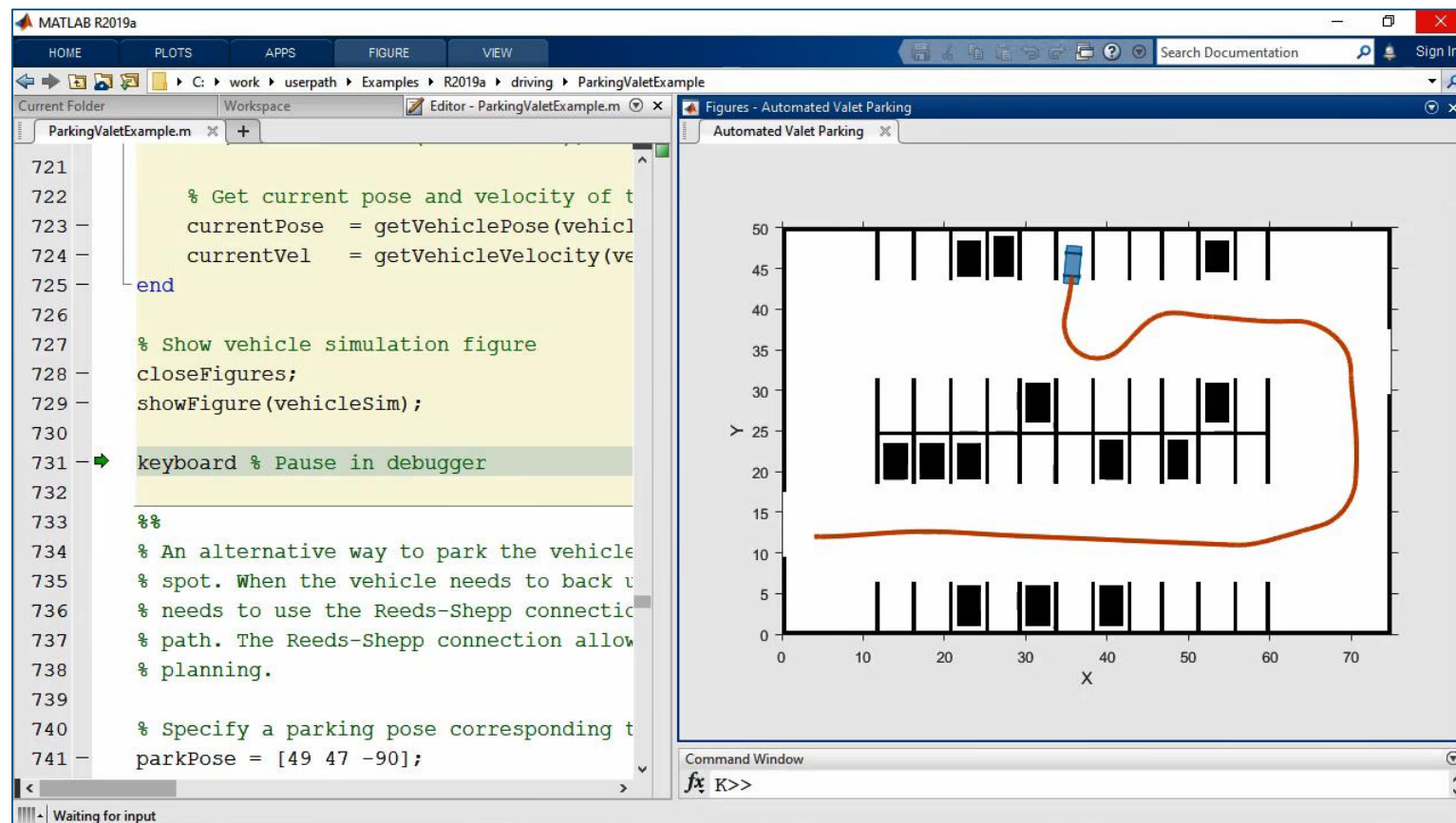
设计路径规划器

Automated Parking Valet

- 创建环境的代价地图
- 膨胀代价地图用于碰撞检测
- 指定目标位置
- 使用快速搜索随机树 (RRT*) 算法规划路径

Automated Driving Toolbox™

R2018a



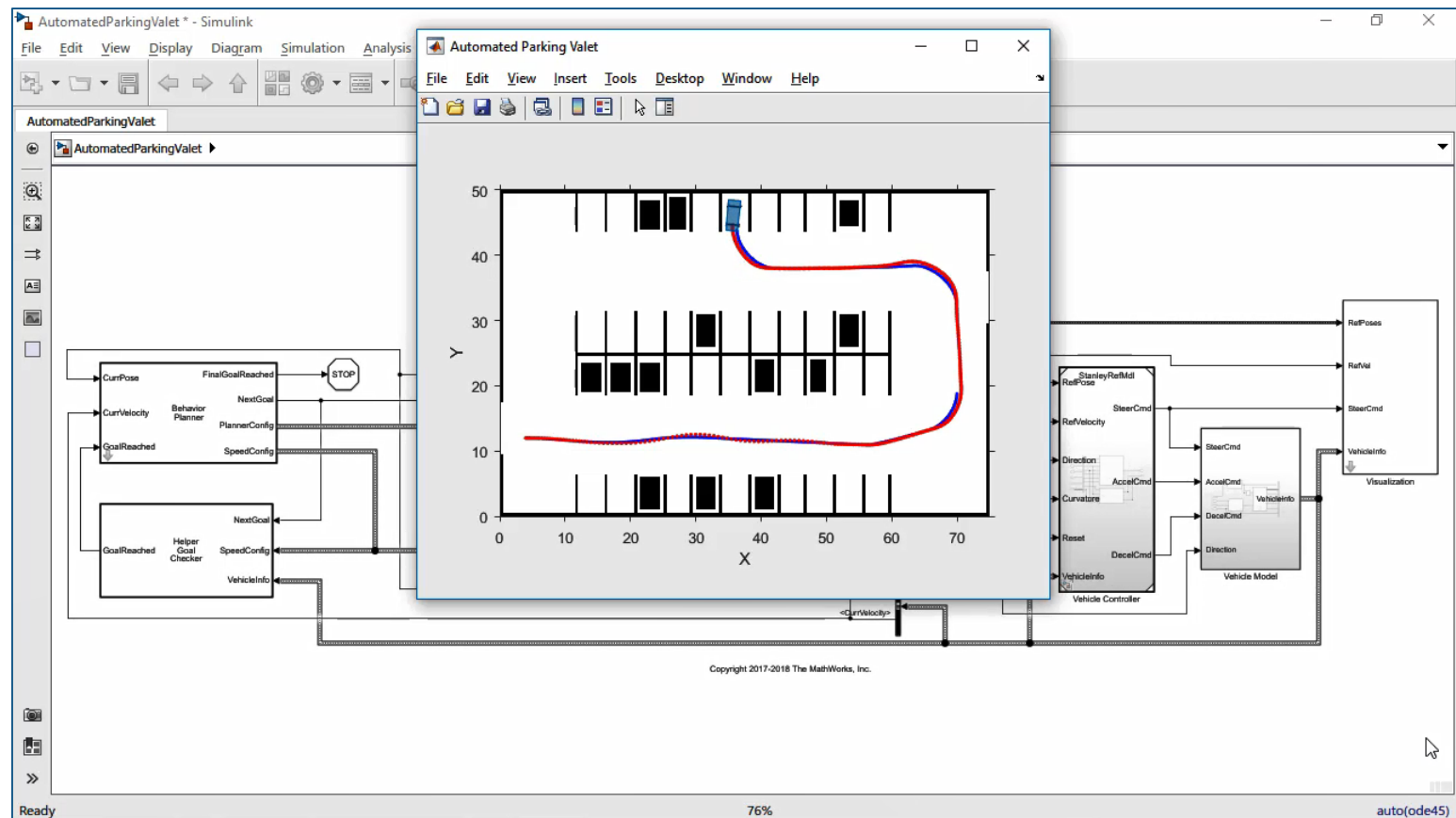
设计路径规划器与车辆控制器

Automated Parking Valet with Simulink

- 路径规划器（RRT*算法）
- 车辆横向与纵向控制器（基于运动学的Stanley算法）
- 与车辆动力学模型结合进行闭环仿真

Automated Driving Toolbox™

R2018b



规划与控制算法生成C/C++代码

Code Generation for Path Planning and Vehicle Control

- 独立的模型文件
- 配置代码生成选项
- 生成C/C++代码
- 软件在环 (SIL) 测试
- 评估代码执行时间

Automated Driving Toolbox™
Embedded Coder™

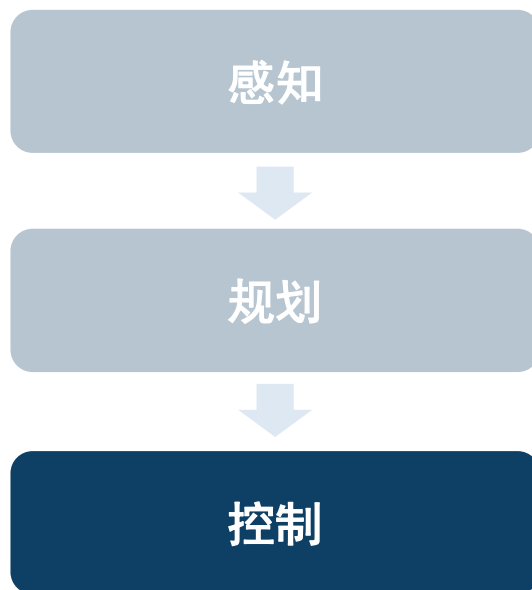
R2019a

```
186
187 // model step function
188 void step0();
189
190 // model step function
191 void step1();
192
193 // model terminate function
194 void terminate();
195
196 // Constructor
197 AutomatedParkingValetModelClass();
198
199 // Destructor
200 ~AutomatedParkingValetModelClass();
201
202 // Root inport: '<Root>/Costmap' set method
203 void setCostmap(costmapBus localArgInput);
204
205 // Root inport: '<Root>/GoalPose' set method
206 void setGoalPose(real_T localArgInput[3]);
207
```

自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？



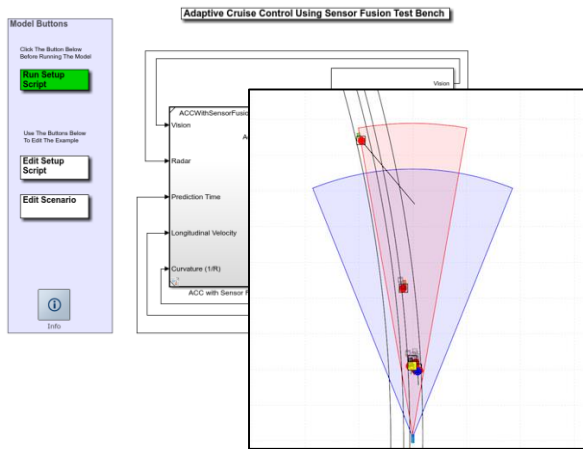
如何串联和加速多个专业
的算法开发？



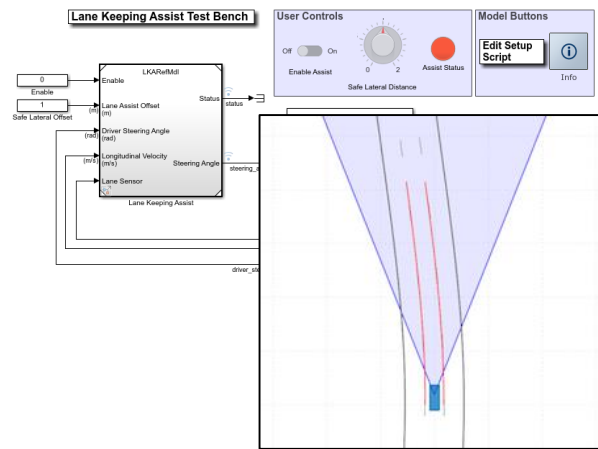
如何将其他资源集成到我们的
仿真环境？

设计纵向与横向模型预测控制器

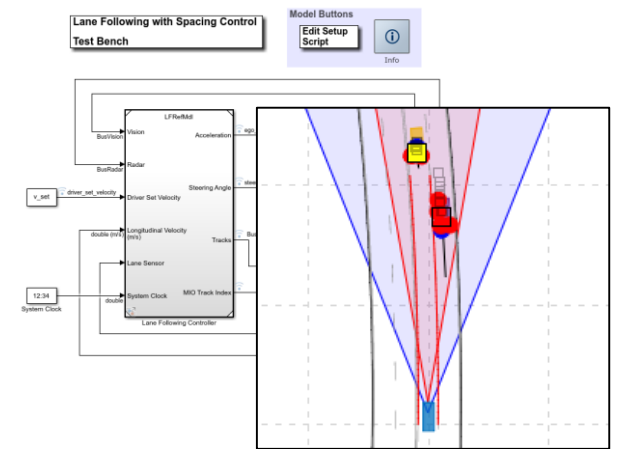
纵向控制



横向控制



纵向 + 横向



[Adaptive Cruise Control with Sensor Fusion](#)

Automated Driving Toolbox™

Model Predictive Control Toolbox™

Embedded Coder®

R2017b

MATLAB EXPO 2019

[Lane Keeping Assist with Lane Detection](#)

Automated Driving Toolbox™

Model Predictive Control Toolbox™

Embedded Coder®

R2018a

[Lane Following Control with Sensor Fusion and Lane Detection](#)

Automated Driving Toolbox™

Model Predictive Control Toolbox™

Embedded Coder®

R2018b

通过闭环仿真设计实际的ADAS功能

Automatic Emergency Braking (AEB) with Sensor Fusion

- 指定驾驶场景
- 设计AEB逻辑
- 设计传感器融合算法
- 仿真完整系统
- 生成C/C++代码
- 软件在环 (SIL) 测试

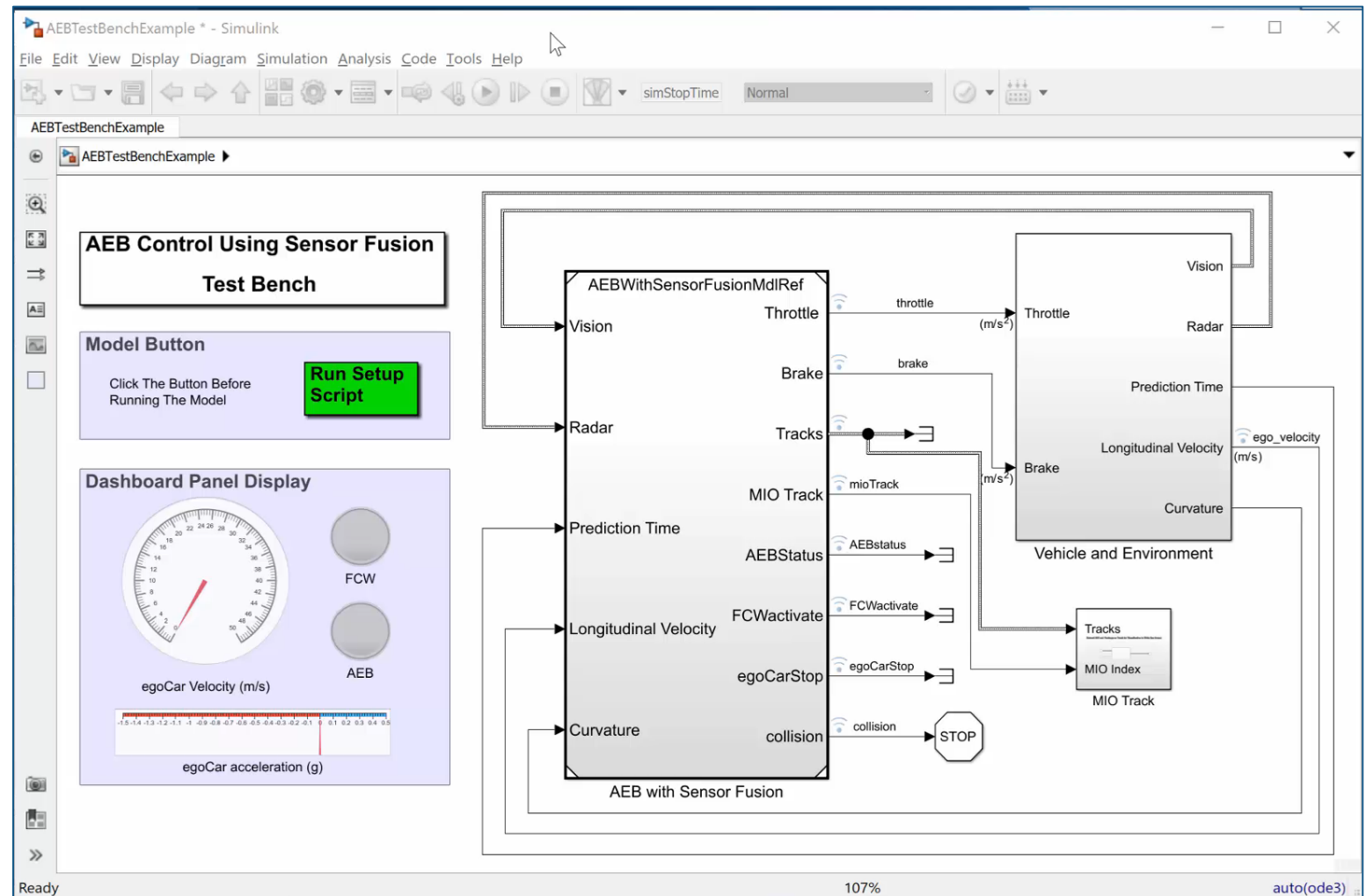
Automated Driving Toolbox™

Stateflow®

Embedded Coder®

R2018b

MATLAB EXPO 2019

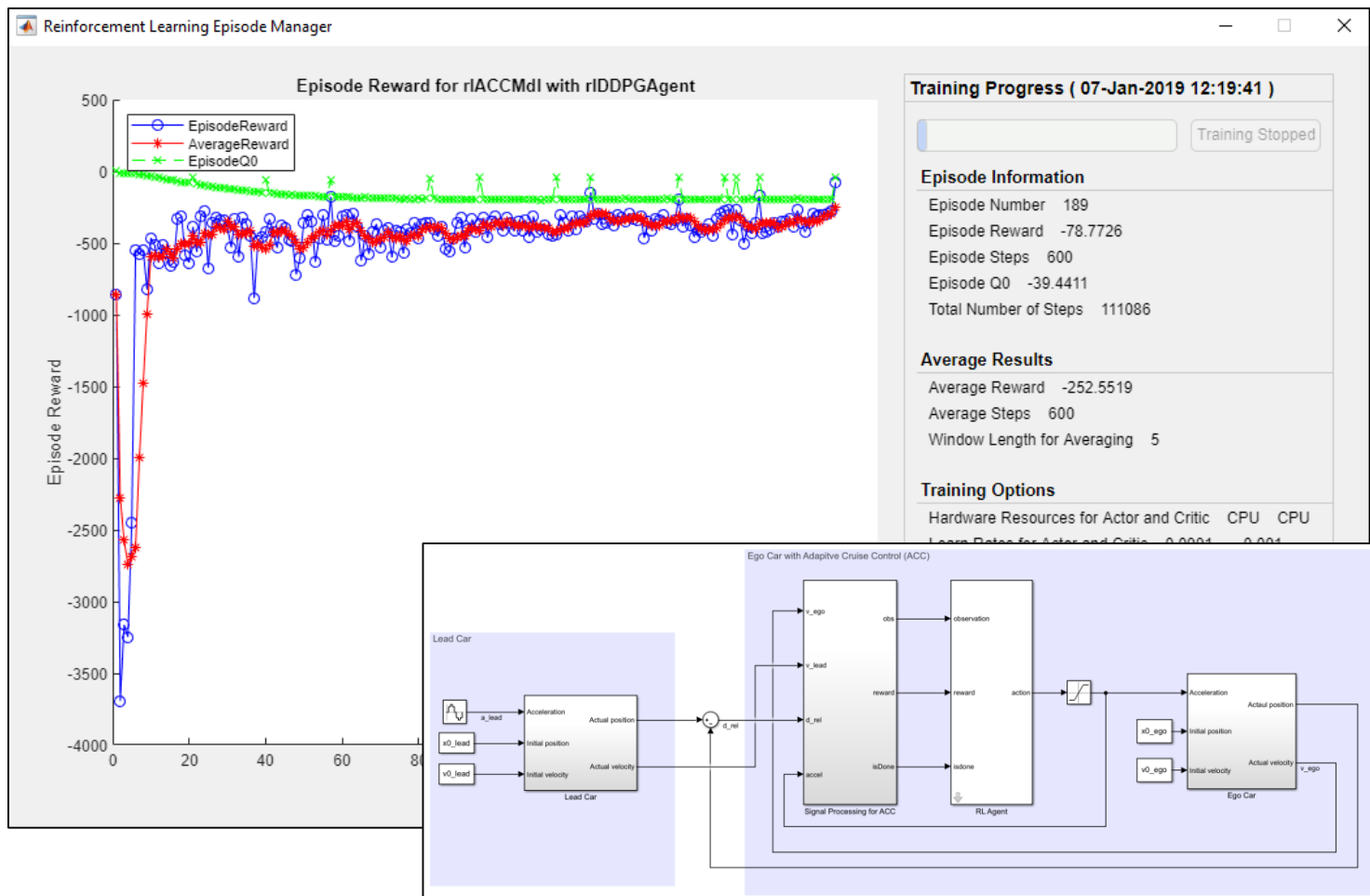


训练用于ADAS控制的增强学习网络

Train Deep Deterministic Policy Gradient (DDPG) Agent for Adaptive Cruise Control

- 创建环境接口
- 创建agent
- 训练agent
- 仿真训练的agent

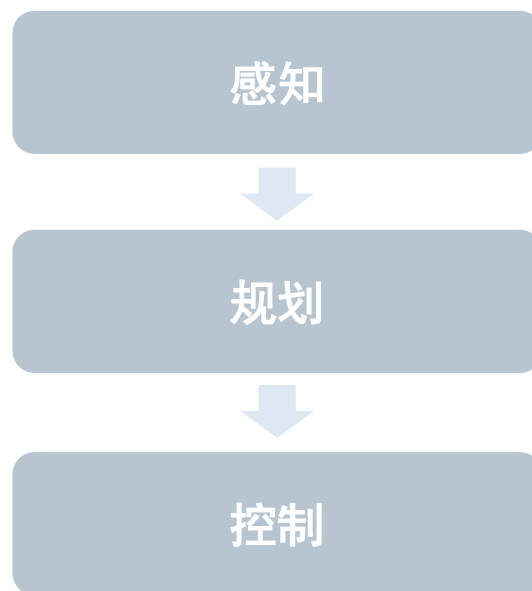
Reinforcement Learning Toolbox™
R2019a



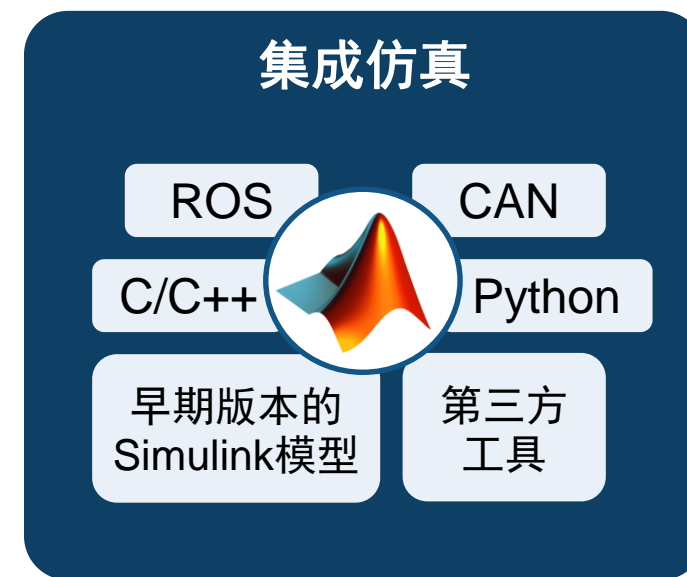
自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？



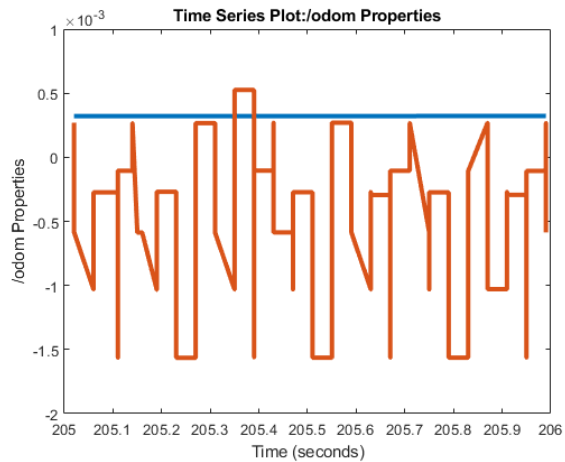
如何串联和加速多个专业
的算法开发？



如何将其他资源集成到我们的
仿真环境？

与ROS集成的三种方式

回放通过ROS记录的数据



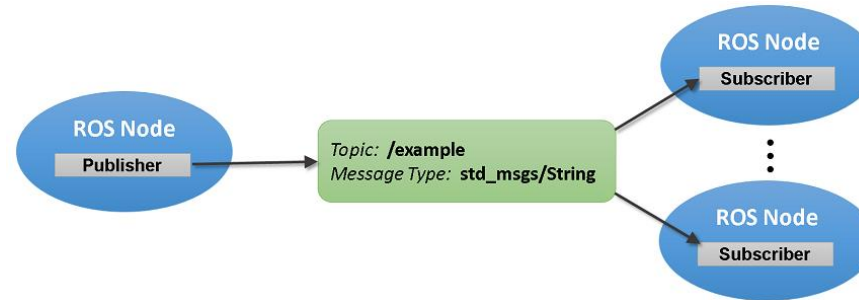
[Work with rosbag Logfiles](#)

Robotics System Toolbox™

Updated **R2018a**

MATLAB EXPO 2019

实时连接ROS系统

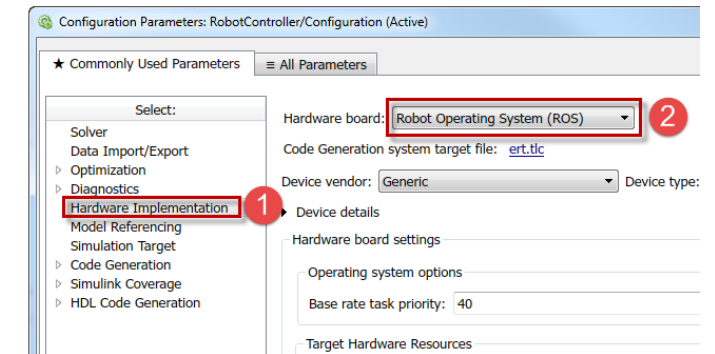


[Exchange Data with ROS Publishers and Subscribers](#)

Robotics System Toolbox™

R2016b

生成独立的ROS节点



[Generate a Standalone ROS Node from Simulink](#)

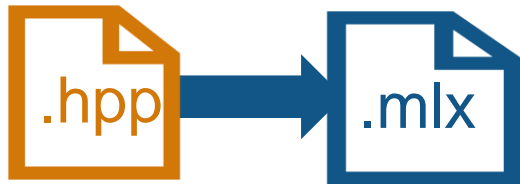
Robotics System Toolbox™

Simulink Coder™

R2016b

从MATLAB调用C++, Python, OpenCV

调用C++



[Import C++ Library
Functionality into MATLAB](#)

MATLAB®

R2019a

调用Python

```
tw = ...
py.textwrap.TextWrapper(...
    pyargs(...
        'initial_indent', '% ', ...
        'subsequent_indent', '% ', ...
        'width', int32(30)))
```

[Call Python from MATLAB](#)
MATLAB®

R2014a

调用OpenCV & OpenCV GPU

```
cv::Rect
cv::KeyPoint
cv::Size
cv::Mat
cv::Ptr
...
```



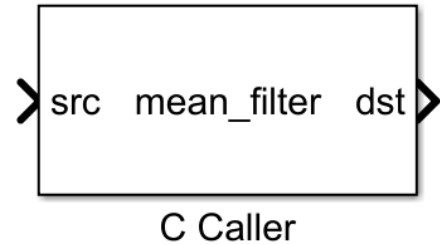
[Install and Use Computer
Vision Toolbox OpenCV
Interface](#)

Computer Vision System Toolbox™
OpenCV Interface Support Package

Updated **R2018b**

从Simulink调用C代码

调用C代码



[Bring Custom Image Filter Algorithms as Reusable Blocks in Simulink](#)

Simulink®
R2017b

MATLAB EXPO 2019

从C结构体创建Bus

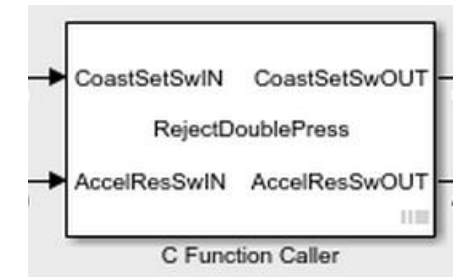
```
typedef struct {
    double coeff;
    double init;
    fault_T fault;
} params_T;
```

Name	DataType
- coeff	double
- init	double
- fault	Enum: fault_T

[Import Structure and Enumerated Types](#)

Simulink®
R2017a

测试与验证C代码

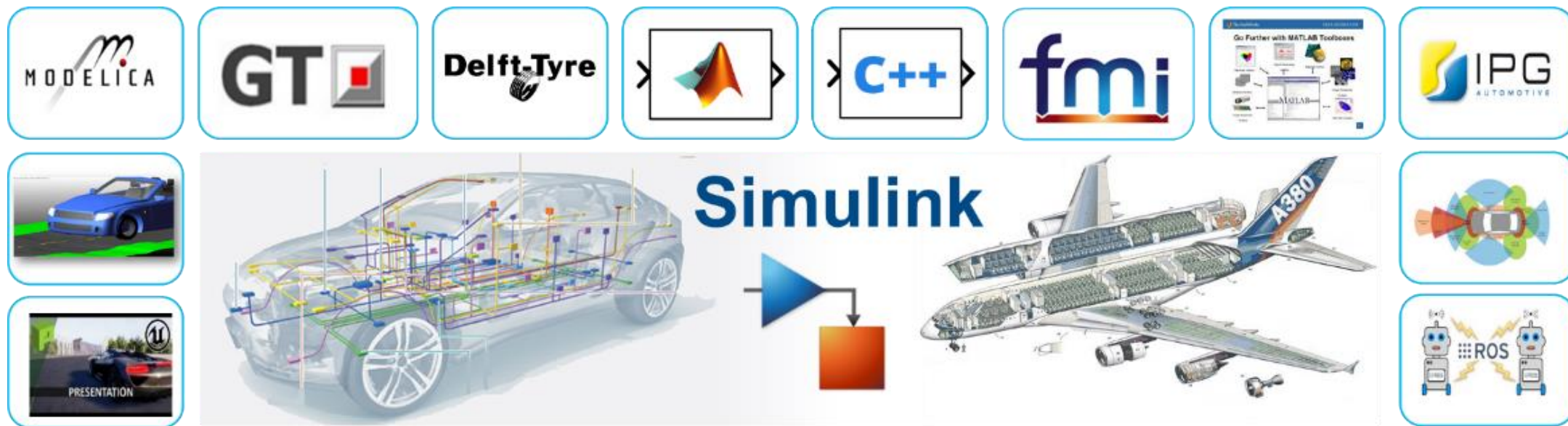


AGGREGATED COVERAGE RESULTS			
ANALYZED MODEL	DECISION	CONDITION	MCDC
RejectDoublePress.c	100%	100%	100%

[Custom C Code Verification with Simulink Test](#)

Simulink Test™
Simulink Coverage™
R2019a

连接第三方工具



我们提供152种到第三方
建模与仿真工具的接口
(2019年3月统计)



通过代码生成，仿真早期版本模型

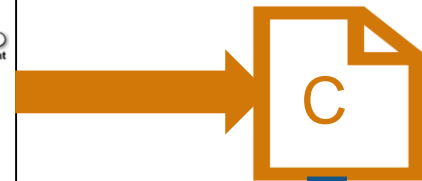
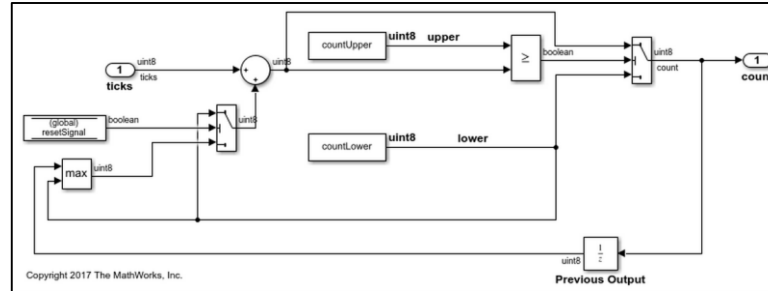
Integrate Generated Code by Using Cross-Release Workflow

- 从早期版本生成代码 (R2010a或以后版本)
- 在当前版本种导入生成的代码作为一个模块
- 允许调节参数
- 允许访问内部信号

Embedded Coder

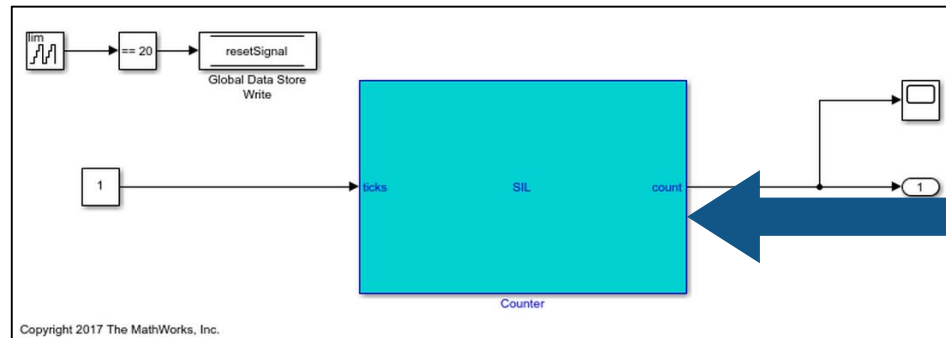
R2016a

Previous Release

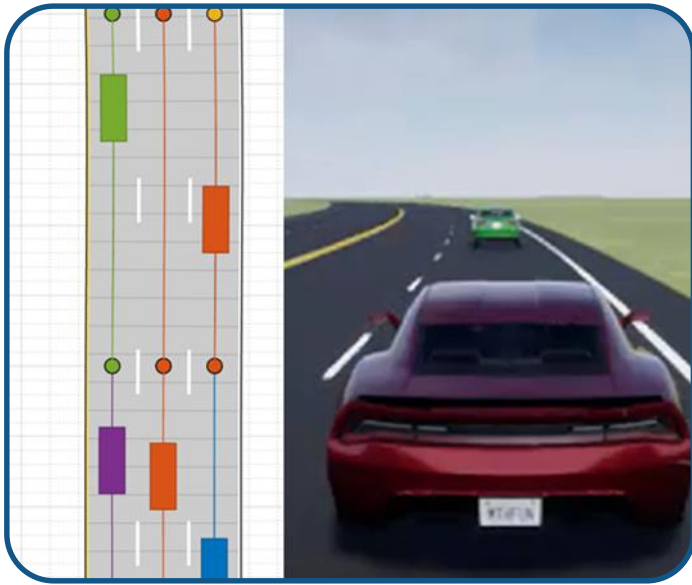


crossReleaseImport

Current Release



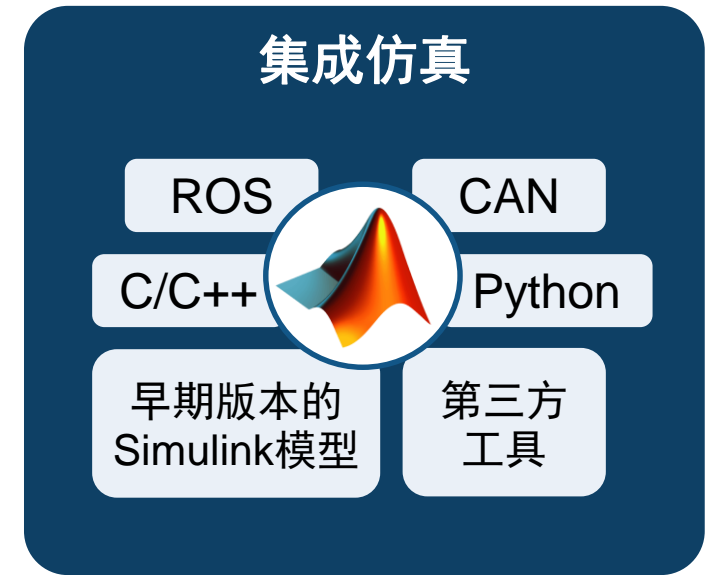
自动驾驶工程师的几个常见问题



如何创建虚拟驾驶场景
来测试我的设计？

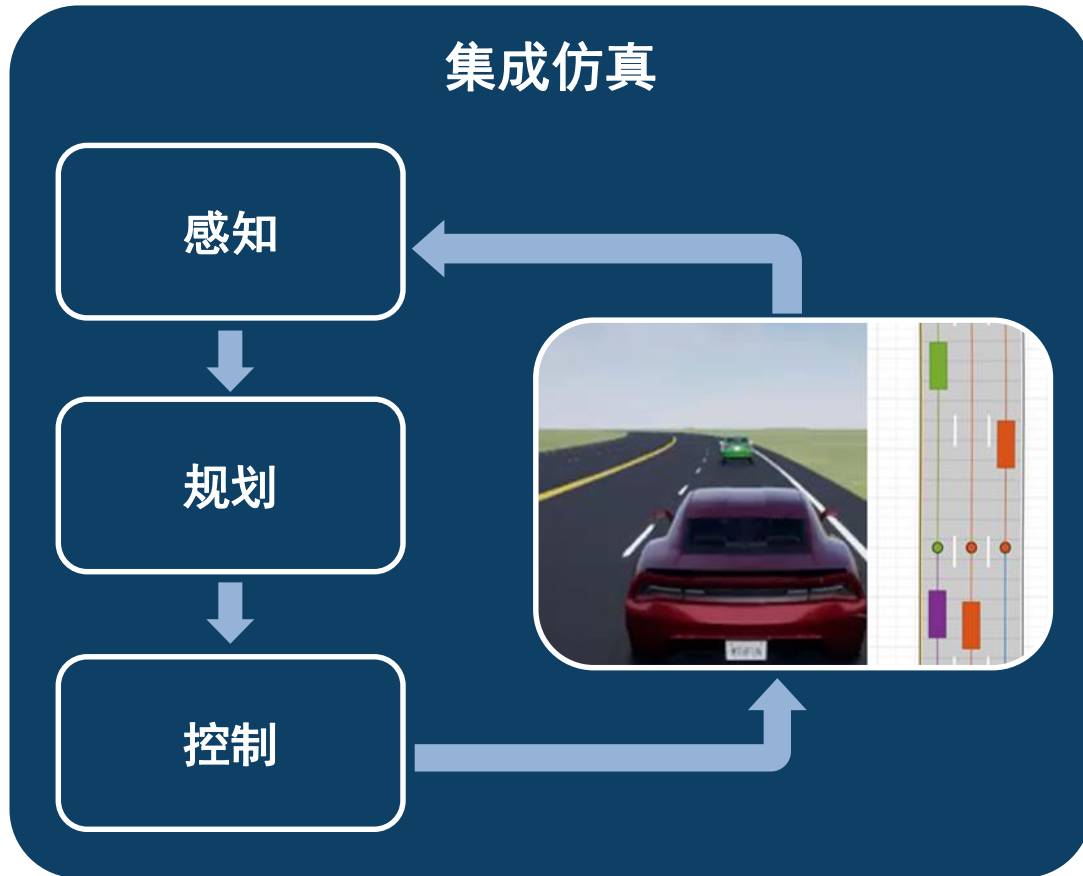


如何串联和加速多个专业
的算法开发？



如何将其他资源集成到我们的
仿真环境？

第一步：从帮助文档中已有的示例开始



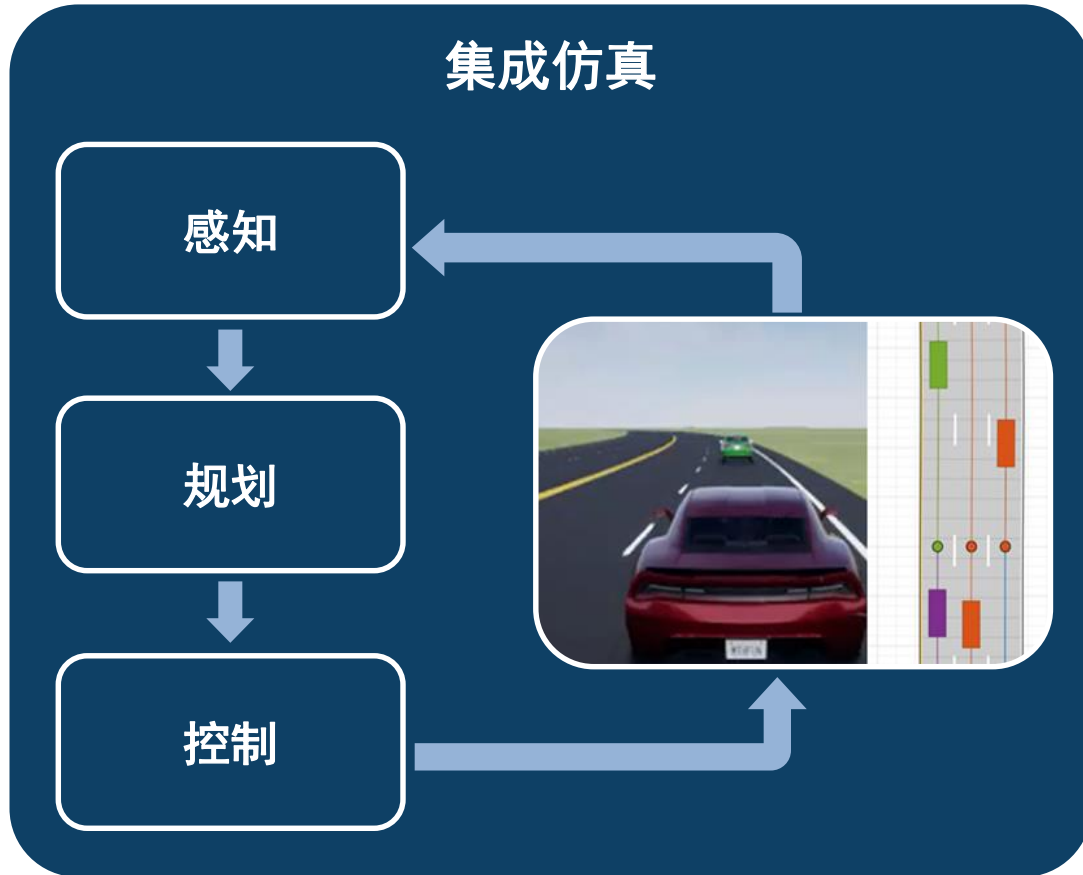
Documentation

All

Examples

- [Automated Driving Toolbox](#)
 - 真值标注, 感知, 传感器融合, 路径规划, 传感器数据合成等
- [Model Predictive Control Toolbox](#)
(分类: [Automated Driving Applications](#))
 - 自适应巡航, 车道保持, 带间距控制的车道跟随等
- [Simulink Test](#)
(分类: [Systematic Testing and Reporting](#))
 - 测试带传感器融合的车道跟随控制器

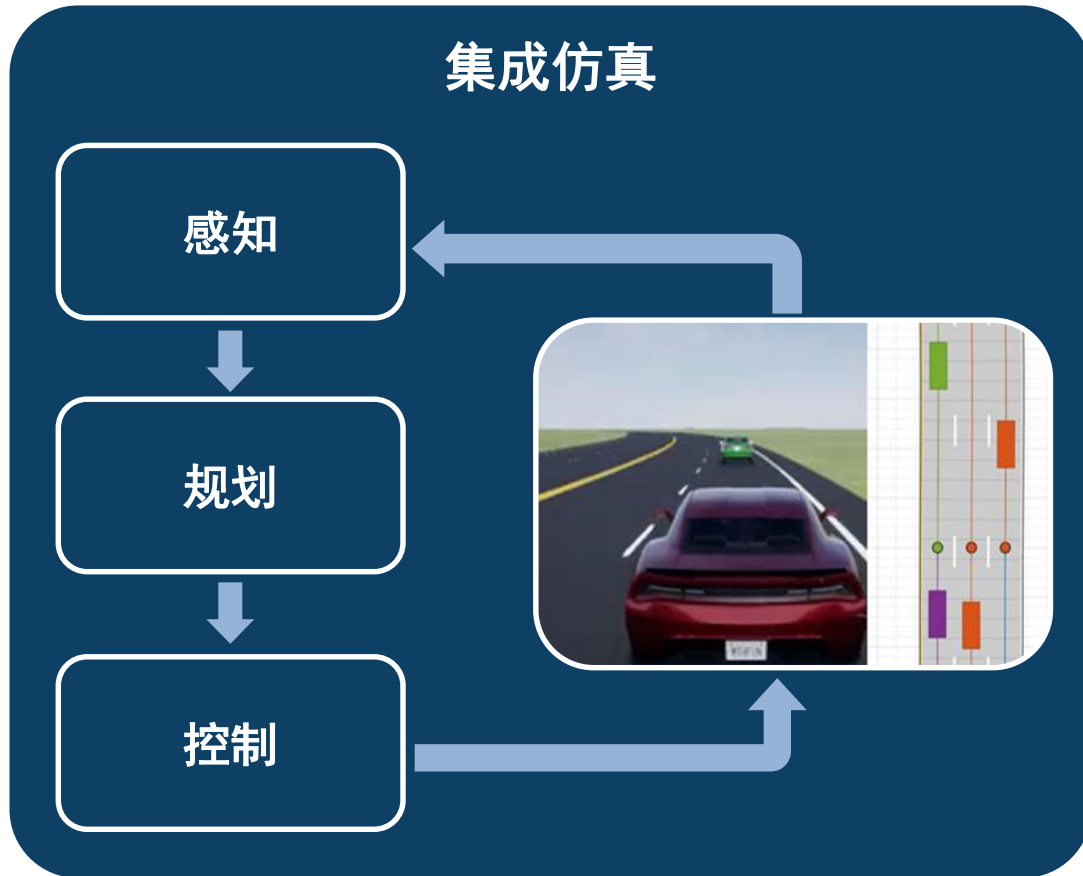
第二步：通过参加培训积累工具使用的经验



MATLAB and Simulink Training

- [使用 MATLAB 实现自动驾驶](#)
- [使用 MATLAB 进行深度学习](#)
- [MATLAB 计算机视觉](#)
- [Simulink 系统和算法建模](#)
- [Simulink 代码集成](#)
- [为 AUTOSAR 软件组件生成代码](#)
- [Simulink 模型测试和验证](#)
- [Polyspace Bug Finder for C/C++ 代码分析](#)
- [按需定制培训课程 \(联系我们\)](#)

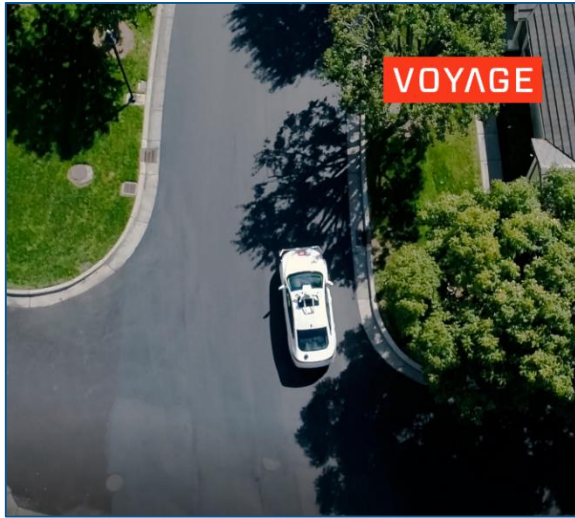
第三步：借助咨询服务推动实际项目的开展



MATLAB and Simulink Consulting Services

- [图像处理与计算机视觉](#)
- [MATLAB 与 Hadoop 和 Spark](#)
- [工具集成](#)
- [ISO 26262 流程的部署](#)
- [基于模型设计流程的建设](#)
- [基于模型设计流程的评估与成熟度框架](#)
- 自动驾驶开发工具的扩展 ([联系我们](#))

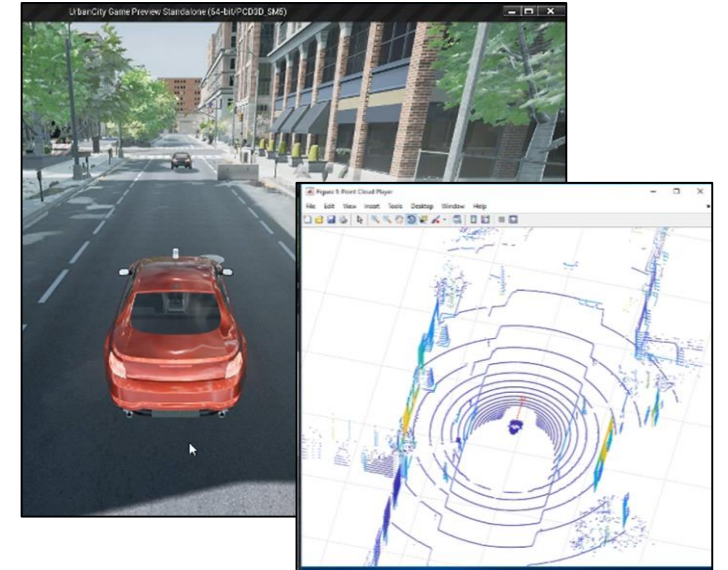
MathWorks帮助用户建立自动驾驶开发方式的成功案例



Voyage: MPC控制器的ROS集成

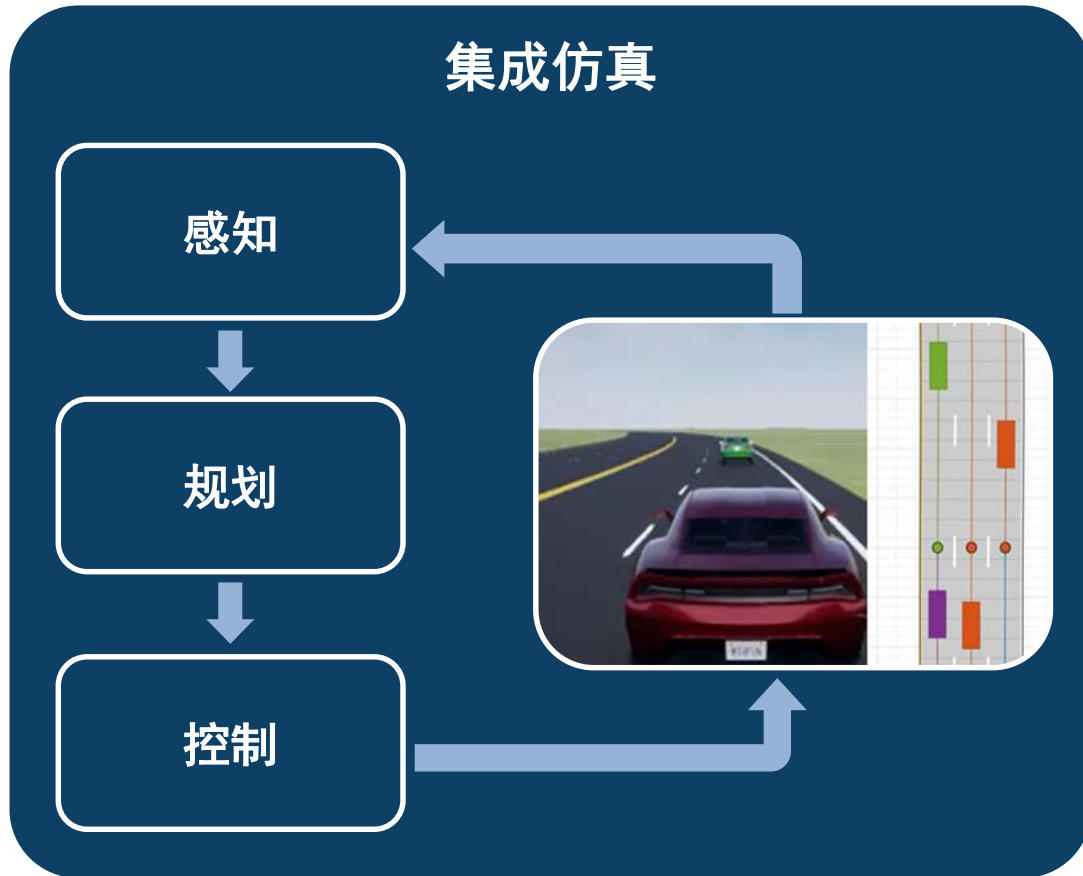


Autoliv: 激光雷达真值标注工具



Ford: 基于“虚幻”引擎的激光雷达模拟

准备好用MATLAB和Simulink开发自动驾驶系统



针对您的自动驾驶应用，MathWorks 现场工程师可随时与您交流：

- 了解您的目标
- 推荐相关工具和方法
- 解答您的问题