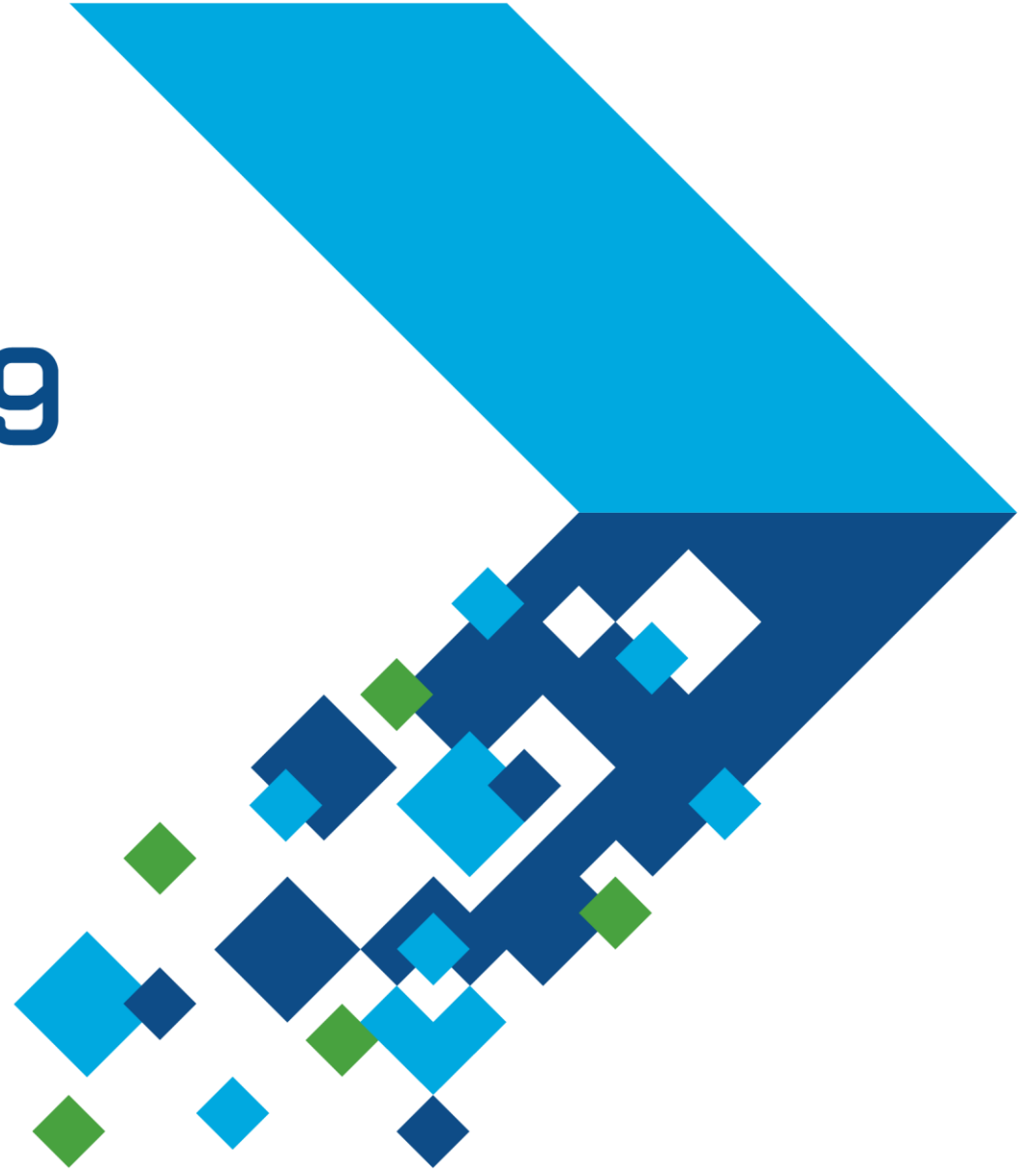
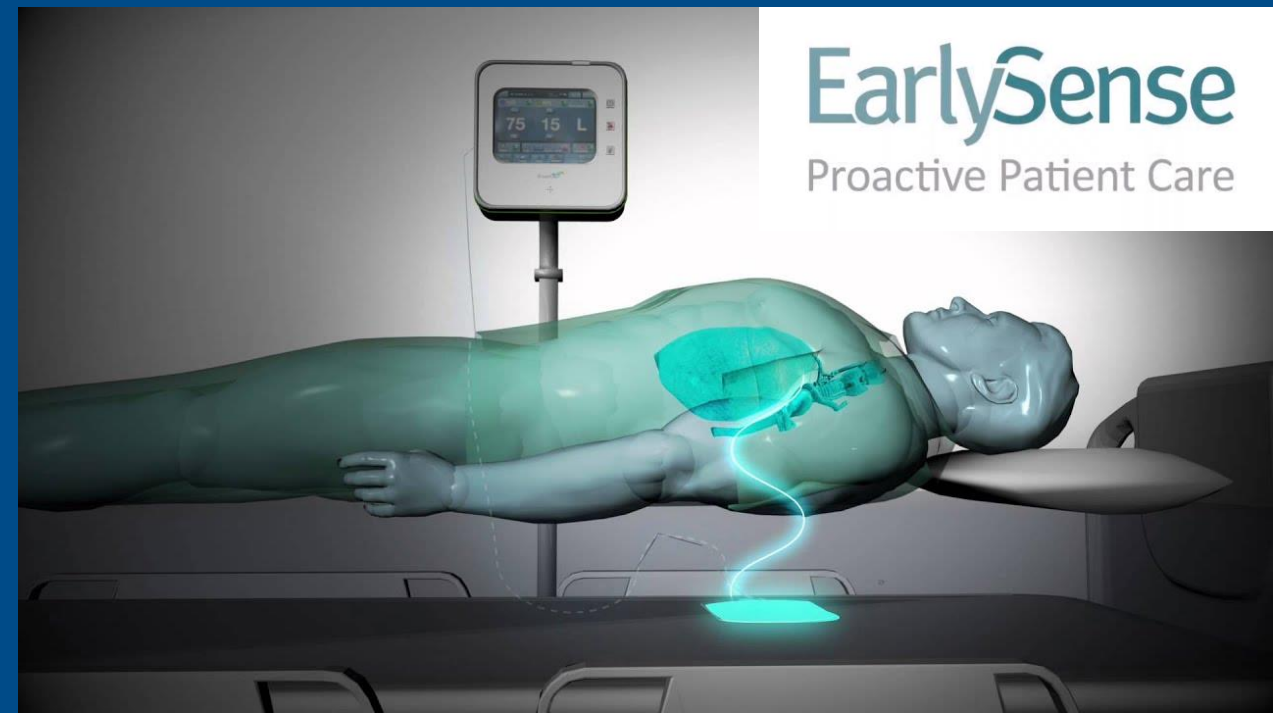


# MATLAB EXPO 2019

## What's New in MATLAB and Simulink

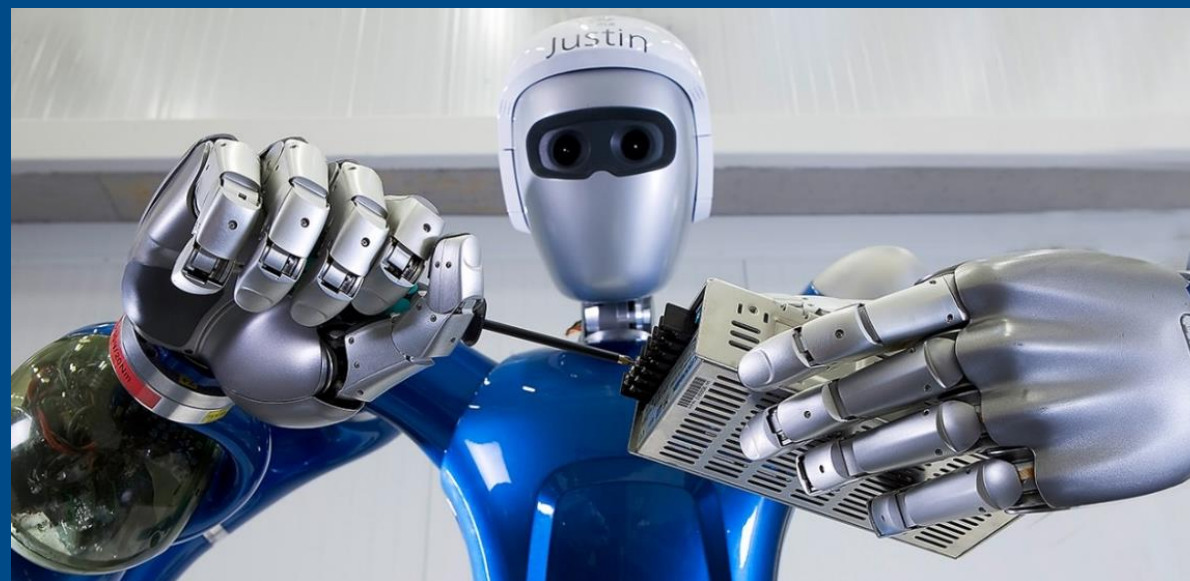
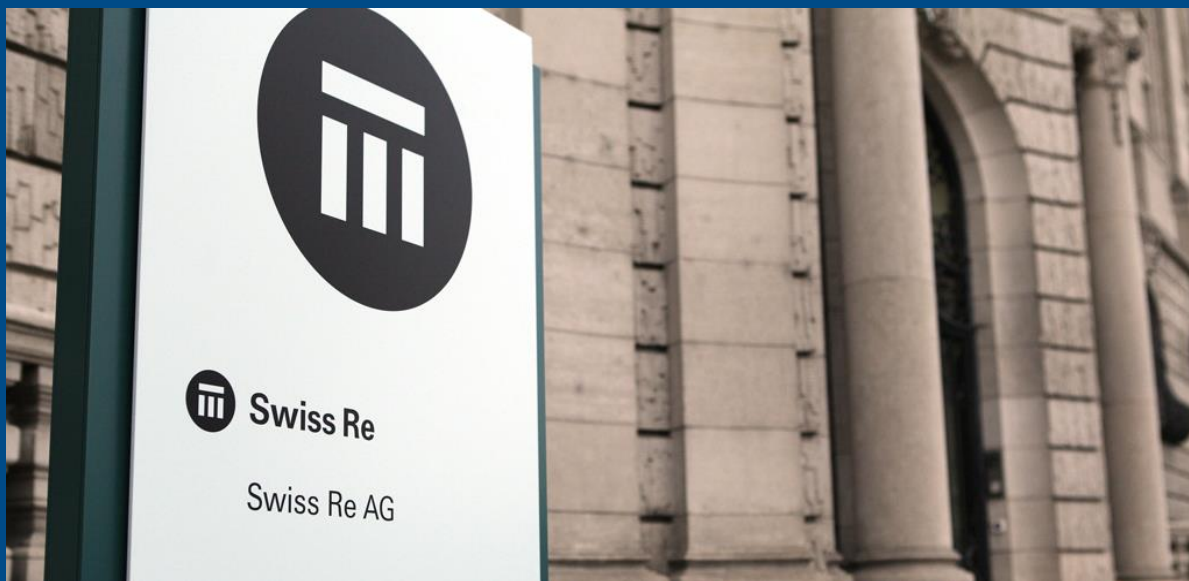
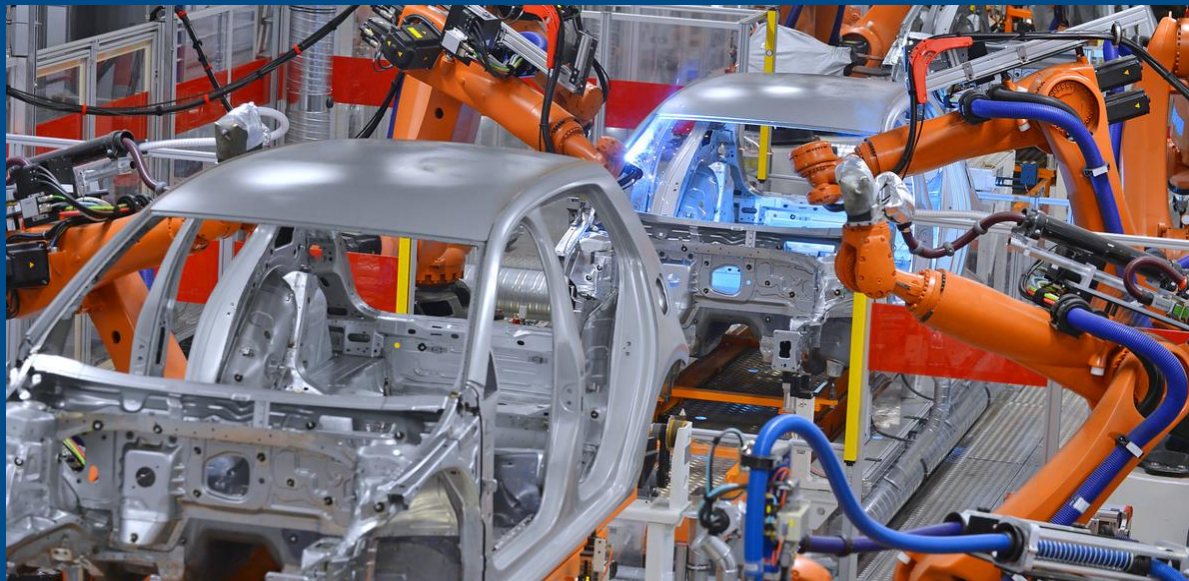
Cynthia Cudicini







# Algorithms in Everything



# Using MATLAB & Simulink to Build Algorithms in Everything

**Simplifying your work...**

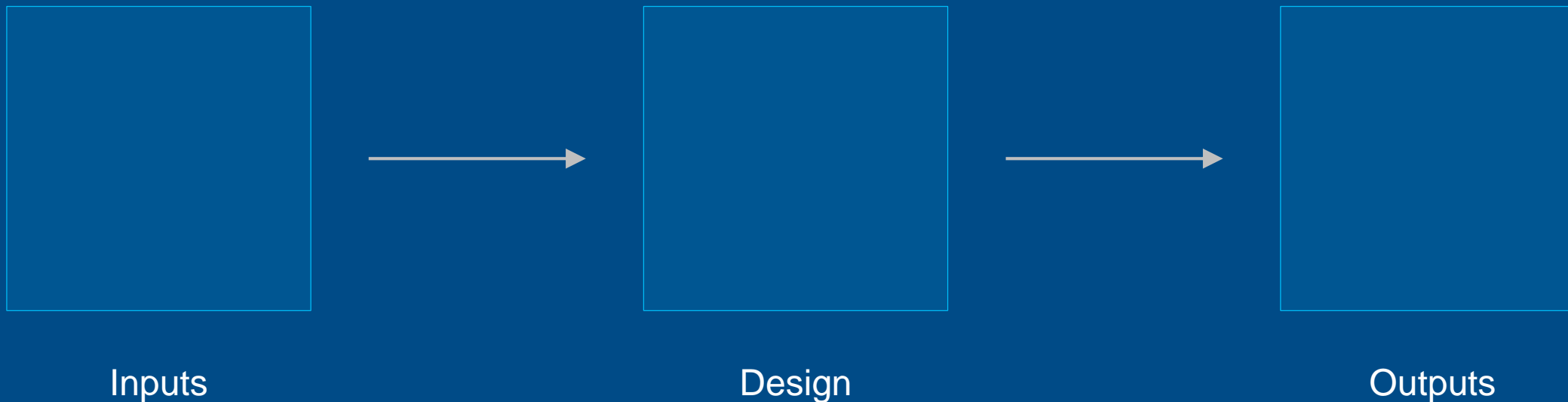
**...often at higher levels of abstraction.**



**MATLAB®SIMULINK®**



# Using MATLAB & Simulink to Build Algorithms in Everything



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# Artificial Intelligence

*The capability of a machine to  
match or exceed intelligent human behavior by  
**training a machine**  
**to learn the desired behavior***

# There are two ways to get a computer to do what you want

## Traditional Programming



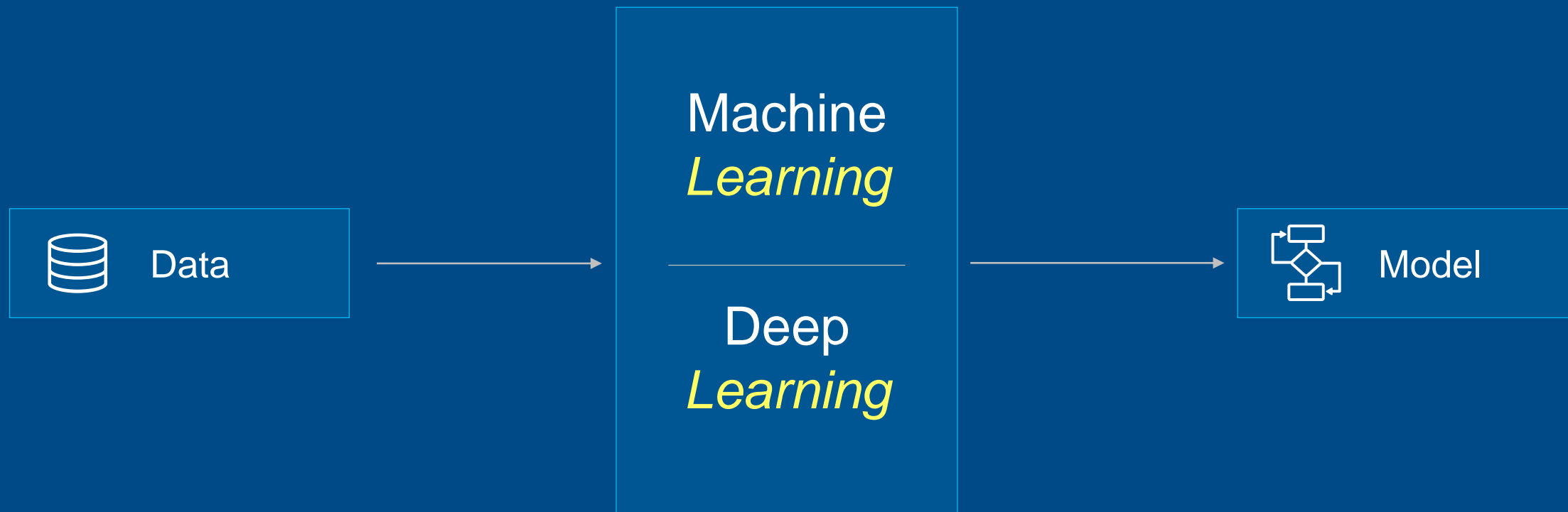
# There are two ways to get a computer to do what you want

## Machine Learning

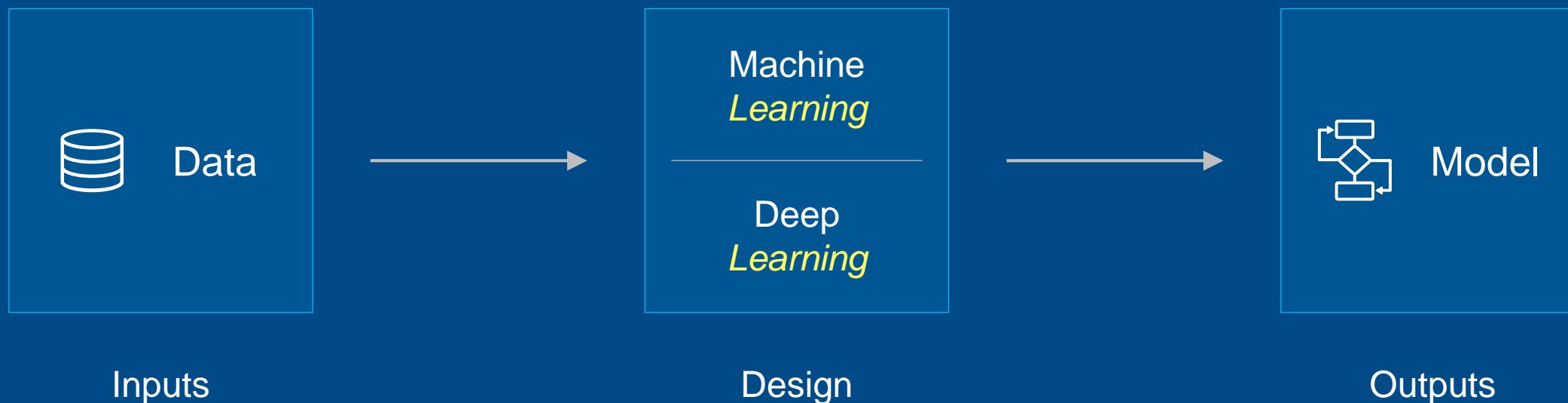




# Artificial Intelligence



# Using MATLAB and Simulink to Build **Deep Learning Models**

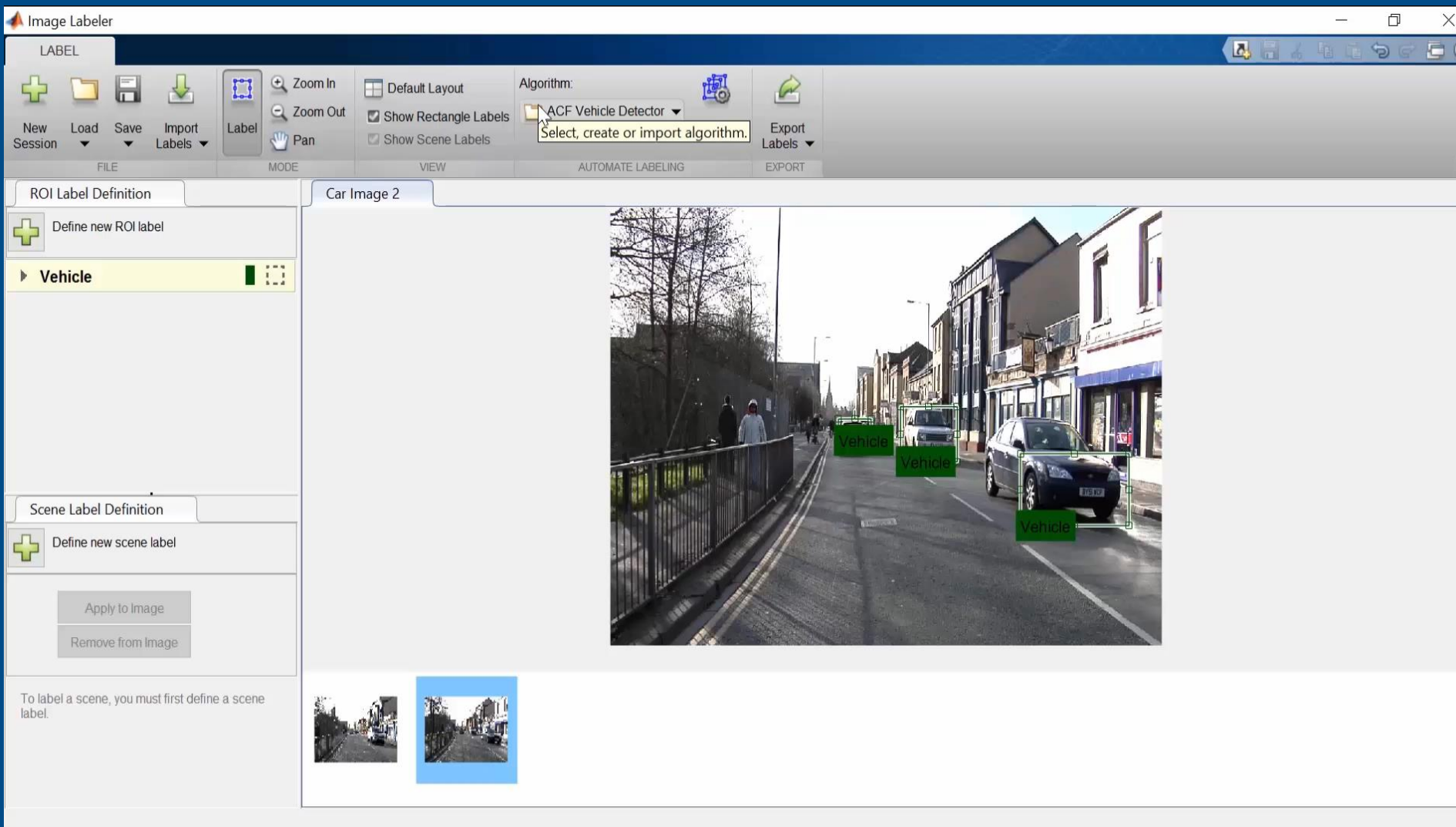


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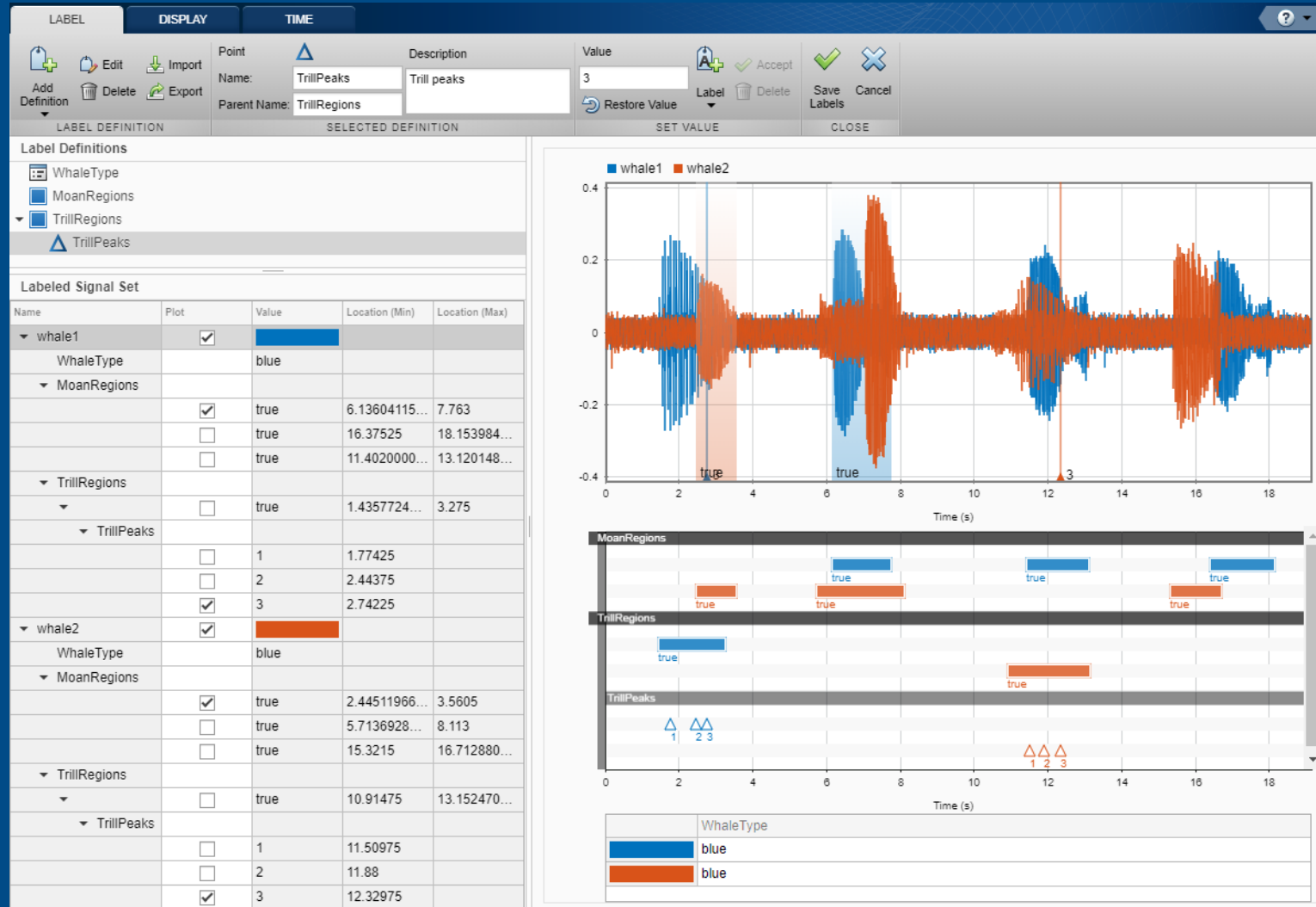
# Using Apps for Ground Truth Labeling

## Image and Video Data



# Using Apps for Ground Truth Labeling

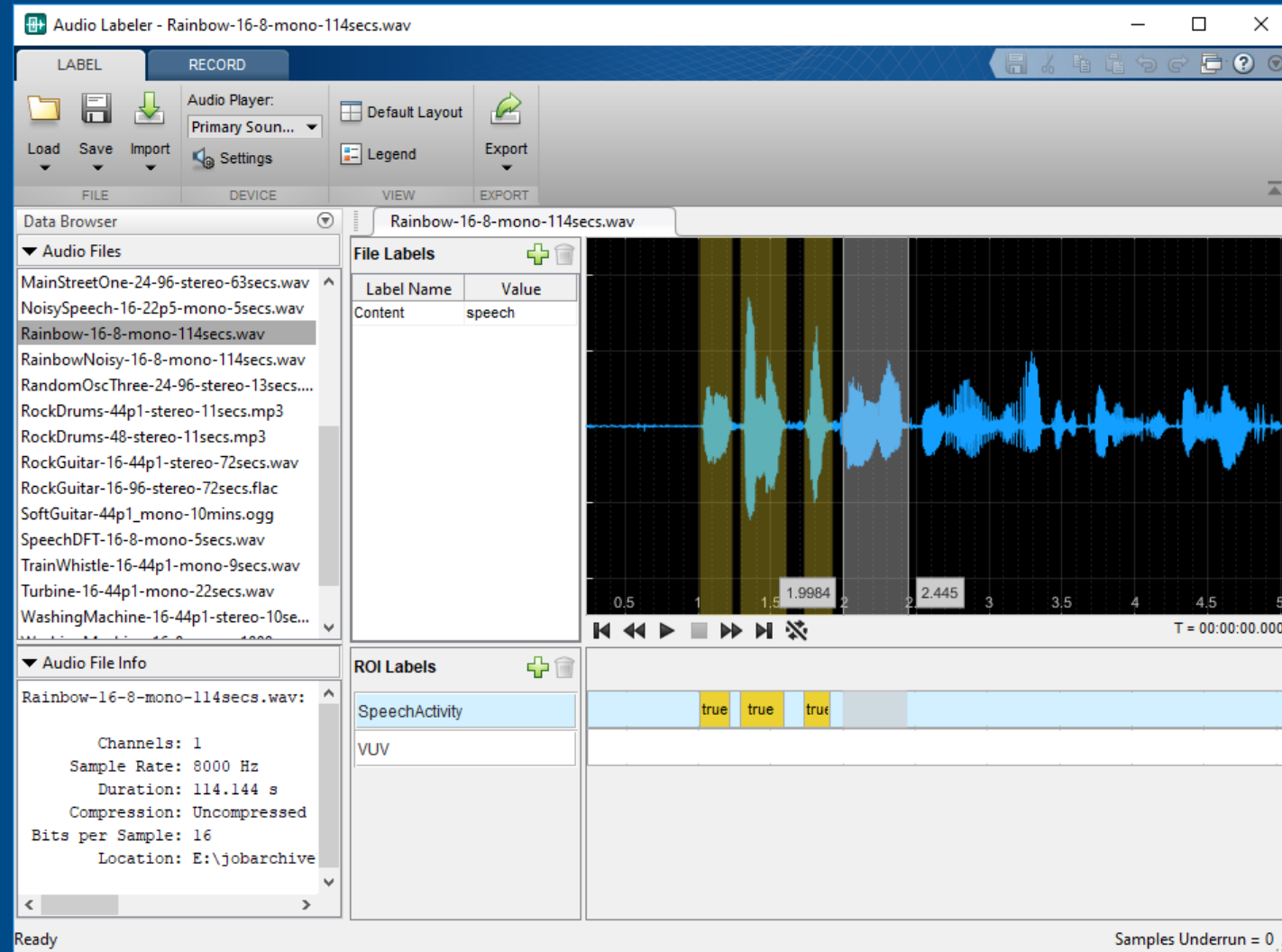
## Signal Data



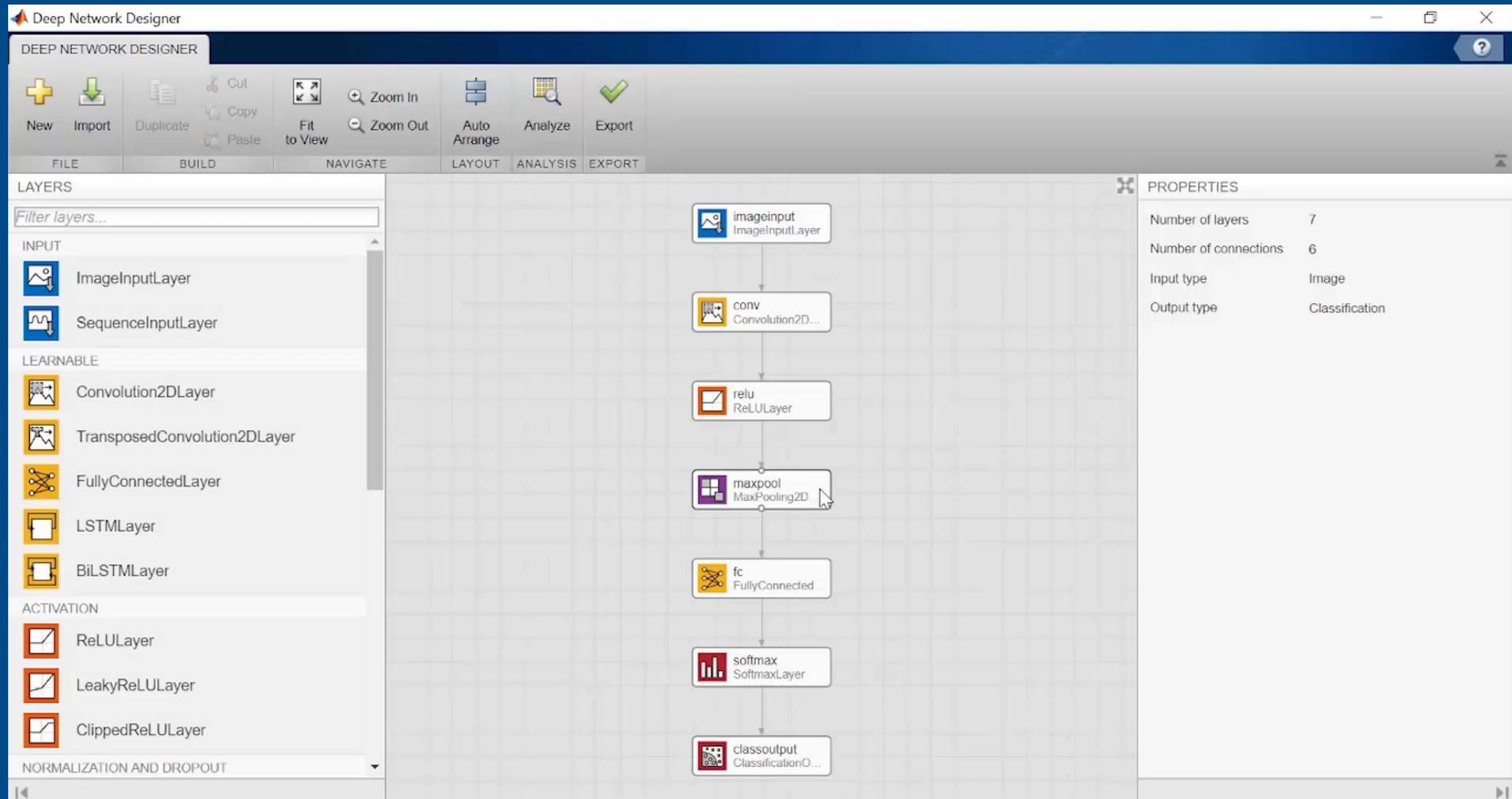


# Using Apps for Ground Truth Labeling

## Audio Data



# Using Apps for Designing Deep Learning Networks



# Using Transfer Learning with Pre-trained Models



Inception-v3

ResNet-101

VGG-16

Inception-ResNet-  
v2

ResNet-18

GoogLeNet

DenseNet-201

VGG-19

SqueezeNet

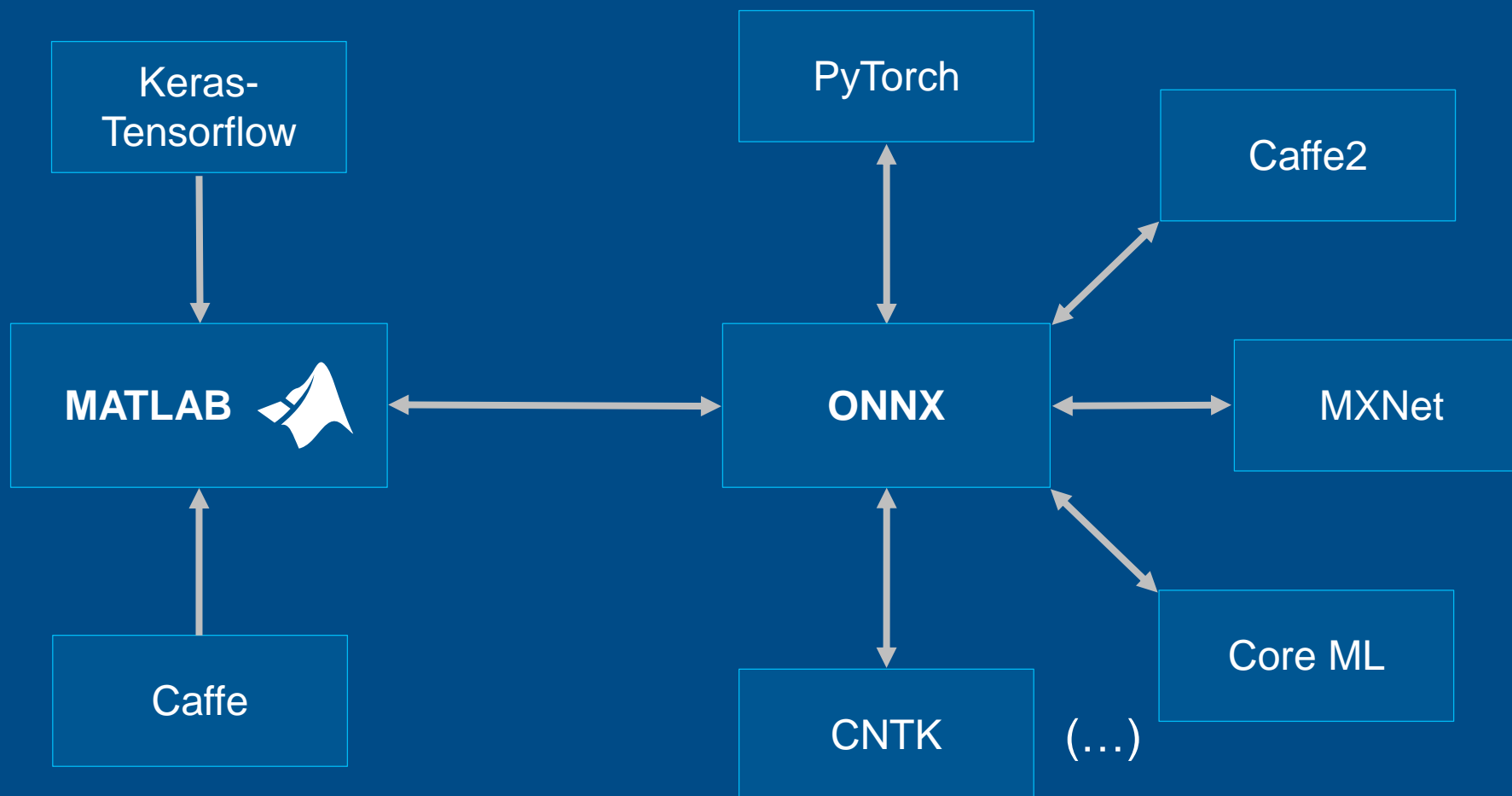
AlexNet

ResNet-50

Xception

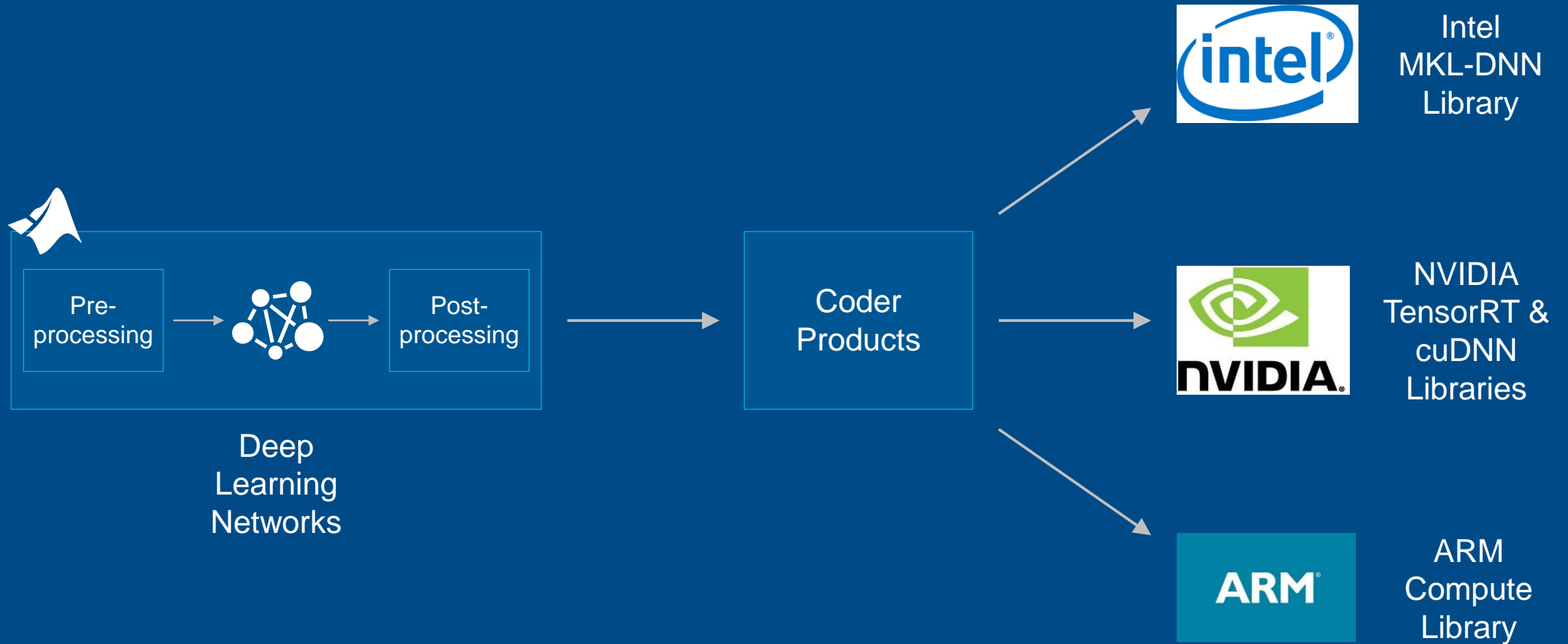
MobileNetV2

# Using Models from Other Frameworks

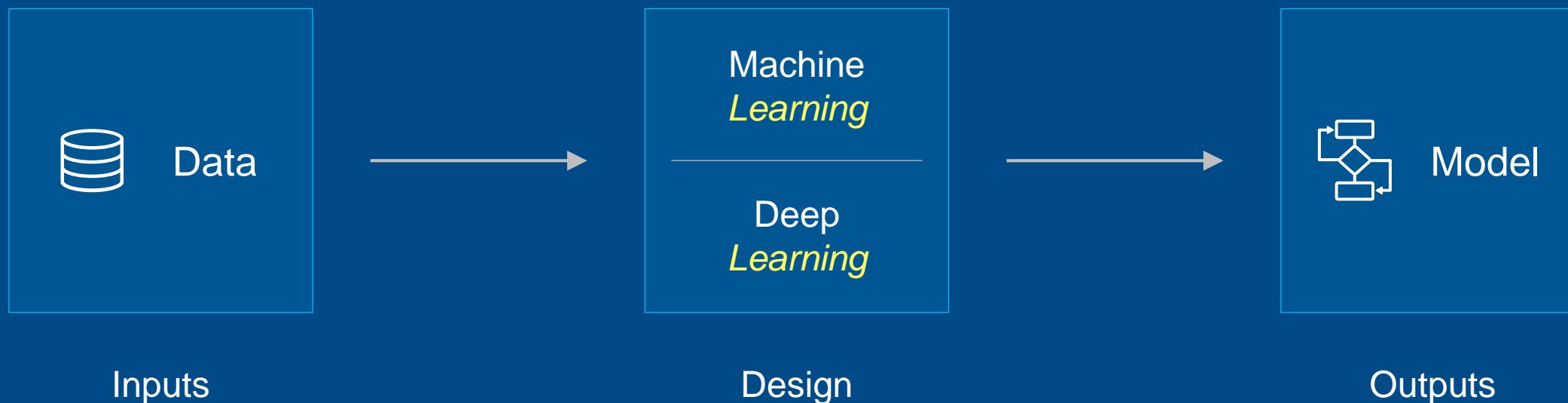




# Deploying Deep Learning Applications



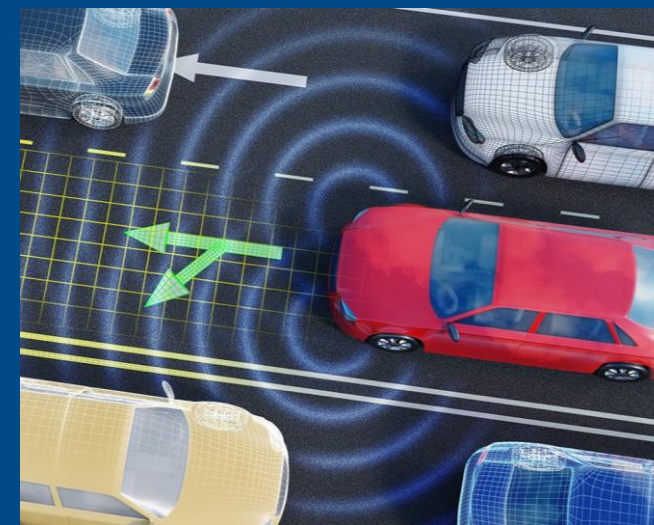
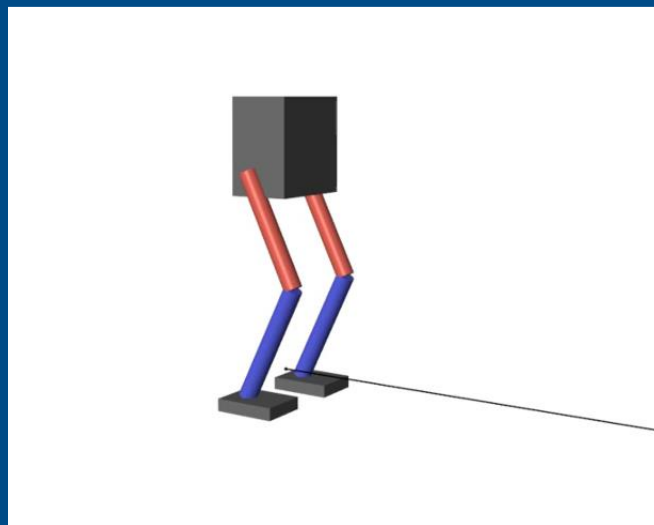
# Using MATLAB and Simulink for Reinforcement Learning



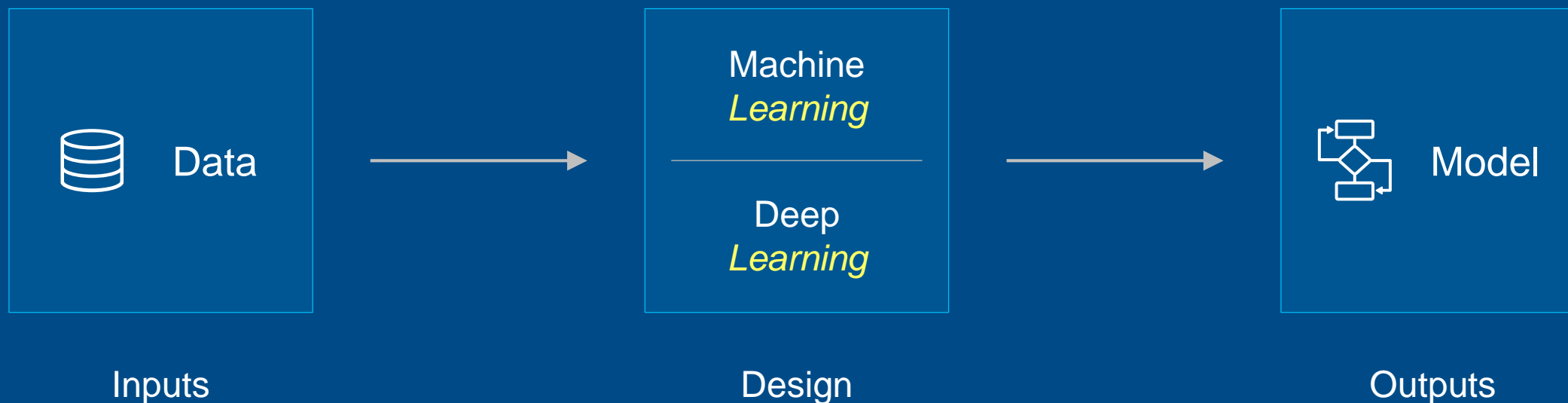
MATLAB® & SIMULINK®



# Using MATLAB and Simulink for Reinforcement Learning



# Using MATLAB and Simulink for Reinforcement Learning

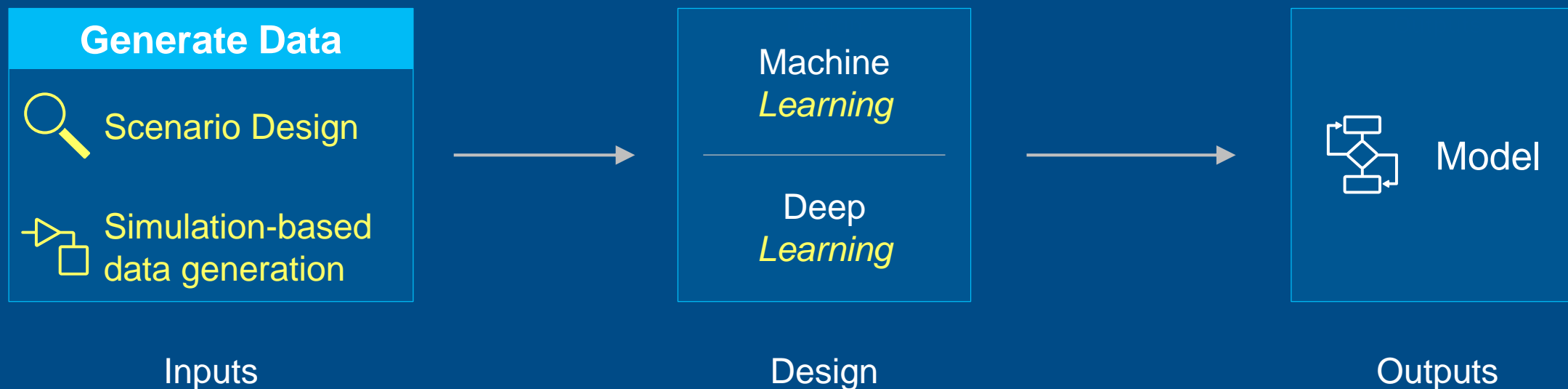


MATLAB® & SIMULINK®





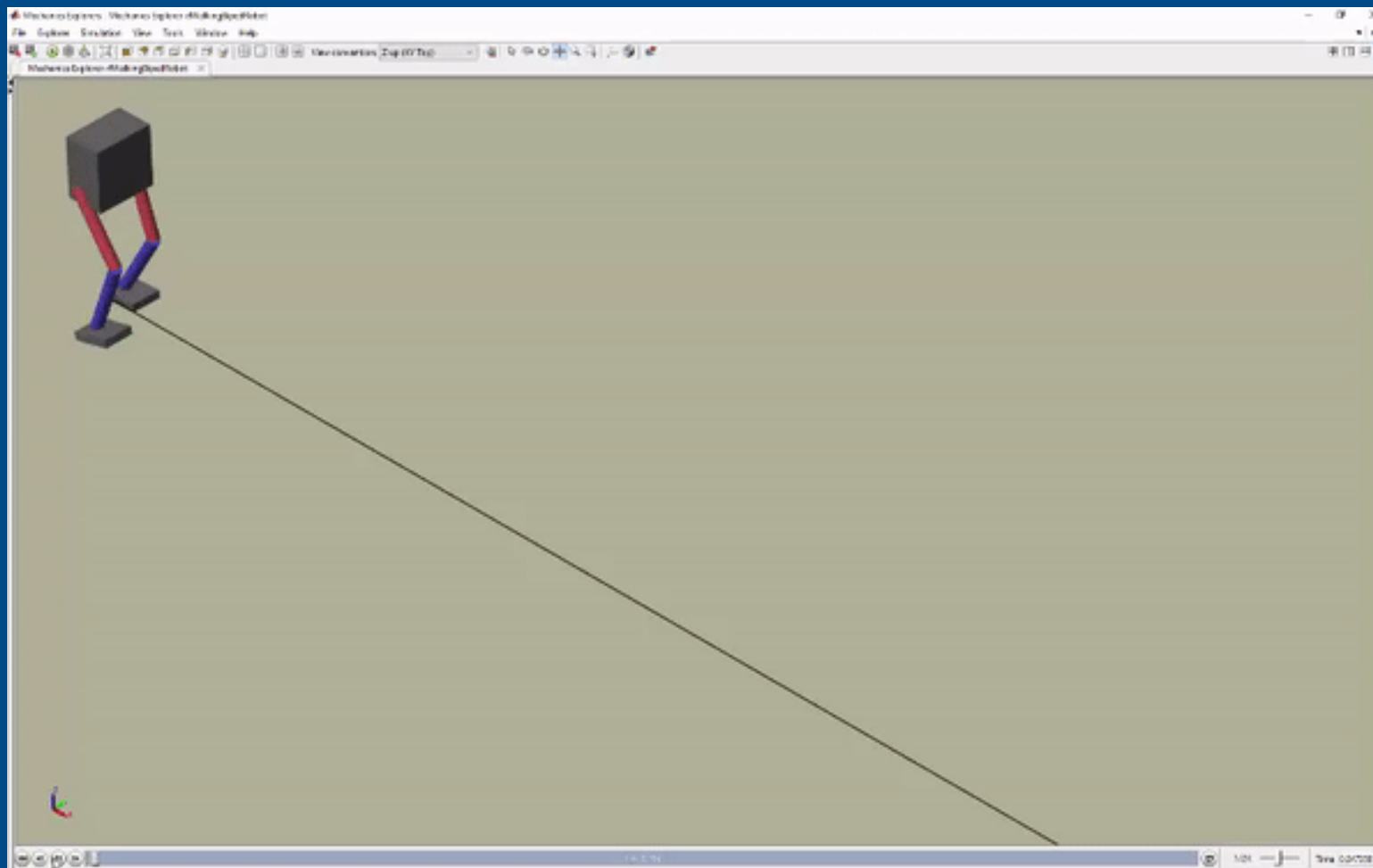
# Using MATLAB and Simulink for Reinforcement Learning



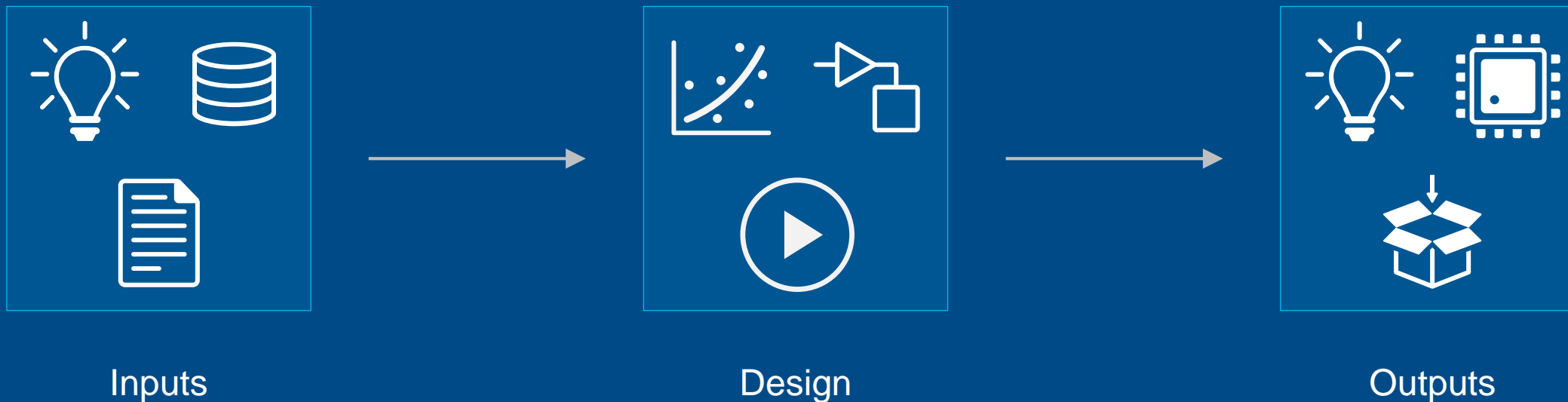
MATLAB® & SIMULINK®



# Using MATLAB and Simulink for Reinforcement Learning



# Using MATLAB & Simulink to Build Algorithms in Everything



MATLAB® & SIMULINK®



# Working with Text Data

Dept	JobDate	jobno	Vehicleid	UnitNo	Reason	Notes	CostParts	CostLabor	CostTotal
1020	01/06/2015	12:00:00	AM,14073	118743	14,04	DRIVER'S REPORT,"PM SERVICE, CHECK TURN SIGNAL, CLUNKING NOISE WHEN DRIVING",	493.85	0	493.85
1020	01/14/2015	12:00:00	AM,14232	230973	13,08	PM SERVICE ***,"SERVICEROB,EXT,5604",	38.869999999999997	0	38.869999999999997
2111	01/02/2015	12:00:00	AM,14006	1243	116,04	DRIVER'S REPORT,NEED 4 PLOW PINS,	45	0	45
2111	01/02/2015	12:00:00	AM,14140	B39109	,178,04	DRIVER'S REPORT,INSTALL SPINNER ASSY,	0	0	0
2111	01/03/2015	12:00:00	AM,14163	574950	215,13	SNOW BREAKDOWN,DONT START,	0	0	0
2111	01/05/2015	12:00:00	AM,14169	A00413	,283,04	DRIVER'S REPORT,DOG BONE PIN BROKEN,	20	0	20
2111	01/06/2015	12:00:00	AM,14000	766153	248,08	PM SERVICE ***,"NEED SERVICE, CHECK BRAKES",	387.17	0	387.17
2111	01/06/2015	12:00:00	AM,14155	525670	232,04	DRIVER'S REPORT,HYD CAP CHECK ENGINE LIGHT ON,	12.95	0	12.95
2111	01/06/2015	12:00:00	AM,14157	621909	213,40	NEGLIGENCE,TARP VALVE STICKINGRIGHT SIDE MIRROR BRACKET BROKEN,	50.02	0	50.02
2111	01/06/2015	12:00:00	AM,14164	1226	117,13	SNOW BREAKDOWN,HANDLES IN CAB LOOSE,	0	0	0
2111	01/06/2015	12:00:00	AM,14165	525999	114,04	DRIVER'S REPORT,NO PLOW LIGHTS,	0	0	0
2111	01/06/2015	12:00:00	AM,14172	B34632	,276,10	ROADCALL,WILL NOT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14174	1469	122,10	ROADCALL,WILL NOT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14175	68932	147,10	ROADCALL,WILL NOT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14176	68933	148,10	ROADCALL,WILL NOT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14177	621907	208,10	ROADCALL,WILL NOT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14181	337657	218,04	DRIVER'S REPORT,CONVEORY NOT WORKING,	0	0	0
2111	01/06/2015	12:00:00	AM,14182	D-1920	,164,10	ROADCALL,DONT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14183	525998	217,10	ROADCALL,DONT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14184	526000	225,10	ROADCALL,DONT START,	0	0	0
2111	01/06/2015	12:00:00	AM,14185	621921	214,04	DRIVER'S REPORT,CONVORY NOT WORKING,	0	0	0
2111	01/07/2015	12:00:00	AM,14188	001469	,201,04	DRIVER'S REPORT,needs def/jim f,	0	0	0
2111	01/07/2015	12:00:00	AM,14190	337656	219,04	DRIVER'S REPORT,NEEDS FLOOR MATTS,	65.069999999999993	0	65.069999999999993
2111	01/07/2015	12:00:00	AM,14191	B34632	,276,10	ROADCALL,DONT START,	0	0	0
2111	01/07/2015	12:00:00	AM,14196	1222	118,04	DRIVER'S REPORT,HARDWARE FOR REAR SPRINGS,	14.32	0	14.32
2111	01/07/2015	12:00:00	AM,14199	52565	626,04	DRIVER'S REPORT,WASHER FLUIDDEF,	28.88	0	28.88
2111	01/09/2015	12:00:00	AM,14107	1467	121,08	PM SERVICE ***,"REMOVE & REPLACE REAR SPRINGS, CHECK COOLANT TUBESPM SERVICE",	4697.55	0	4697.55



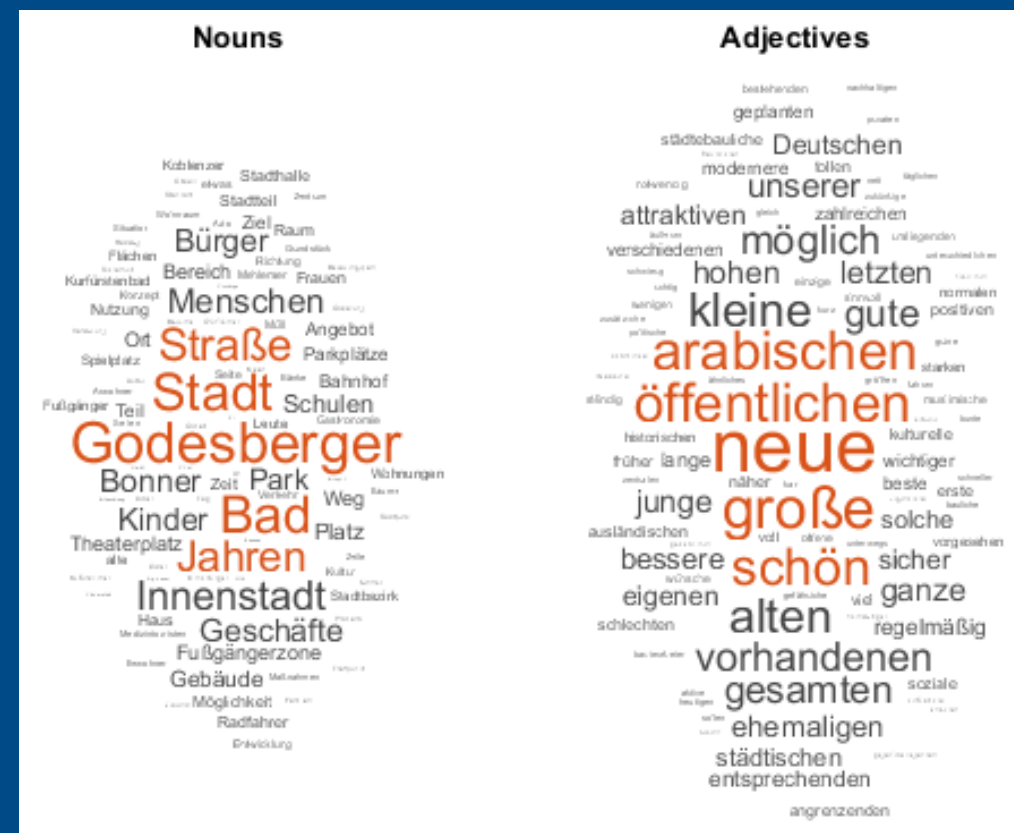
# Working with Text Data

```
t = readtable(filename, 'TextType', 'string');
disp(t(1:20,6:7))
```

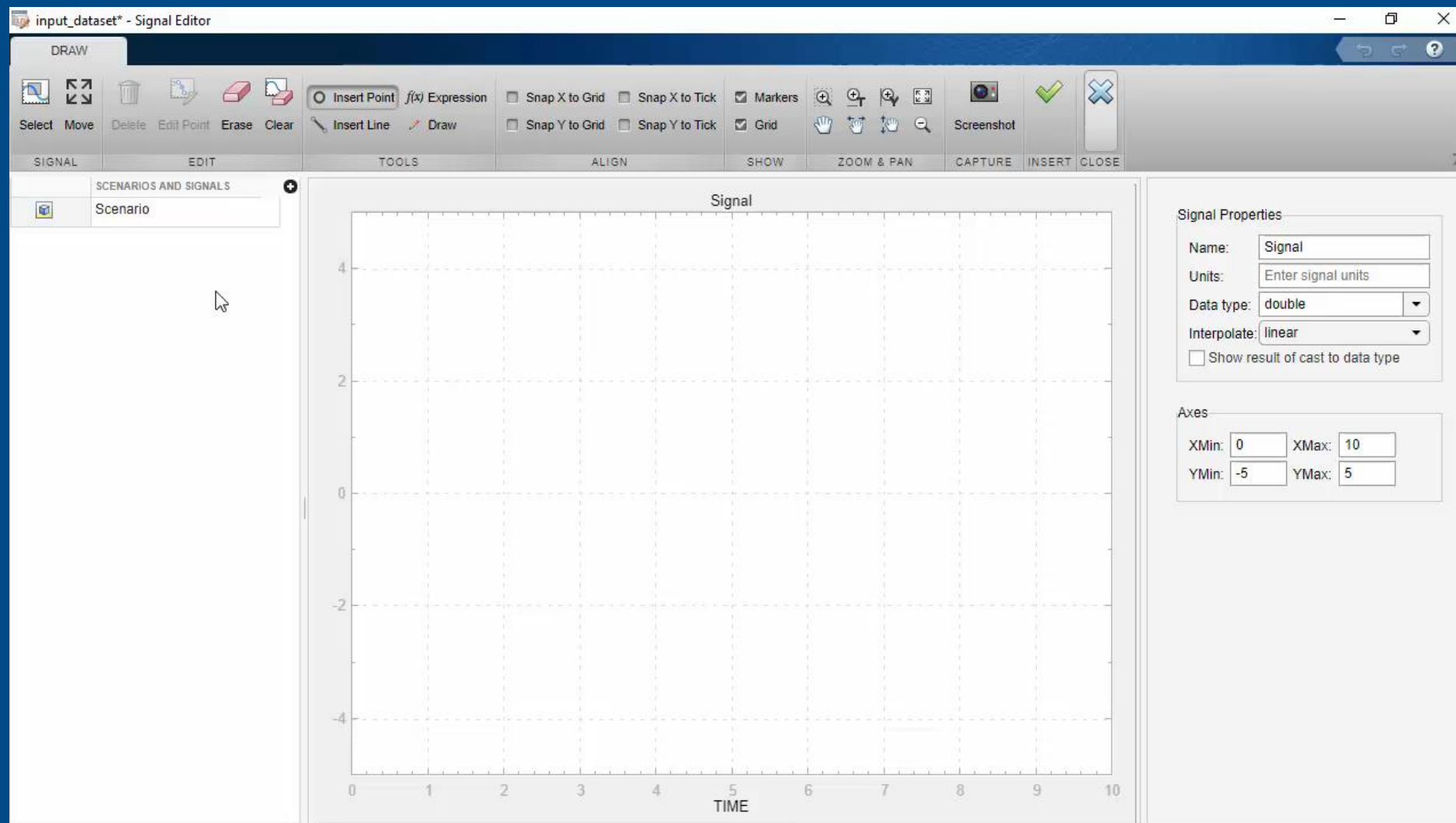
	Reason		Notes
"04	DRIVER'S REPORT"		"PM SERVICE, CHECK TURN SIGNAL, CLUNKING NOISE WHEN DRIVING"
"08	PM SERVICE	***"	"SERVICEROB,EXT,5604"
"04	DRIVER'S REPORT"		"NEED 4 PLOW PINS"
"04	DRIVER'S REPORT"		"INSTALL SPINNER ASSY"
"13	SNOW BREAKDOWN"		"DONT START"
"04	DRIVER'S REPORT"		"DOG BONE PIN BROKEN"
"08	PM SERVICE	***"	"NEED SERVICE, CHECK BRAKES"
"04	DRIVER'S REPORT"		"HYD CAP CHECK ENGINE LIGHT ON"
"40	NEGLIGENCE"		"TARP VALVE STICKINGRIGHT SIDE MIRROR BRACKET BROKEN"
"13	SNOW BREAKDOWN"		"HANDLES IN CAB LOOSE"
"04	DRIVER'S REPORT"		"NO PLOW LIGHTS"
"10	ROADCALL "		"WILL NOT START"
"10	ROADCALL "		"WILL NOT START"
"10	ROADCALL "		"WILL NOT START"
"10	ROADCALL "		"WILL NOT START"
"10	ROADCALL "		"WILL NOT START"
"04	DRIVER'S REPORT"		"CONVEORY NOT WORKING"
"10	ROADCALL "		"DONT START"
"10	ROADCALL "		"DONT START"
"10	ROADCALL "		"DONT START"

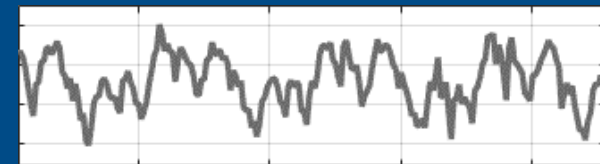
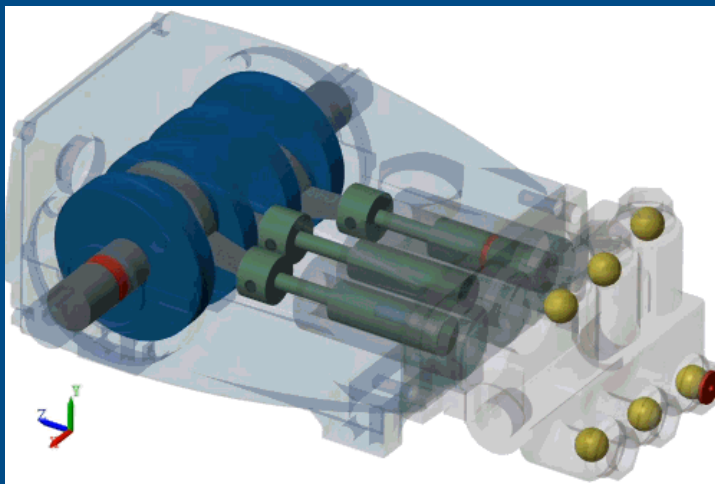
Deep Learning Toolbox  
Statistics and Machine Learning Toolbox  
Text Analytics Toolbox  
MATLAB





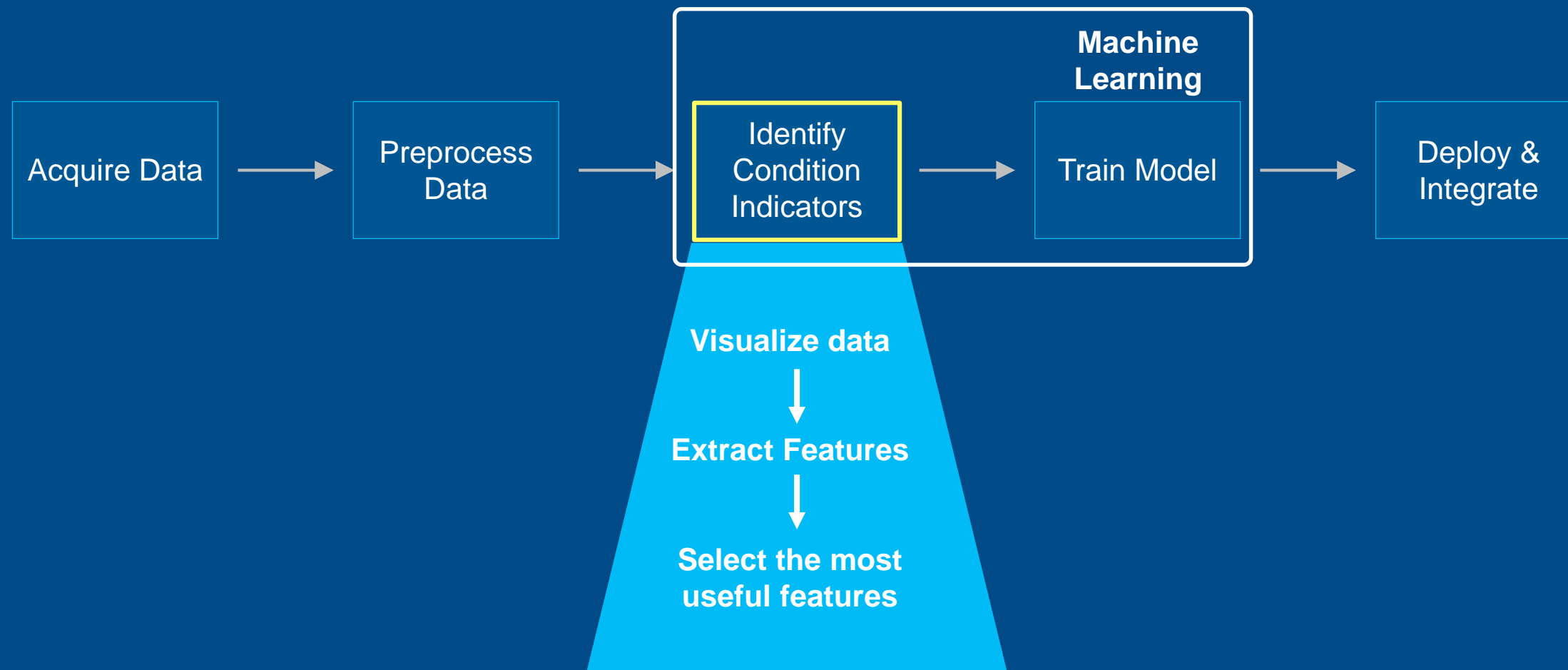
# Creating Your Own Data



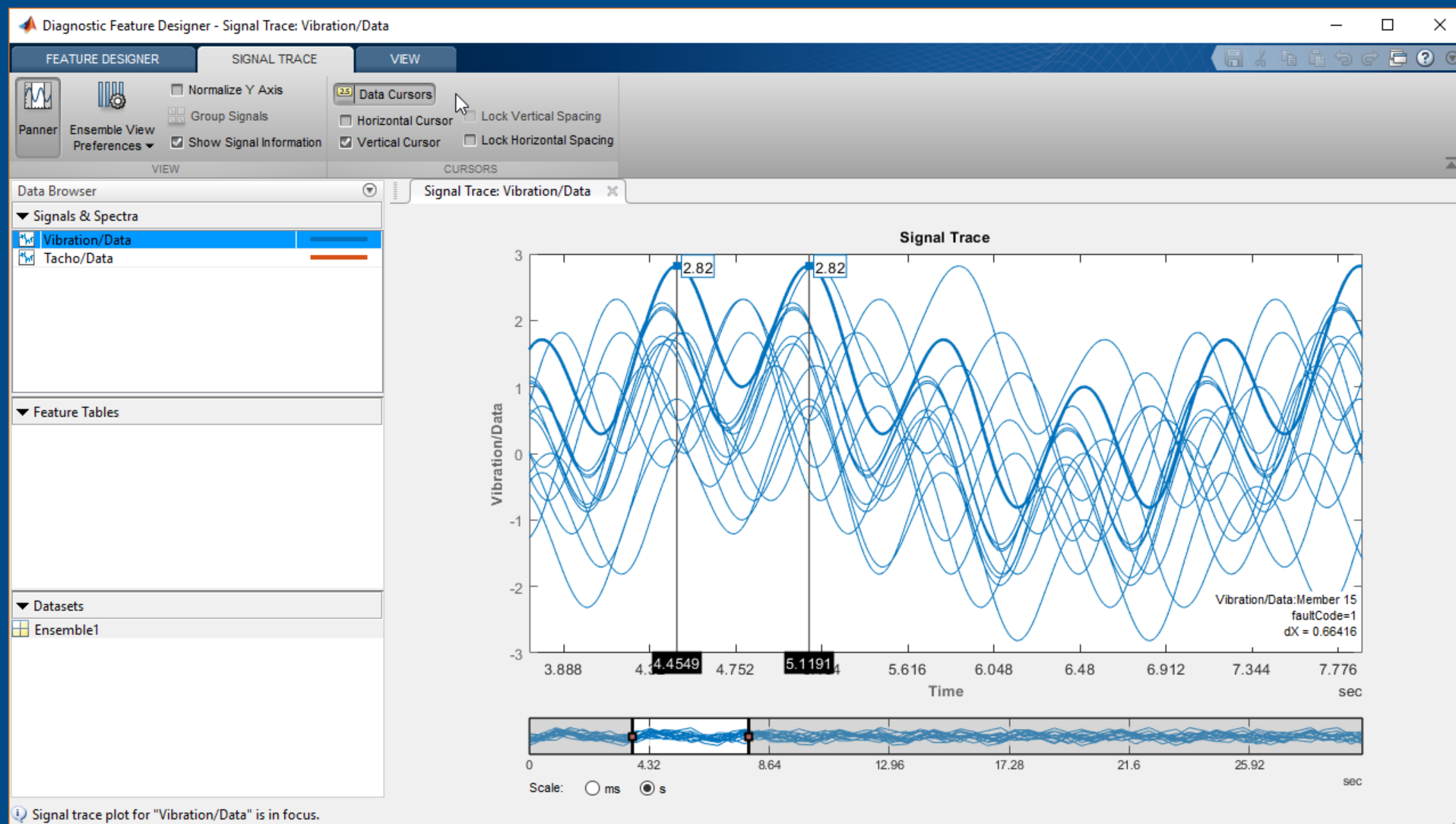




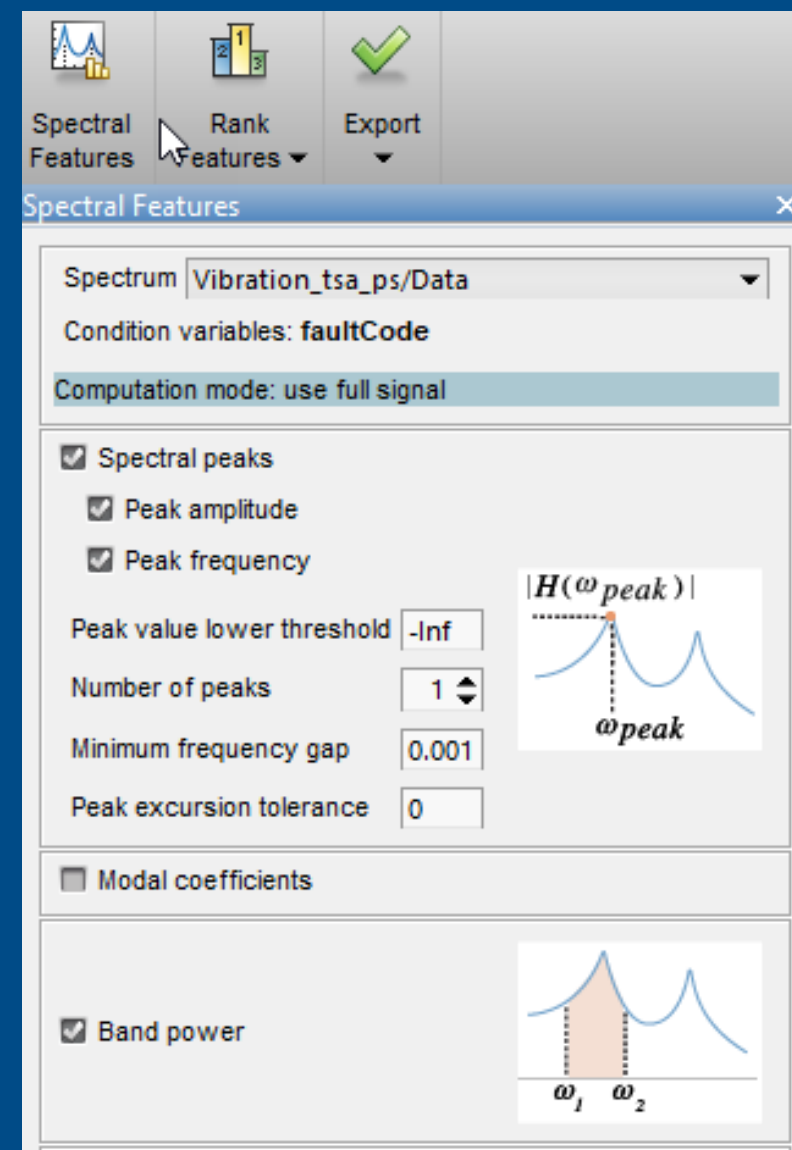
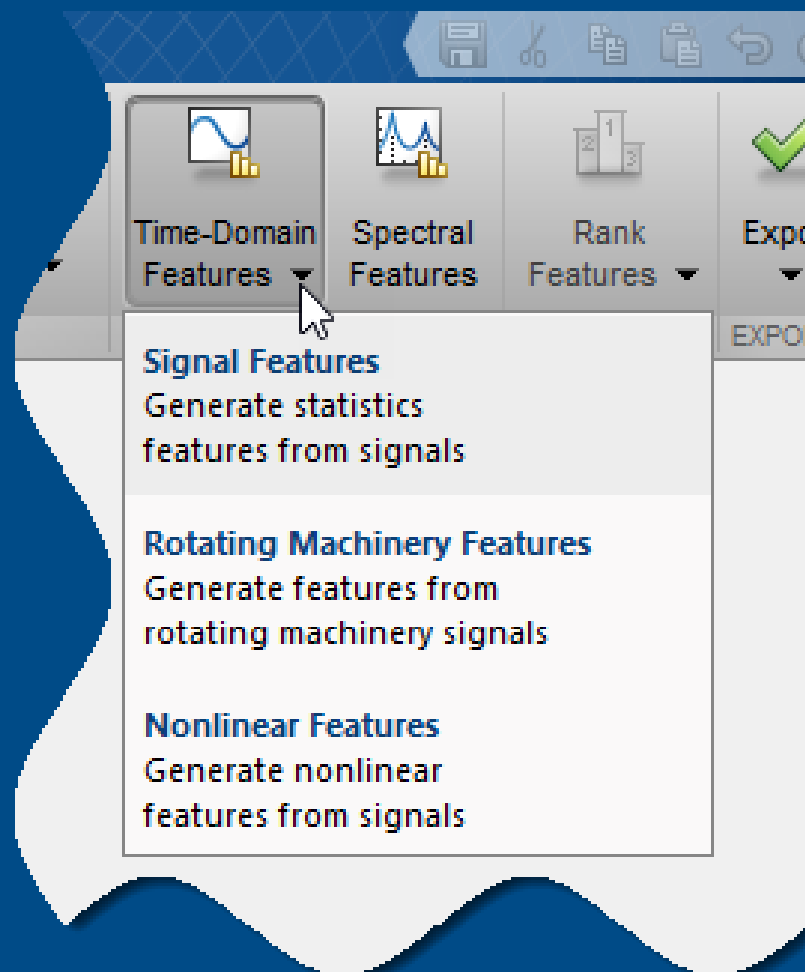
# Identifying the Useful Data



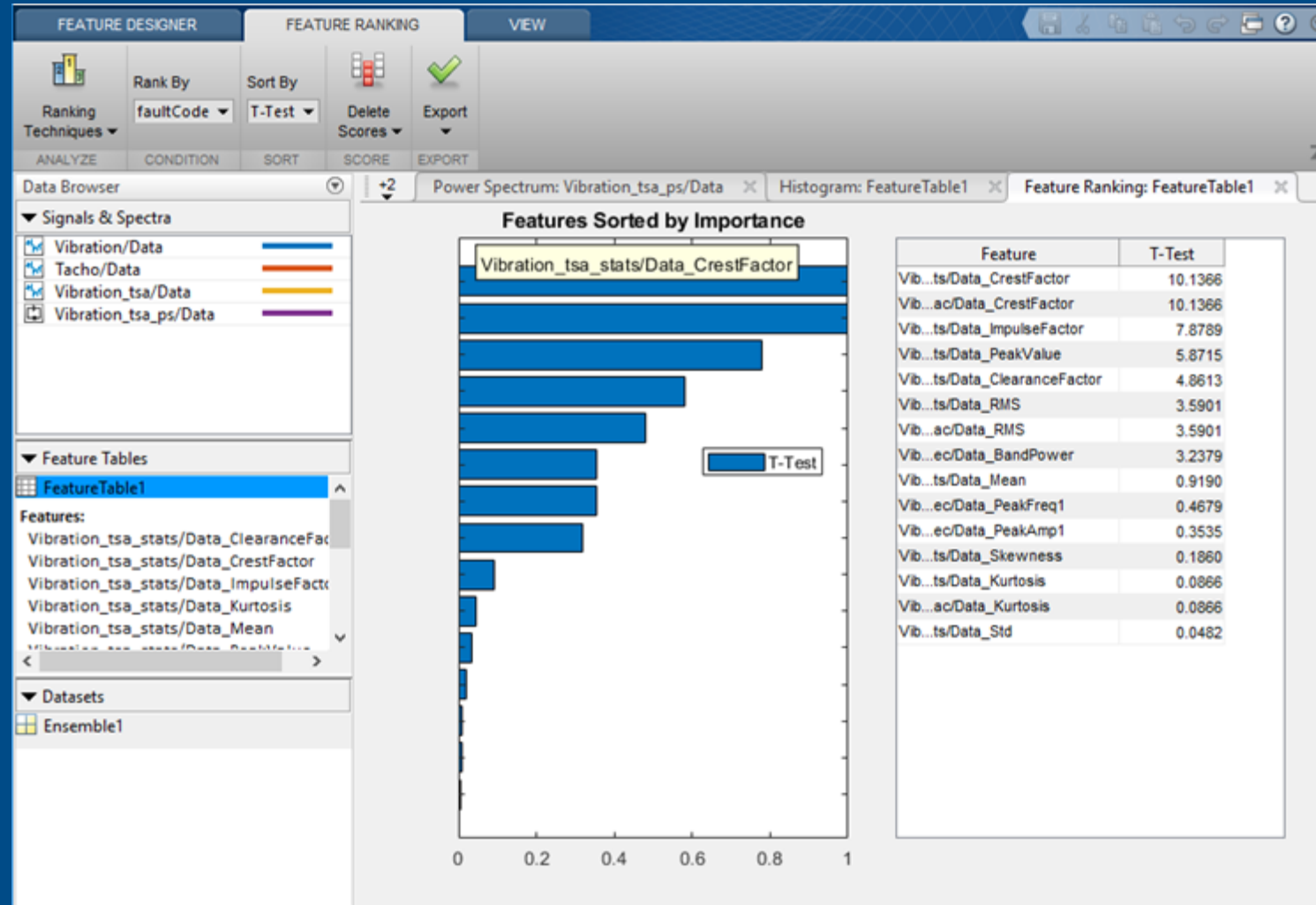
# Identifying the Useful Data



# Identifying the Useful Data



# Identifying the Useful Data

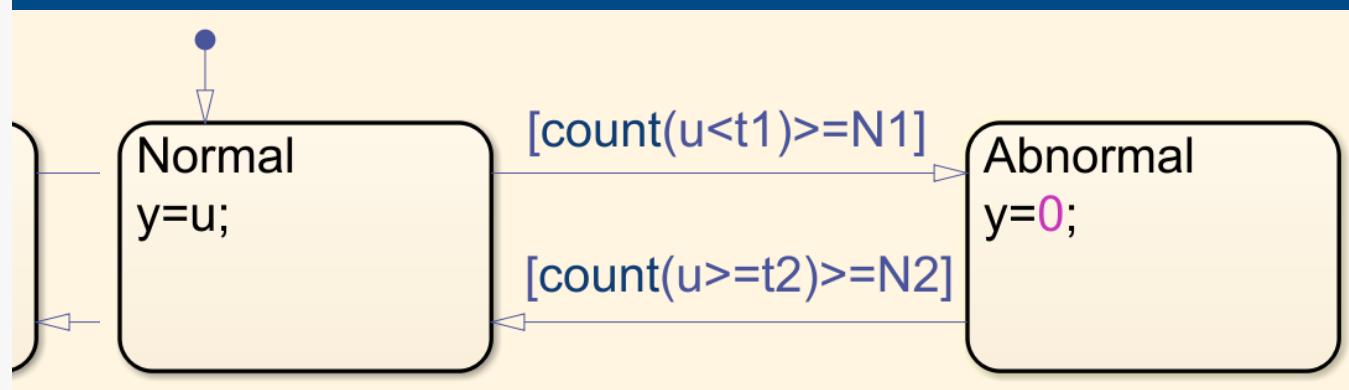


# Designing Decision Logic with Stateflow

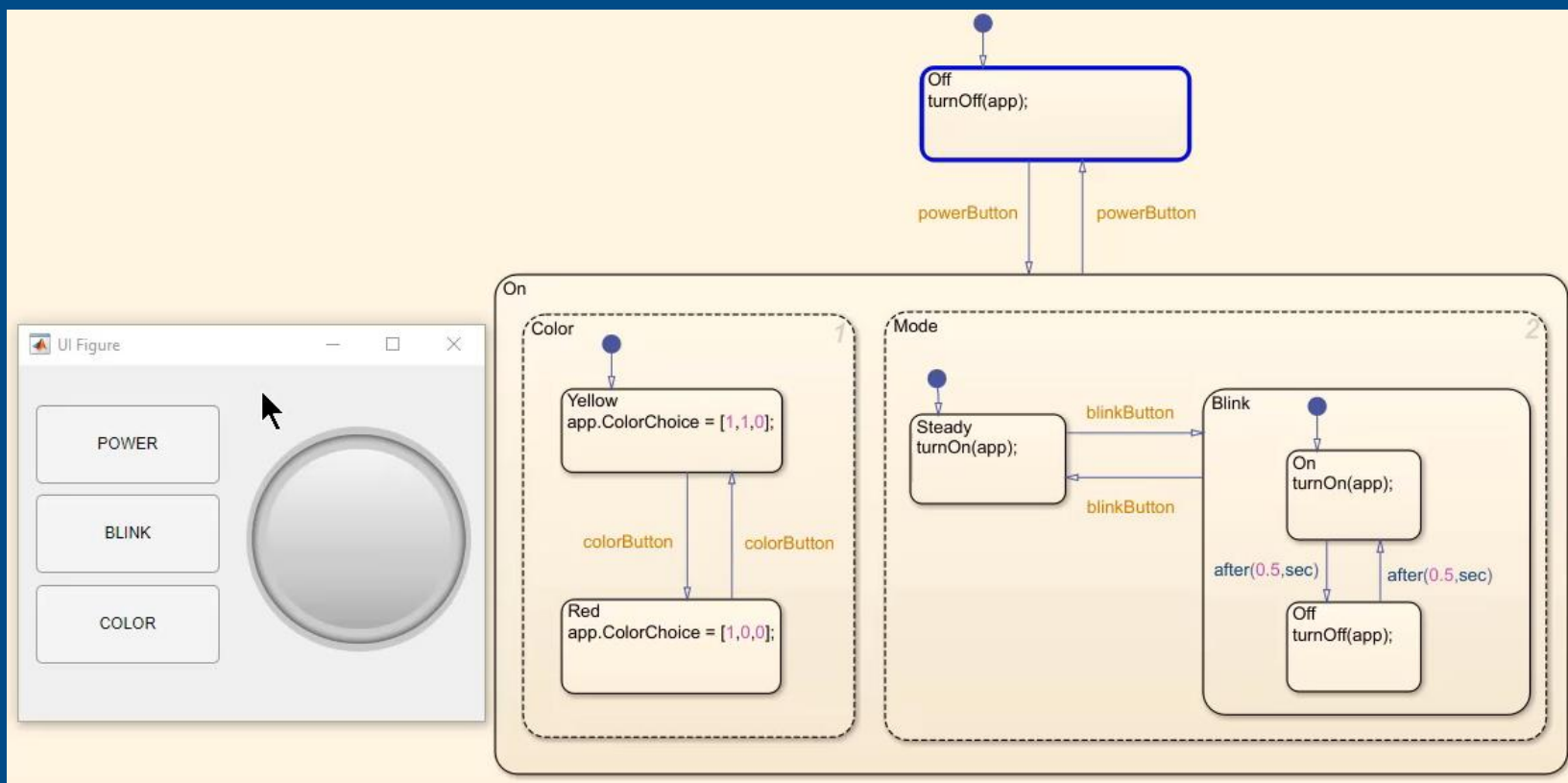
```

inNormalRegion = true;
counter = 0;
for i=1:length(inData)
    if(inNormalRegion)
        if(inData(i)<t1)
            counter = counter+1;
            if(counter>=N1)
                inNormalRegion = false;
            end
        else
            counter = 0;
        end
    else
        if(inData(i)>=t2)
            counter = counter+1;
            if(counter>=N2)
                inNormalRegion = true;
            end
        else
            counter = 0;
        end
    end
    if(inNormalRegion)
        outData(i) = inData(i);
    else
        outData(i) = 0;
    end
end

```



# Using Stateflow in MATLAB



```
% Callbacks that handle component events
methods (Access = private)

% Code that executes after component creation
function startupFcn(app)
    app.LanternLogic = BlinkLanternLogic('app',app);
end

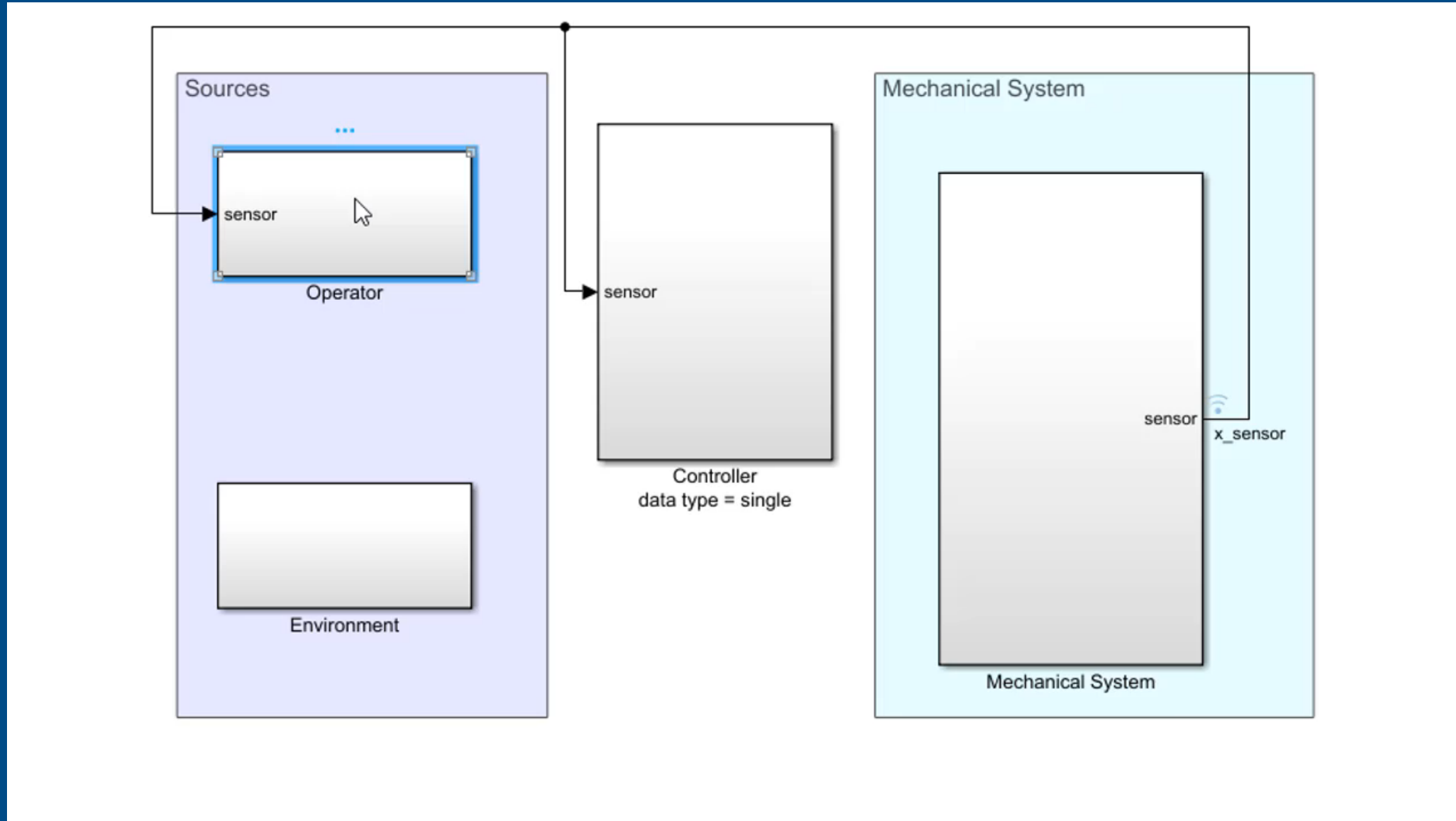
% Button pushed function: POWERButton
function POWERButtonPushed(app, event)
    app.LanternLogic.powerButton();
end

% Button pushed function: COLORButton
function COLORButtonPushed(app, event)
    app.LanternLogic.colorButton();
end

% Close request function: UIFigure
function UIFigureCloseRequest(app, event)
    delete(app.LanternLogic);
    delete(app);
end

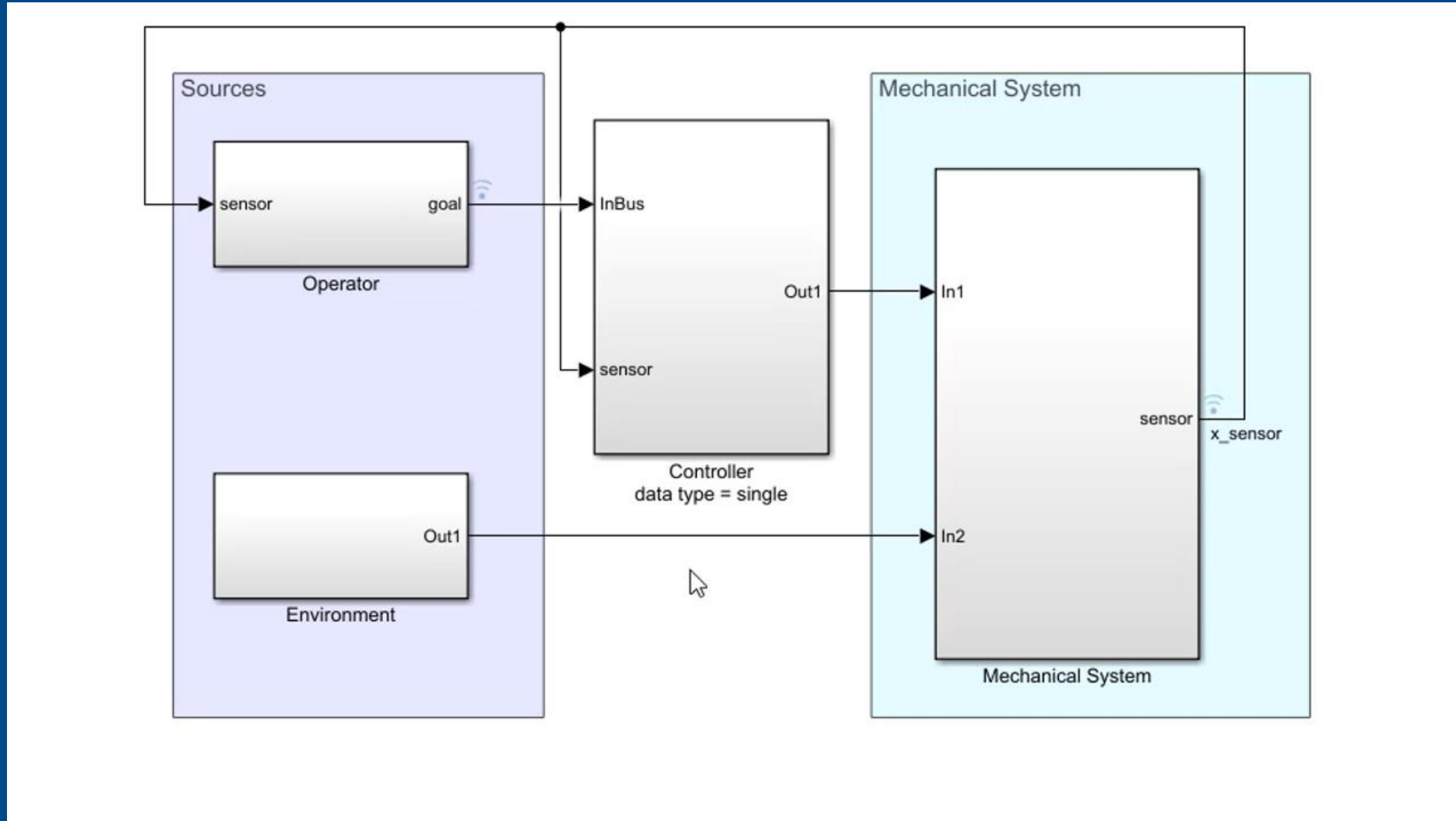
% Button pushed function: BLINKButton
function BLINKButtonPushed(app, event)
    app.LanternLogic.blinkButton();
end
end
```

# Editing at the Speed of Thought

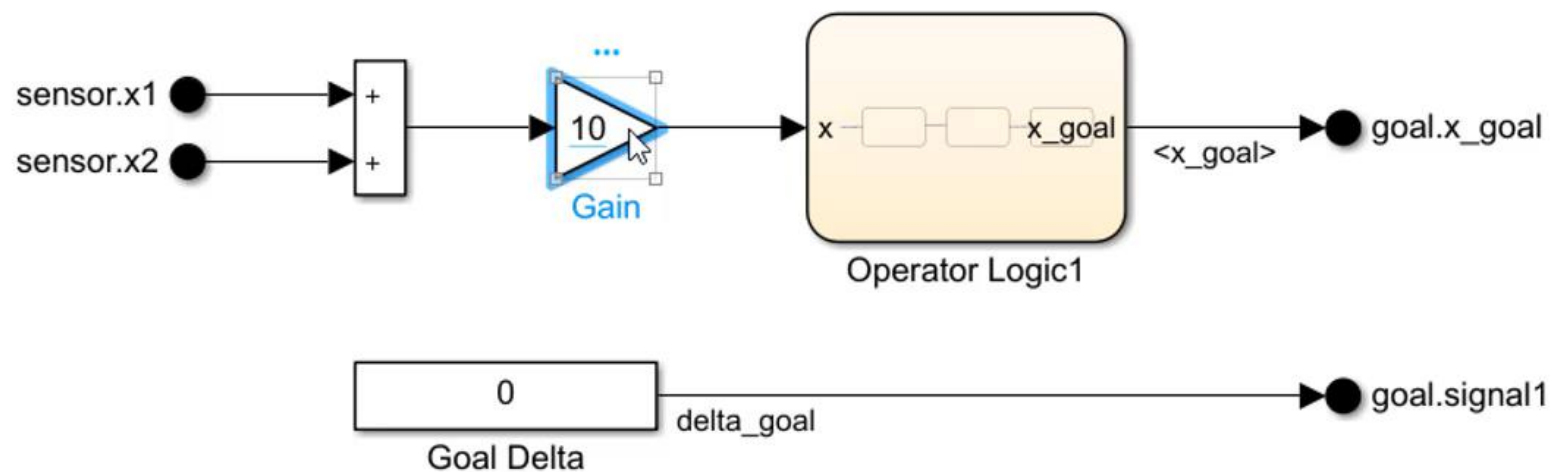




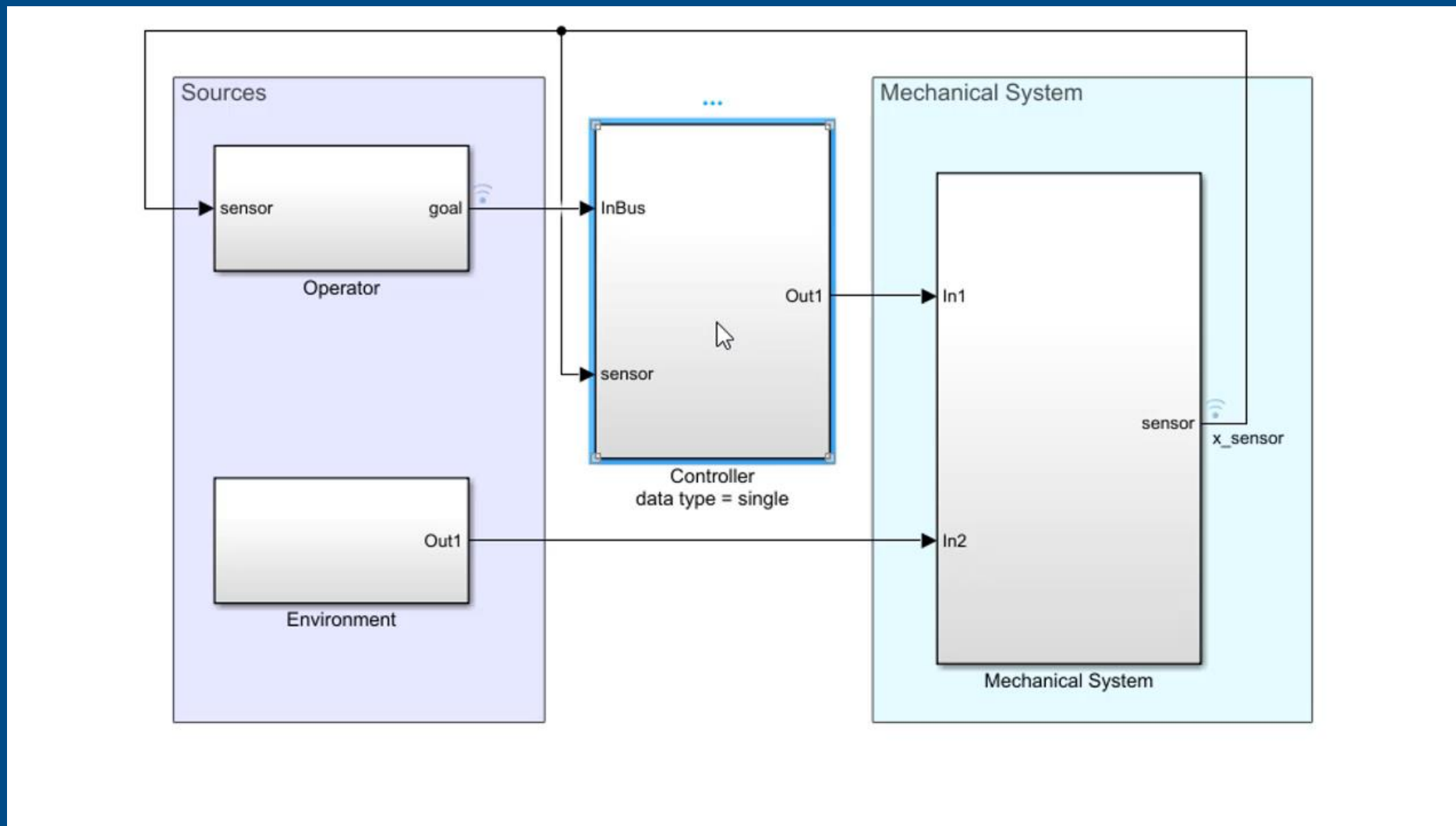
# Editing at the Speed of Thought



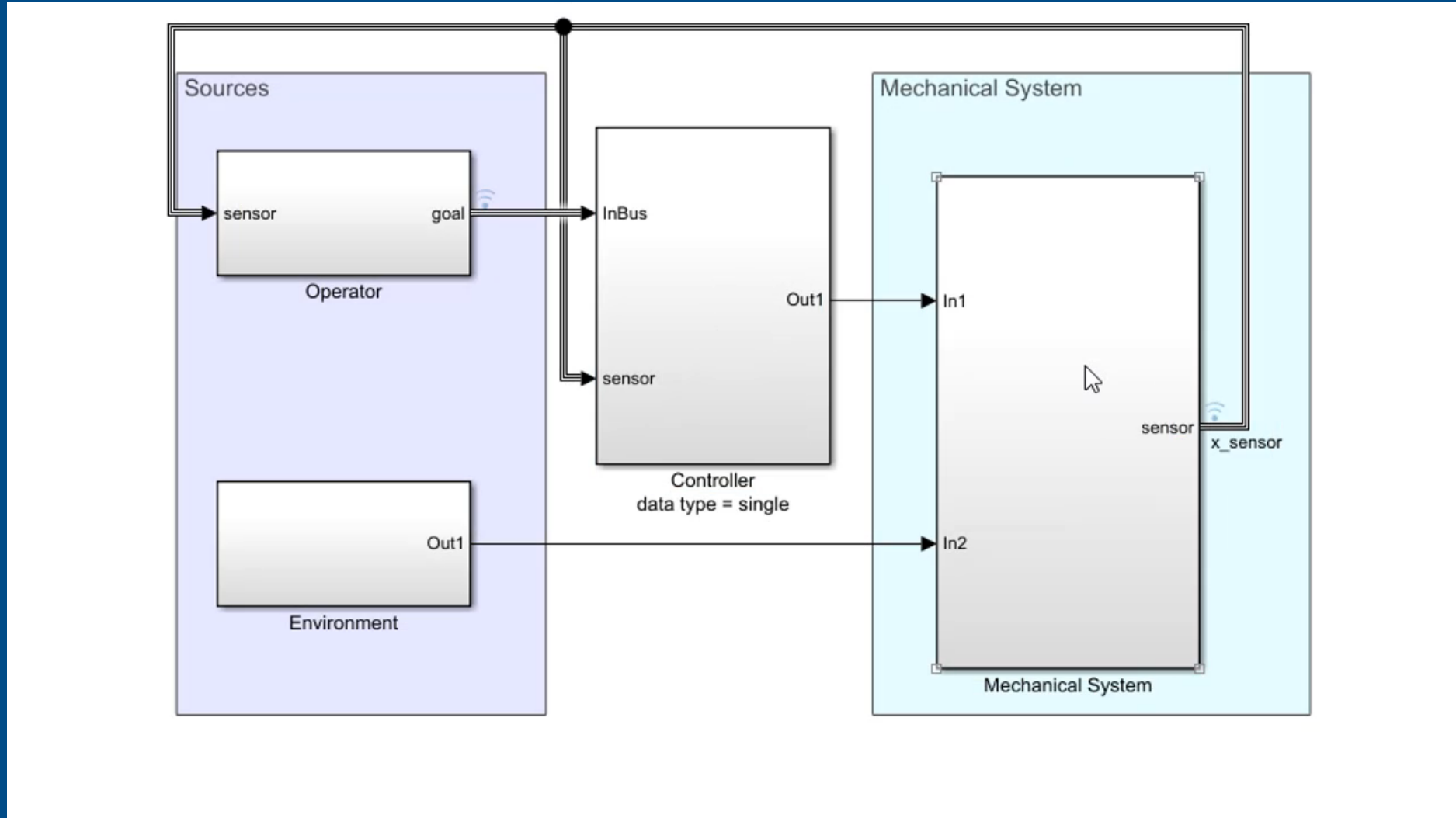
# Editing at the Speed of Thought



# Editing at the Speed of Thought

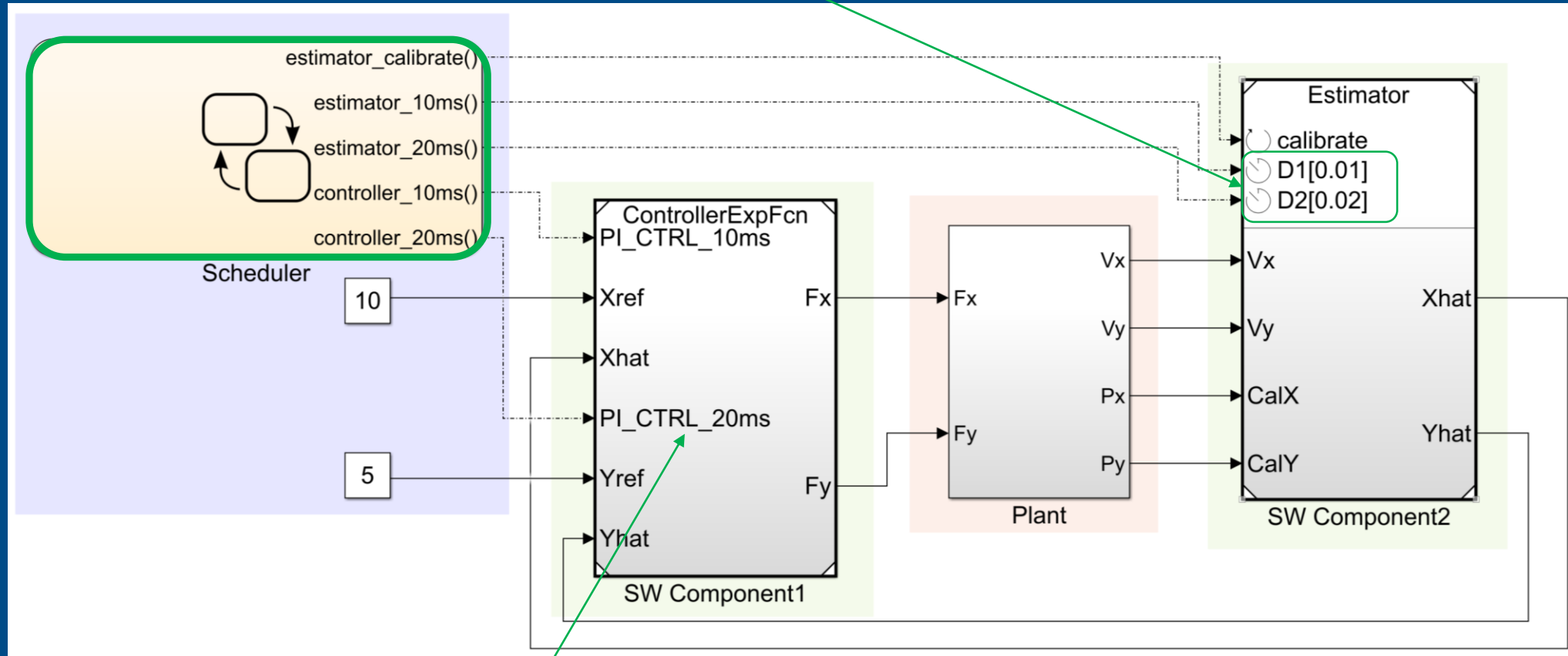


# Editing at the Speed of Thought



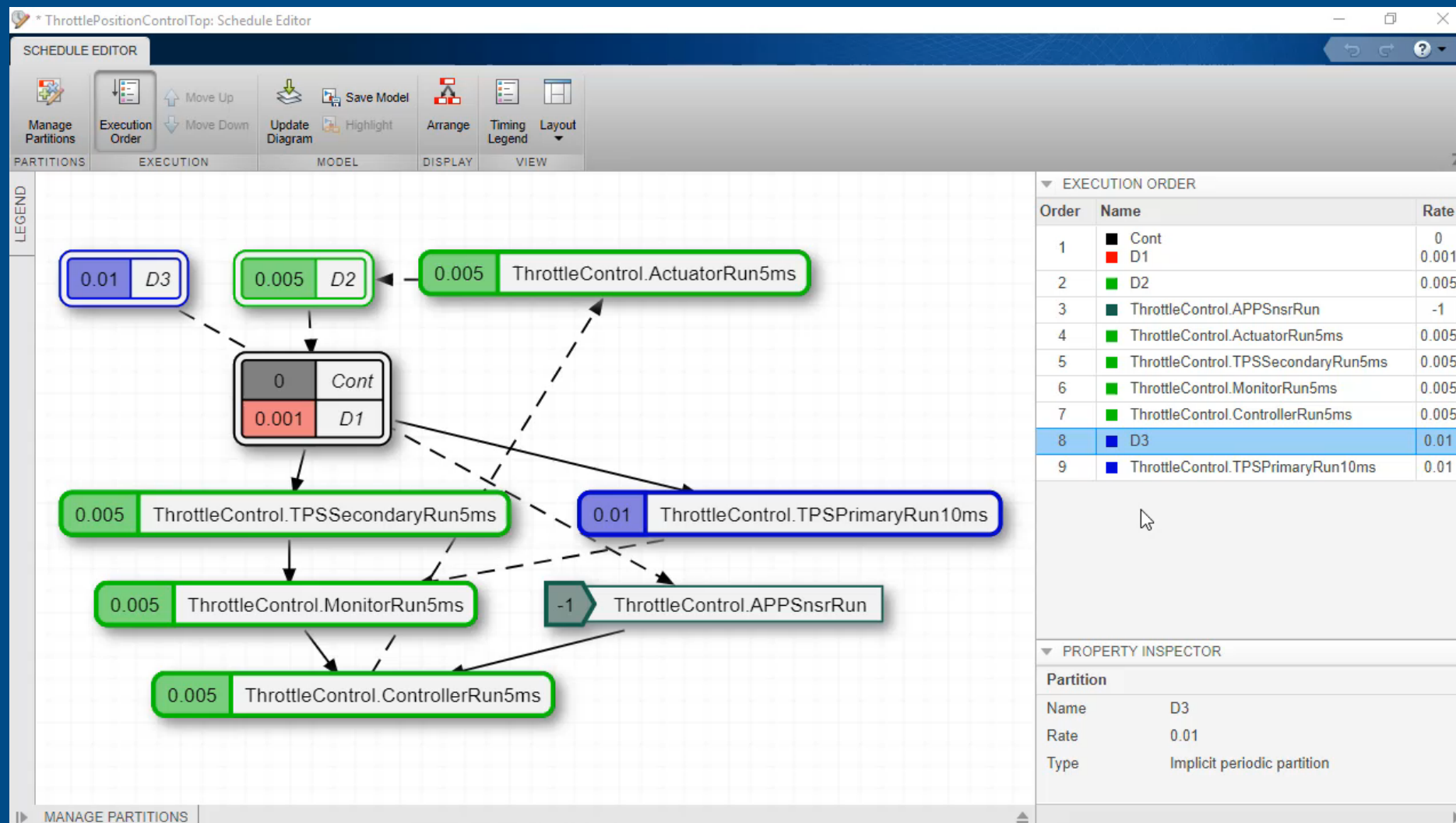
# Controlling the Execution of Model Components

## Schedulable Rate-Based Model

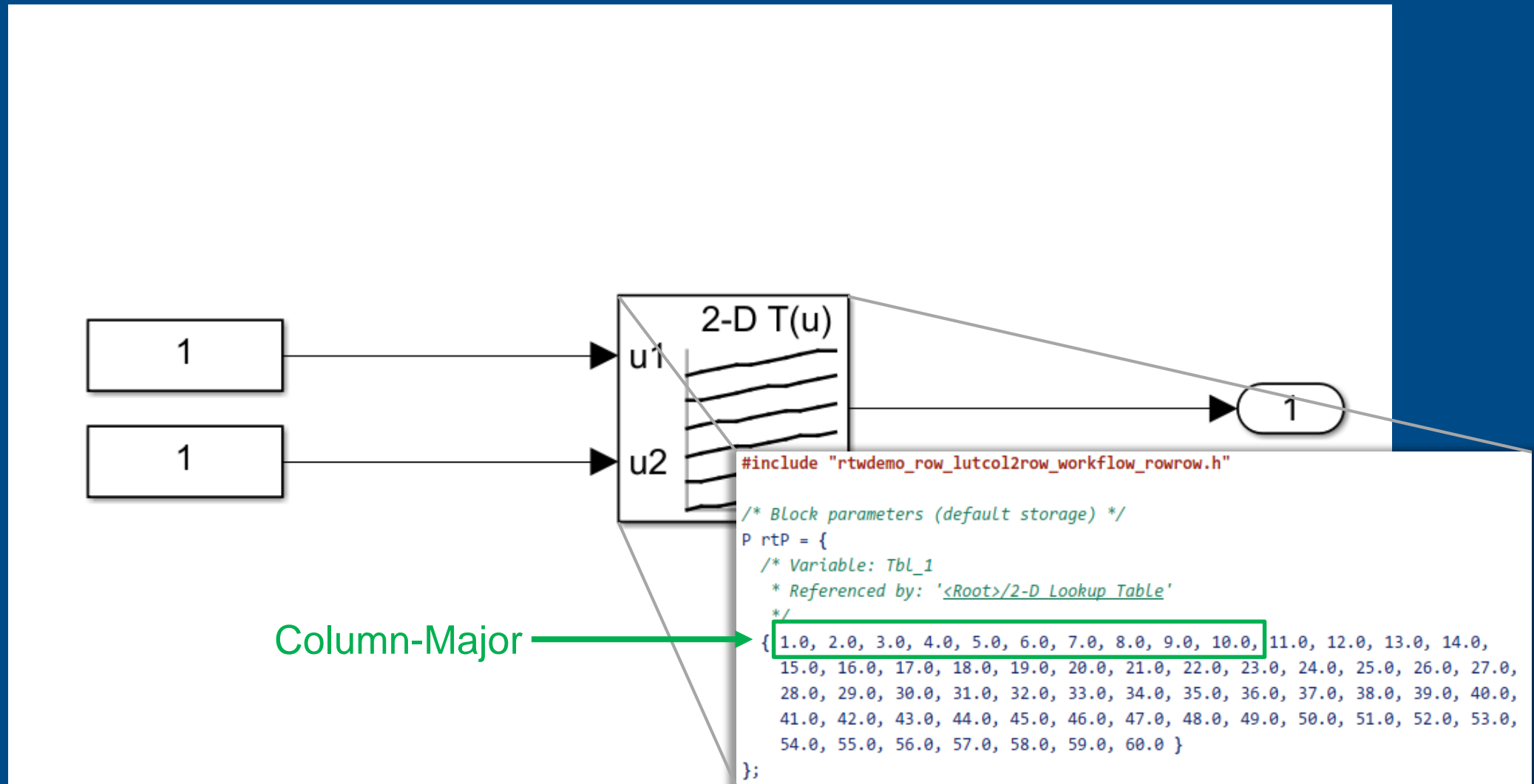


## Export Function Model

# Controlling the Execution of Model Components

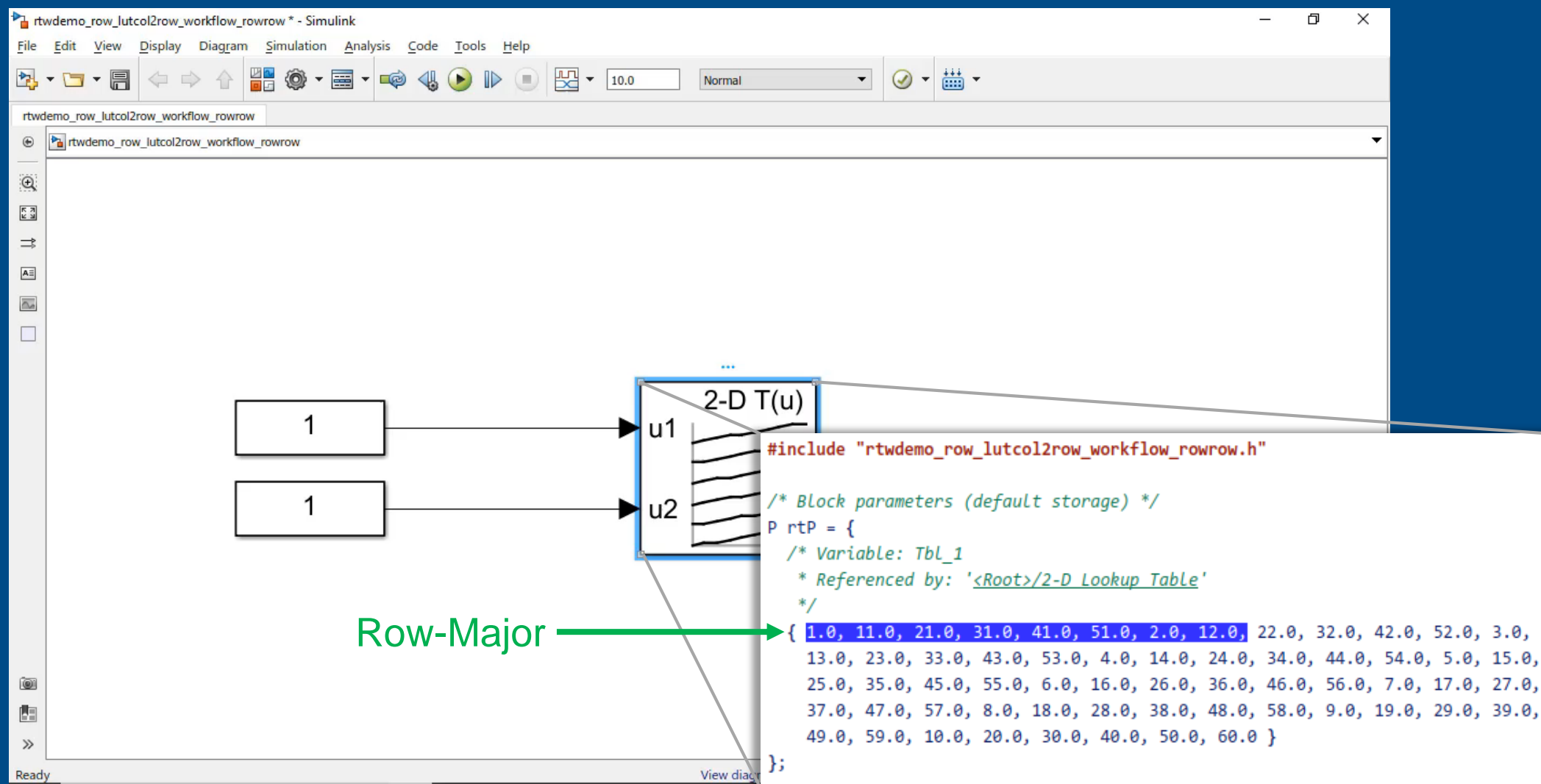


# Simplifying Integration with External C/C++ Code

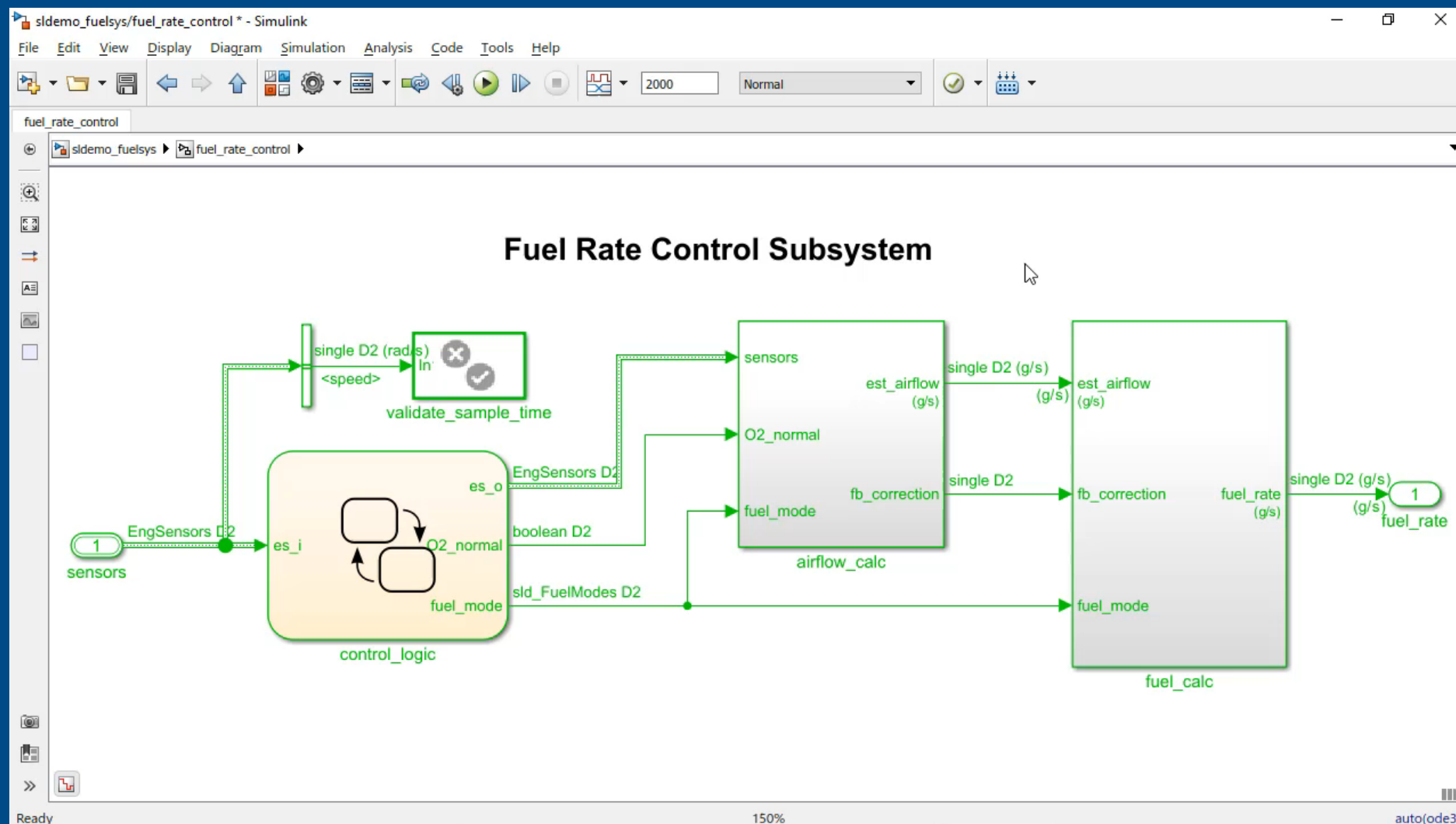




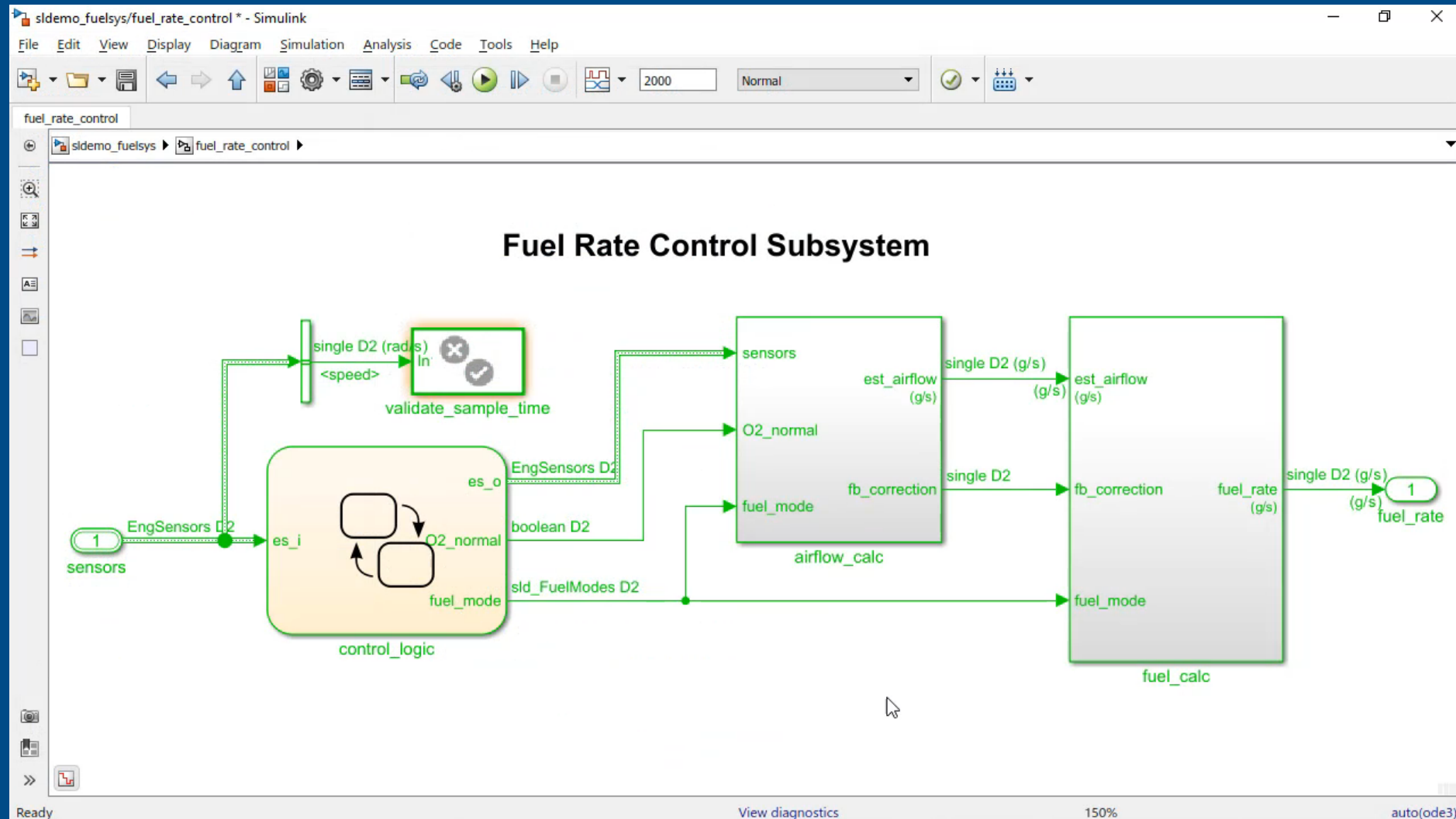
# Simplifying Integration with External C/C++ Code



# Viewing Generated Code Alongside the Model



# Viewing Generated Code Alongside the Model



# Sharing Live Scripts

Live Editor - C:\MATLAB\SunriseSunset\_final.mlx \*

FILE NAVIGATE TEXT CODE SECTION RUN

Find Files Find Compare Go To Find

New Open Save Print

Text Normal B I U M

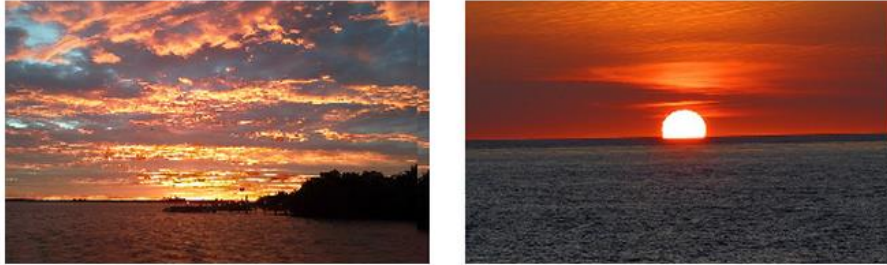
Code Control Refactor

Run Section Run and Advance Run to End

Run Step Stop

SunriseSunset\_final.mlx \*

## Estimating Sunrise and Sunset



Using the latitude ( $\phi$ ), the sun's declination ( $\delta$ ) and the solar time correction ( $SC$ ) we can calculate sunrise and sunset times.

$$\text{sunrise} = 12 - \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$$
$$\text{sunset} = 12 + \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ}$$

Refer to [this page](#) for background and details on the equations used.

script

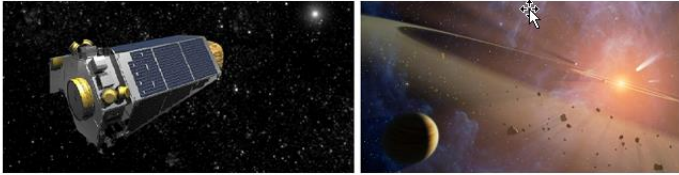
# Sharing Live Scripts

AutoSave ExploringExoplanets.docx - Compatibility Mode David Garrison

File Home Insert Design Layout References Mailings Review View Help Tell me what you want to do Share

Clipboard Font Paragraph Styles Editing

## Exploring Exoplanets



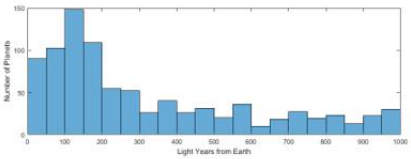
In this example we will explore some data on exoplanets - planets outside our own solar system. The data used here is a subset of data from the [NASA Exoplanet Archive](#). We will start by using the data to answer some questions about the set of exoplanets in the archive. Then we will do some calculations to try to identify planets in the archive that might be capable of supporting life.

```
exoplanets = readtable("exoplanets.xlsx");  
exoplanets(1:10,:);
```

### How Far Away Are these Planets?

There are 90 exoplanets within 50 light-years of earth and 450 exoplanets within 200 light-years.

```
histogram(3.26*exoplanets.st_distance,'BinWidth', 50)  
xlim([0 1000])  
ylabel 'Number of Planets'  
xlabel 'Light Years from Earth'
```

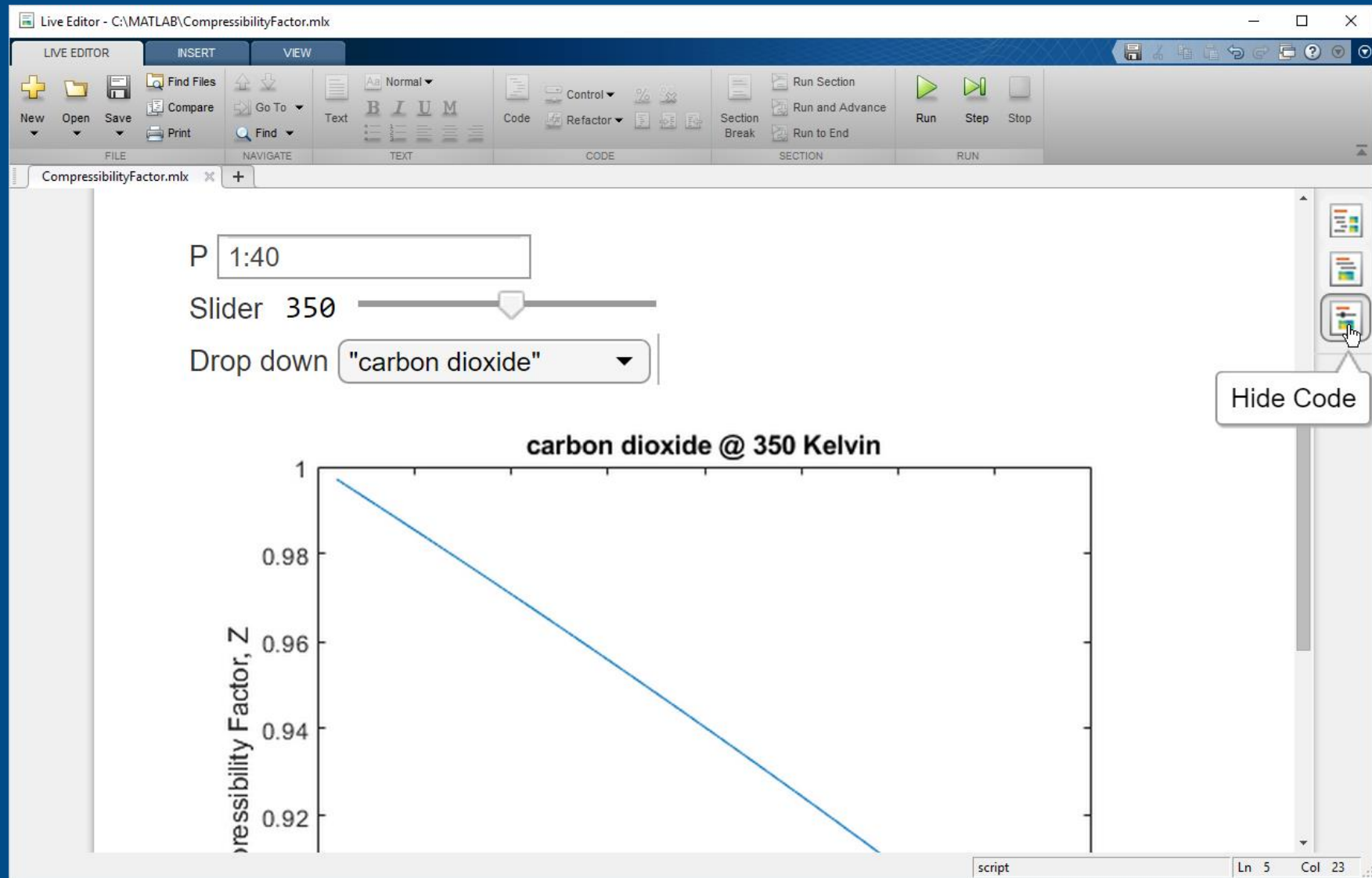


### Where is the nearest exoplanet?

```
idx = find(exoplanets.st_distance == min(exoplanets.st_distance));  
name = char(exoplanets{idx,'st_name'});
```

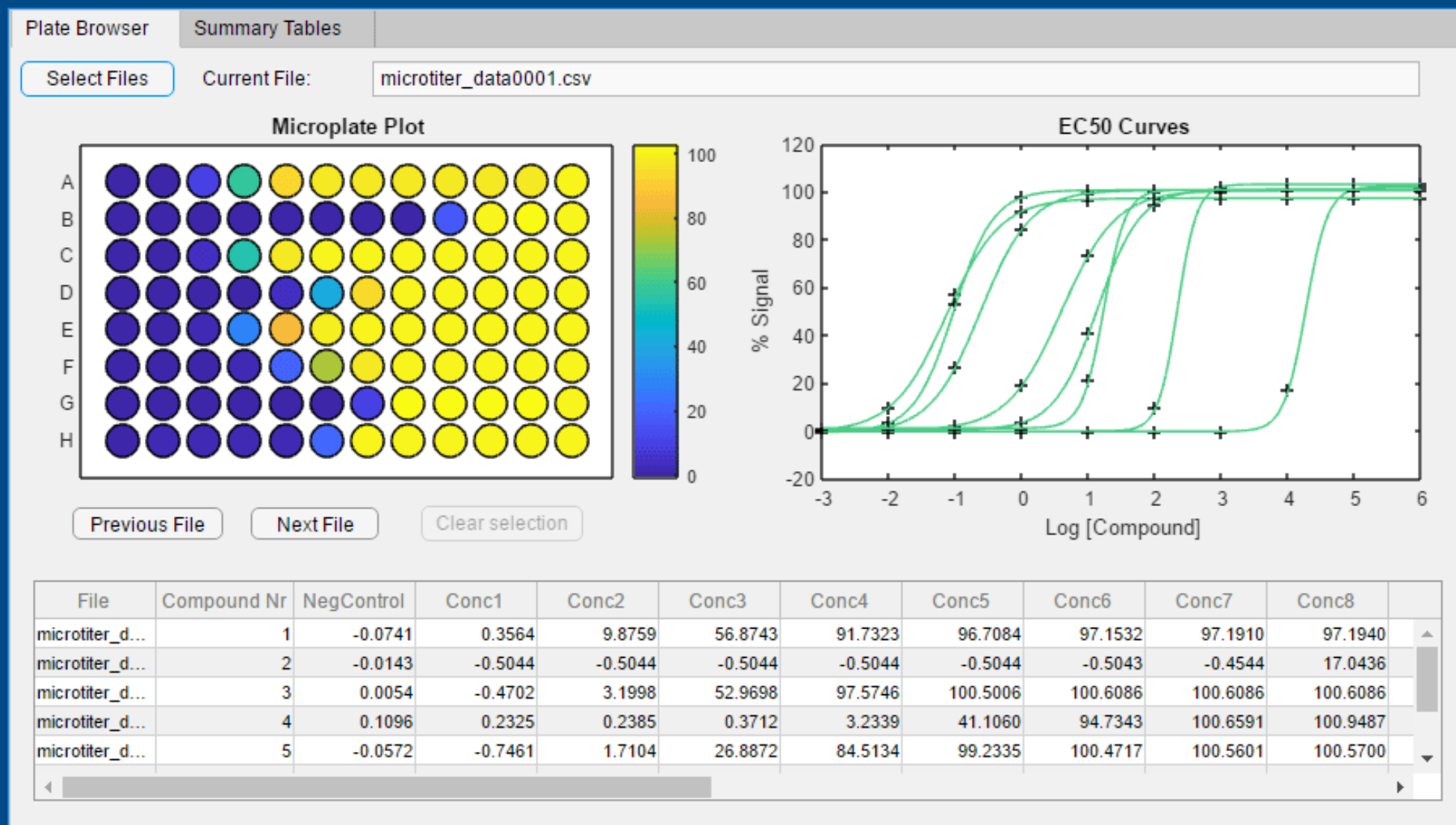
Page 1 of 7 1468 words

# Sharing Live Scripts



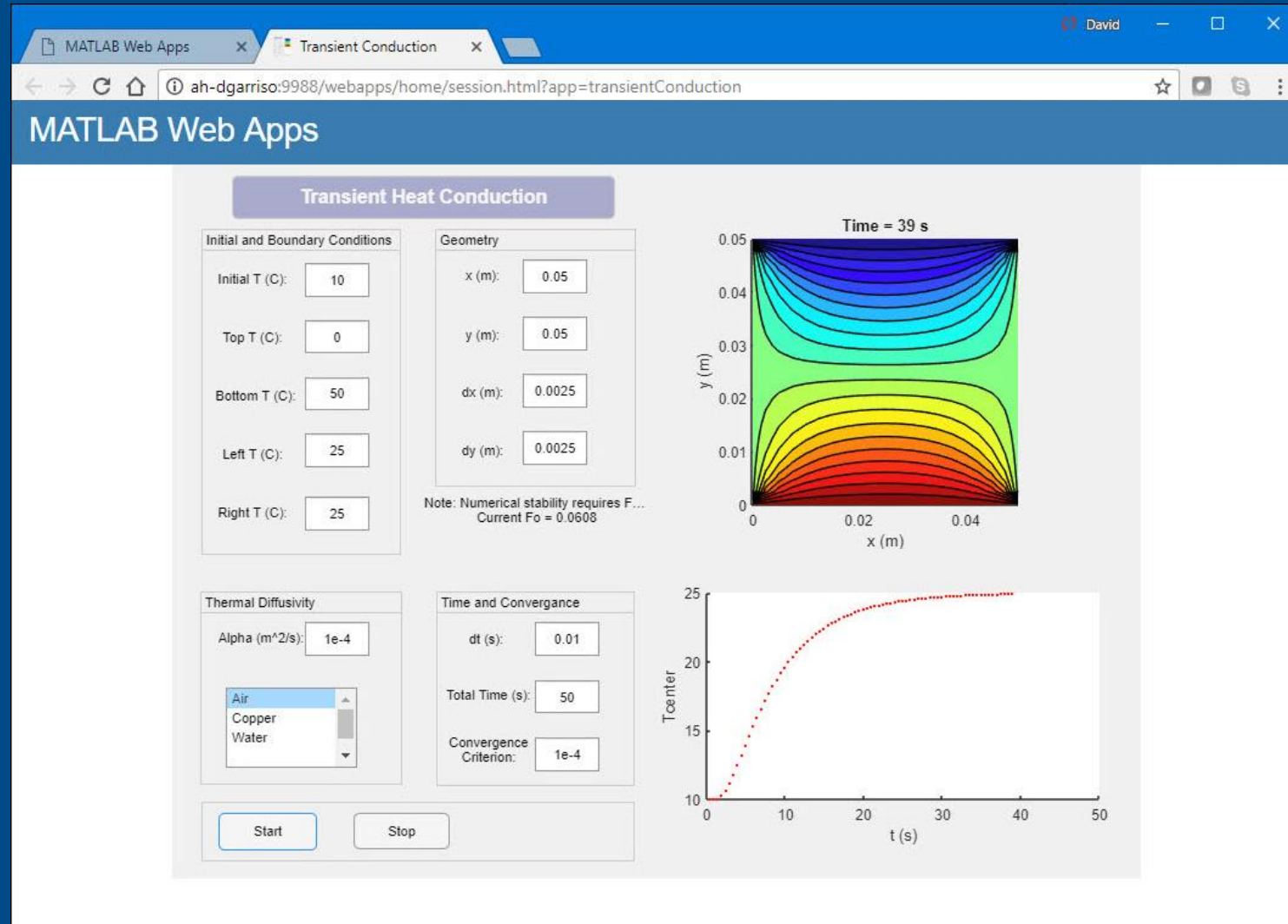


# Creating Apps

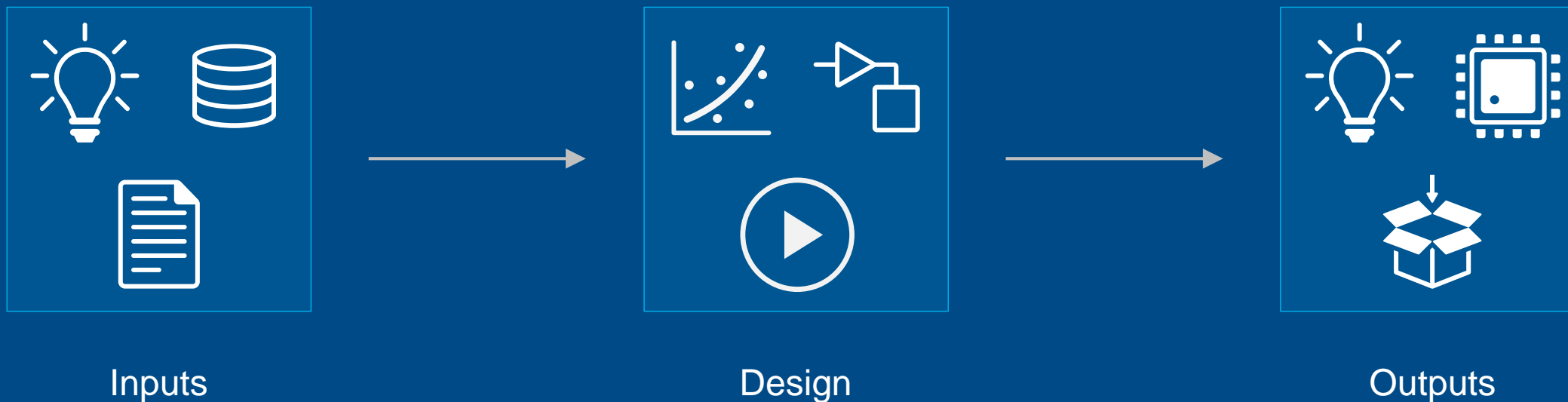




# Deploying Web Apps



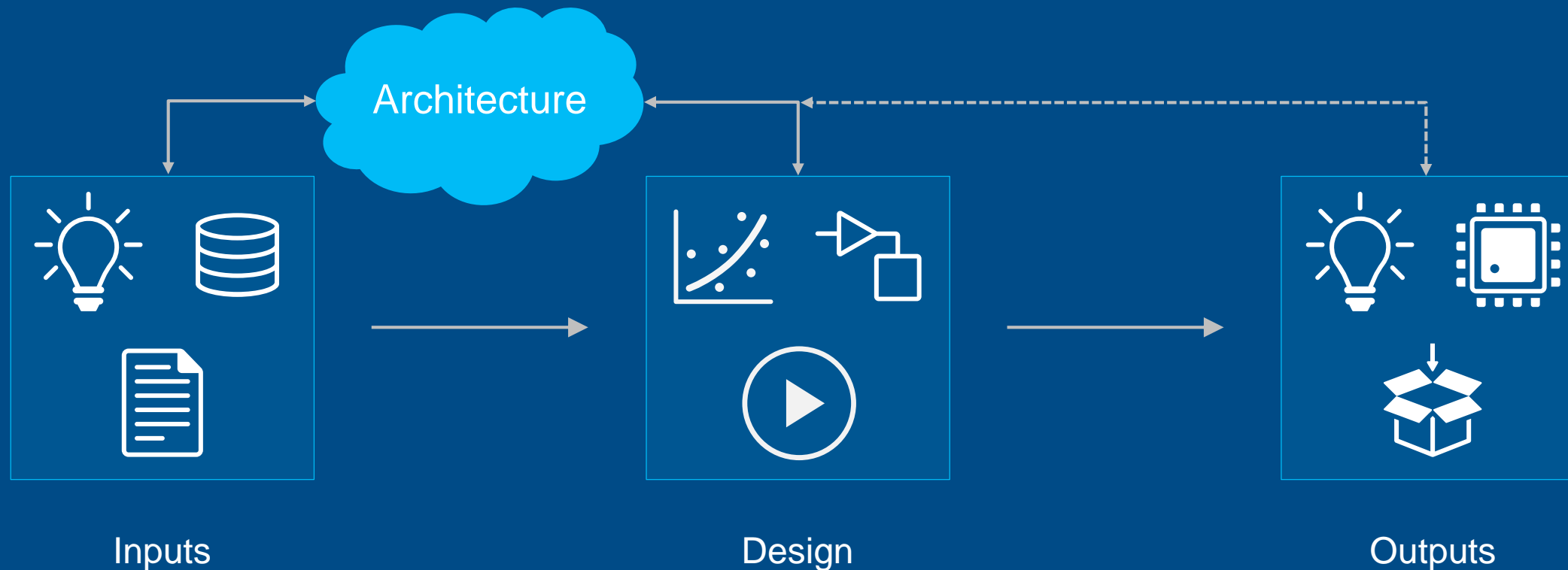
# Using MATLAB & Simulink to Build Algorithms in Everything



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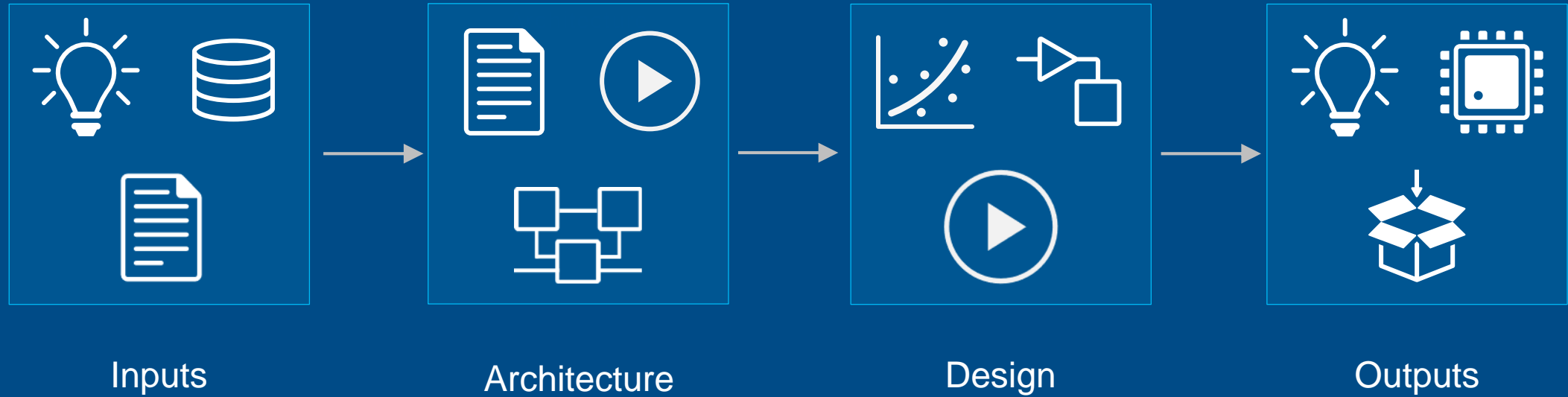
# Evaluating Architectures



MATLAB® & SIMULINK®



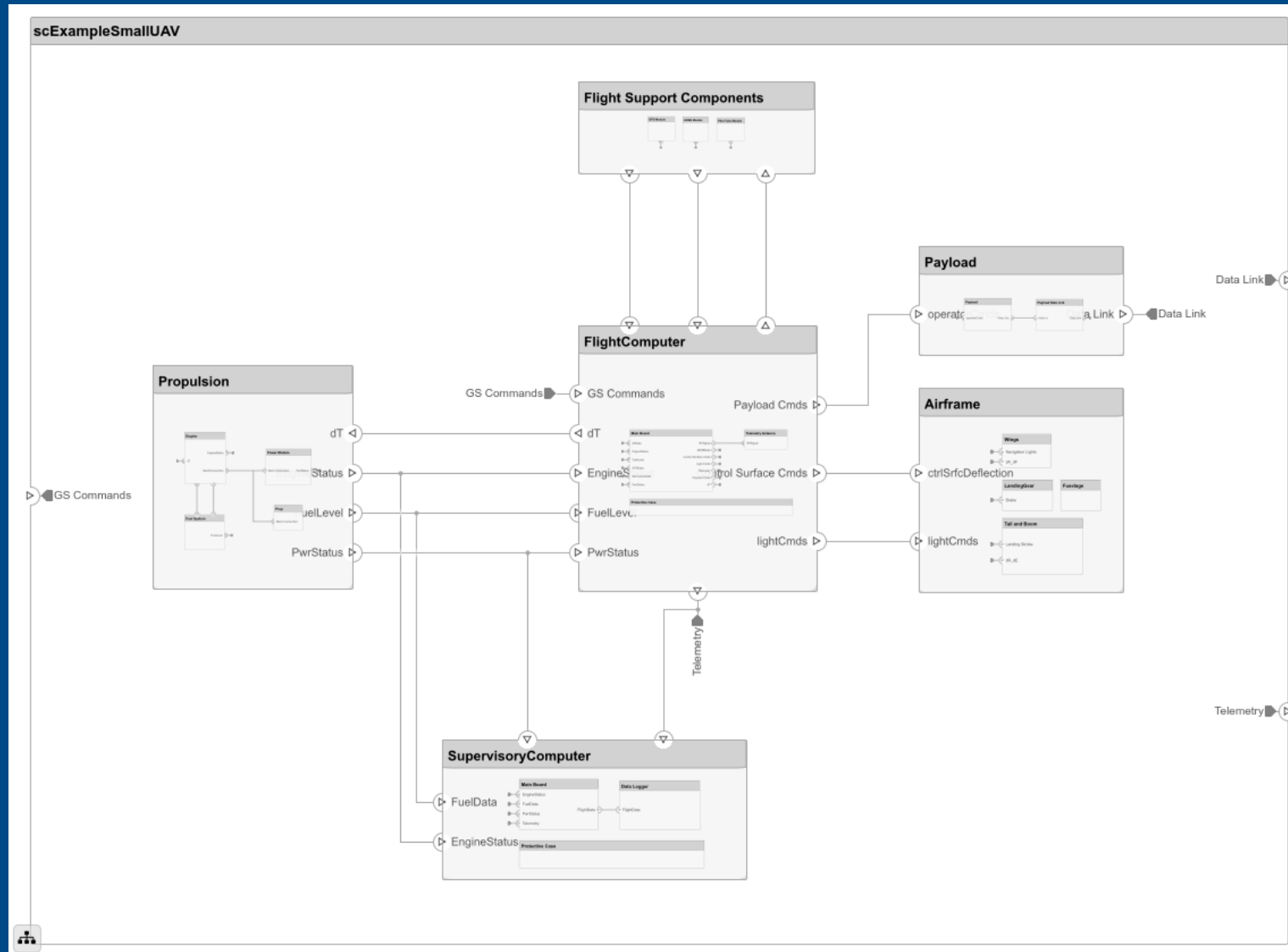
# Evaluating Architectures



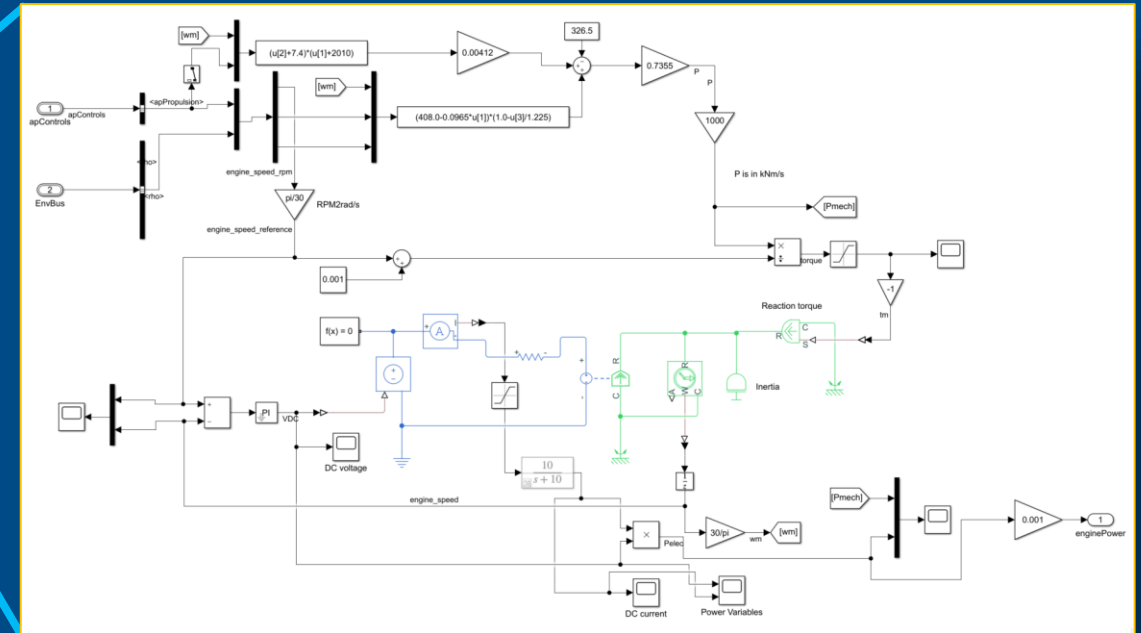
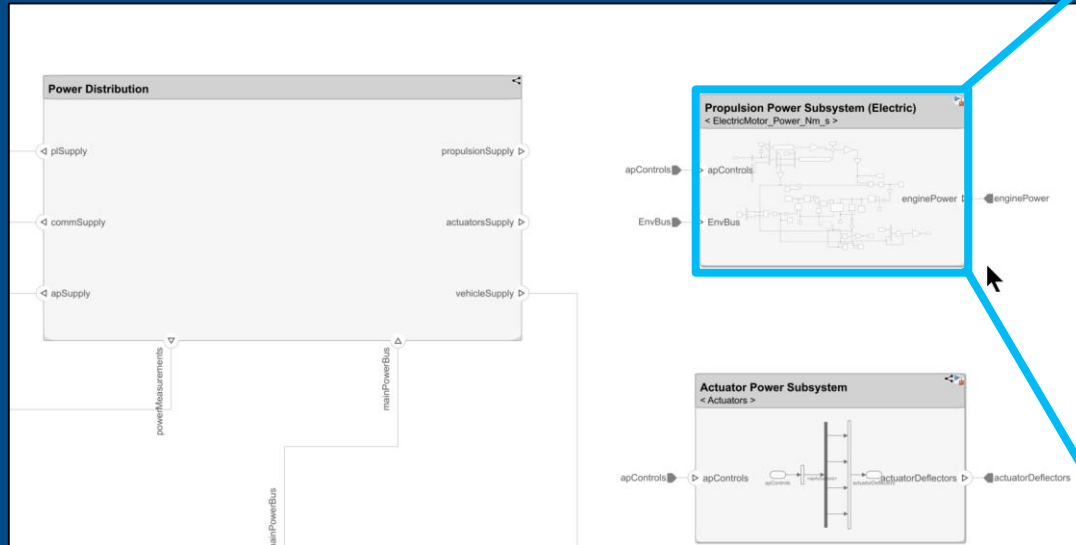
MATLAB® & SIMULINK®



# Designing System and Software Architectures



# Designing System and Software Architectures



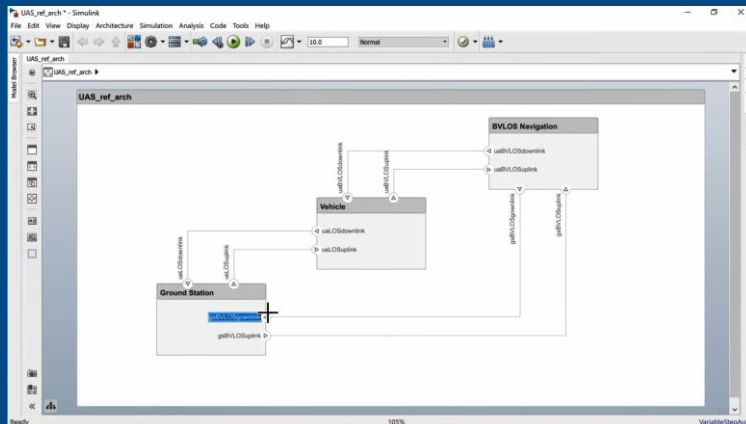
# Designing **Beyond** System and Software Architectures



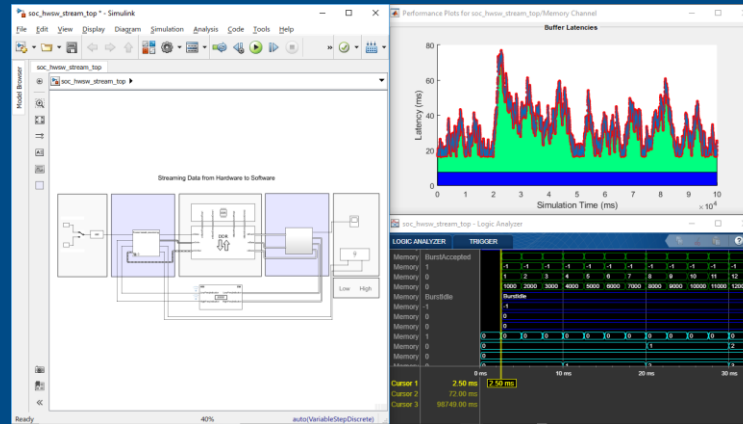
Systems and  
Software

SoC Hardware  
and Software

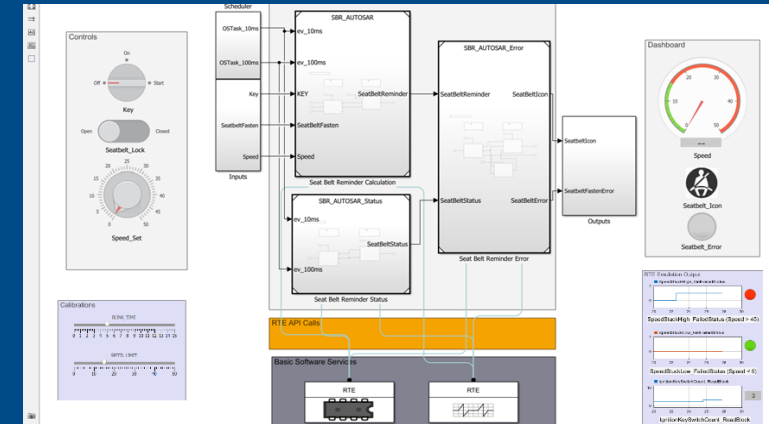
AUTOSAR Software



System Composer



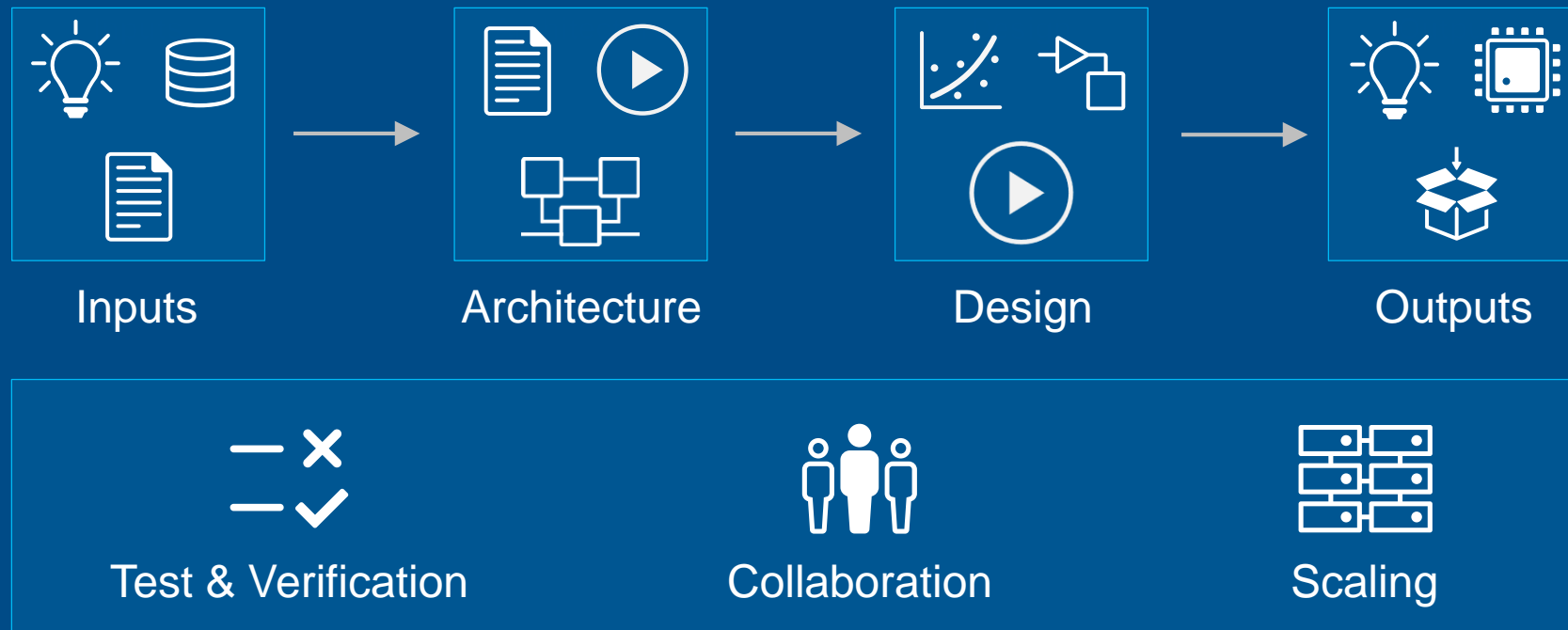
SoC Blockset



AUTOSAR Blockset



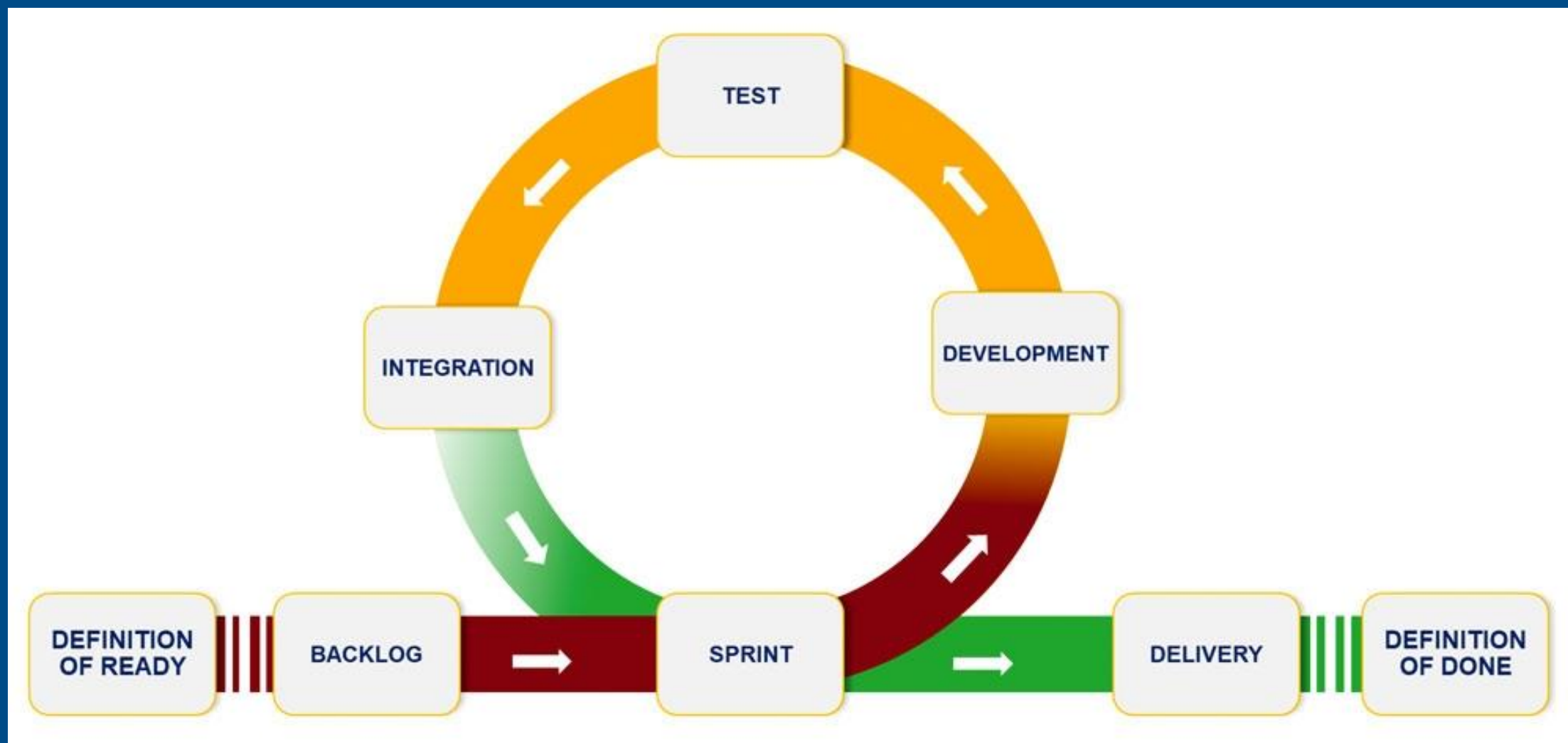
# Using MATLAB & Simulink to Build Algorithms in Everything



MATLAB® & SIMULINK®



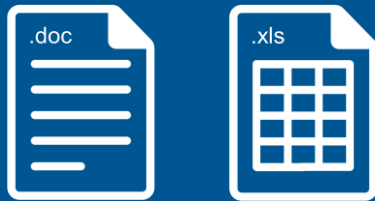
# Using MATLAB & Simulink to Build Algorithms in Everything



# Integrating with Third-party Requirements Tools



## External Requirements



Requirements  
Management  
Tools

R2019a



ReqIF

## Simulink Requirements

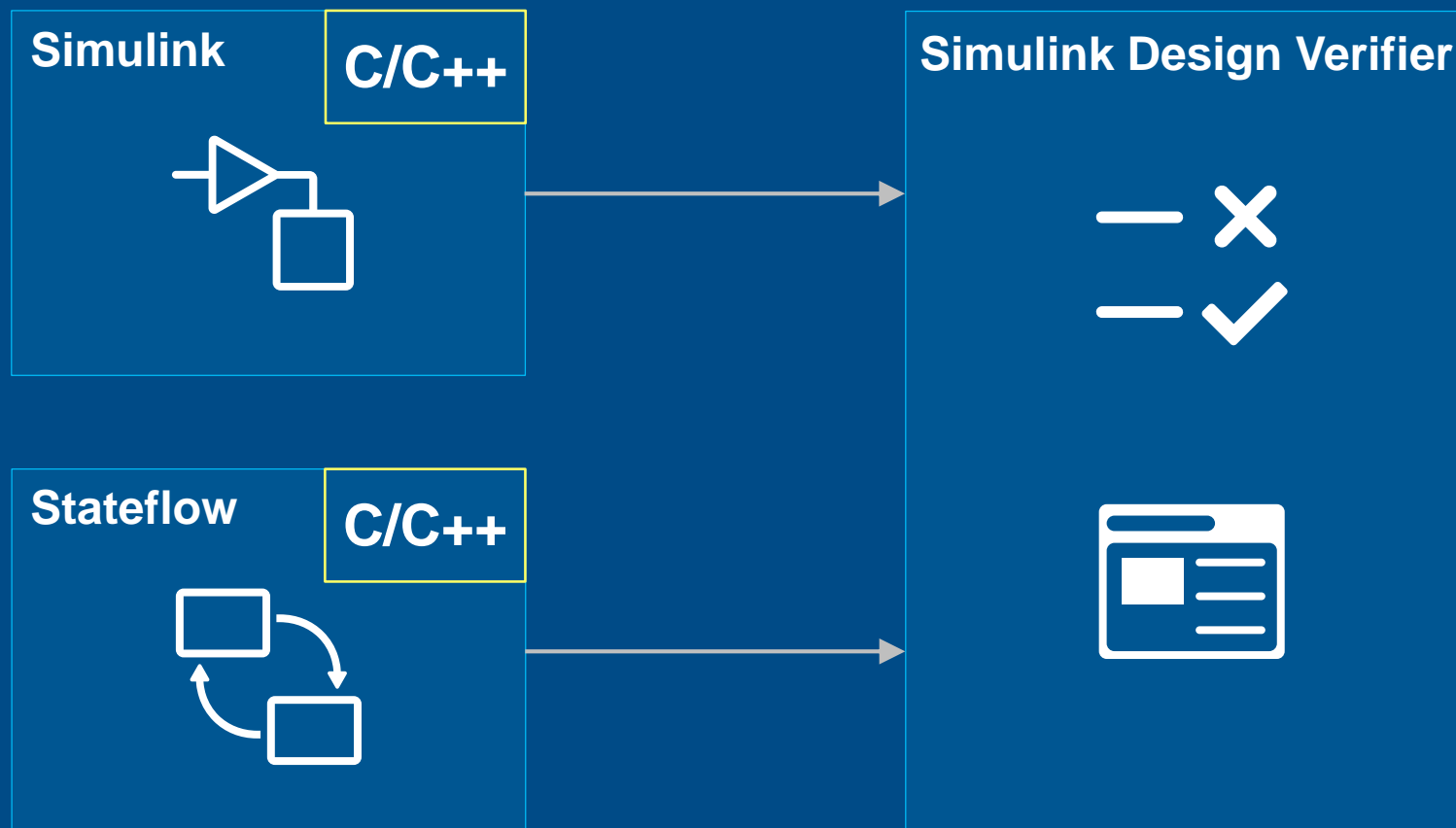
External Requirements



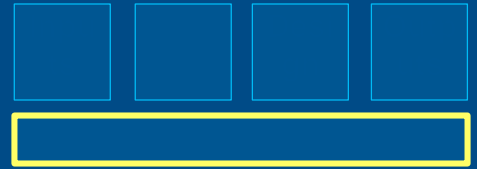
Authored Requirements



# Include Custom Code in Test & Verification



# Using the MATLAB Unit Test Framework



```
>> result.table
```

```
ans =
```

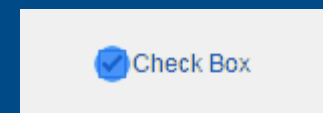
```
2×6 table
```

Name	Passed	Failed	Incomplete	Duration	Details
'test_Predictions/Test_ModelType'	true	false	false	0.12241	[1×1 struct]
'test_Predictions/Test_Prediction'	false	true	true	0.11542	[1×1 struct]

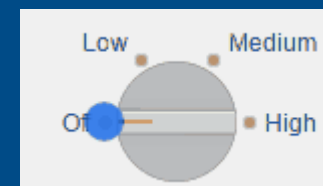
# Using the MATLAB App Testing Framework



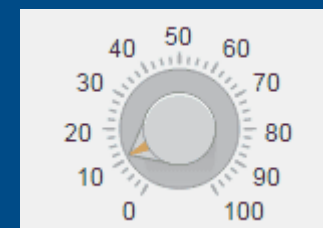
```
testCase.press(myApp.checkbox)
```



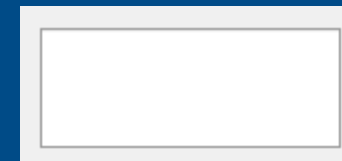
```
testCase.choose(myApp.discreteKnob, "Medium")
```



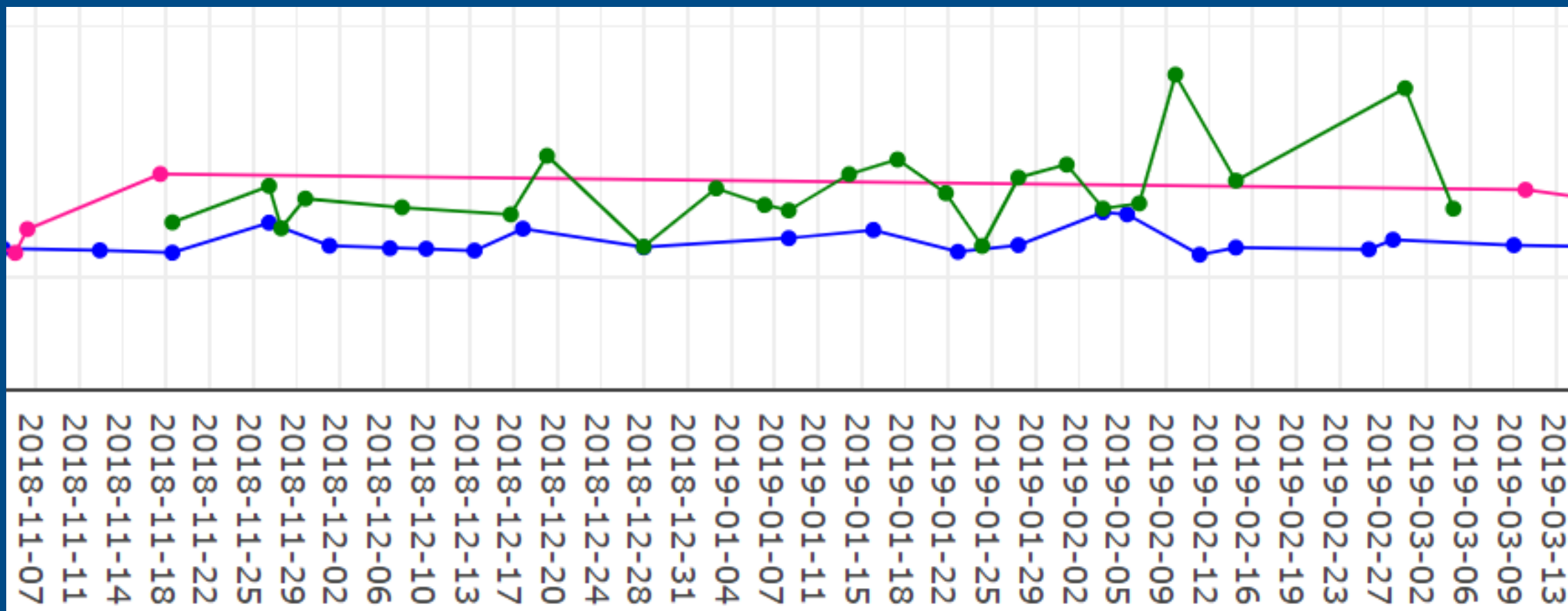
```
testCase.drag(myApp.continuousKnob, 10, 90)
```



```
testCase.type(myApp.editfield, myTextVar)
```



# Using the MATLAB Performance Testing Framework



# Using Continuous Integration



The image shows the Jenkins Plugins Index page. At the top, there's a navigation bar with links for Blog, Documentation, Plugins (highlighted), Community, Sub-projects, About, and English, along with a Download button. Below the navigation bar is a large blue banner featuring the Jenkins logo (a robot) on the left. To the right of the logo, the text 'Plugins Index' is displayed in a large, white, serif font. Below this, a smaller line of text says 'Discover the 1000+ community contributed Jenkins plugins to support building, deploying and automating any project.' Below the text is a search bar with a 'Browse' button on the left, a text input field containing 'Find plugins...', and a magnifying glass icon on the right. Below the search bar, there's a section titled 'Browse categories' with a list of categories: Platforms, User interface, Administration, and Source code management. To the right of this section is a 'New Plugins' section with a list of plugins: QRebel, MATLAB (highlighted with a red box), MISRA Compliance Report, Zoom, VectorCAST Execution, Klocwork Community, JQuery, and Analysis Model API. A large red box highlights the 'MATLAB' plugin name in the 'New Plugins' section. A blue triangle points from the 'MATLAB' plugin name to a large, light blue box containing the word 'MATLAB' in a large, blue, serif font.

**Jenkins** Blog Documentation Plugins Community Sub-projects About English Download

## Plugins Index

Discover the 1000+ community contributed Jenkins plugins to support building, deploying and automating any project.

Browse Find plugins...

**Browse categories**

- Platforms
- User interface
- Administration
- Source code management

**New Plugins**

- QRebel
- MATLAB**
- MISRA Compliance Report
- Zoom
- VectorCAST Execution
- Klocwork Community
- JQuery
- Analysis Model API

# MATLAB



# Using Continuous Integration



**Jenkins**BlogDocumentation ▾

← Find plugins

## MATLAB <sup>1.0.0</sup>

Minimum Jenkins requirement: 2.7.3  
ID: matlab

Installs: No usage data available  
[GitHub →](#)  
Last released: 2 days ago

**Maintainers**  
MathWorks

**Dependencies**  
[bouncycastle API v.2.16.0](#) (implied) (what's this?)  
[Command Agent Launcher v.1.0](#) (implied) (what's this?)  
[JDK Tool v.1.0](#) (implied) (what's this?)  
[JAXB v.2.3.0](#) (implied) (what's this?)

The Jenkins plugin for MATLAB® enables you to easily run your MATLAB tests and generate test artifacts in formats such as JUnit, TAP, and Cobertura code coverage reports.

**Features**

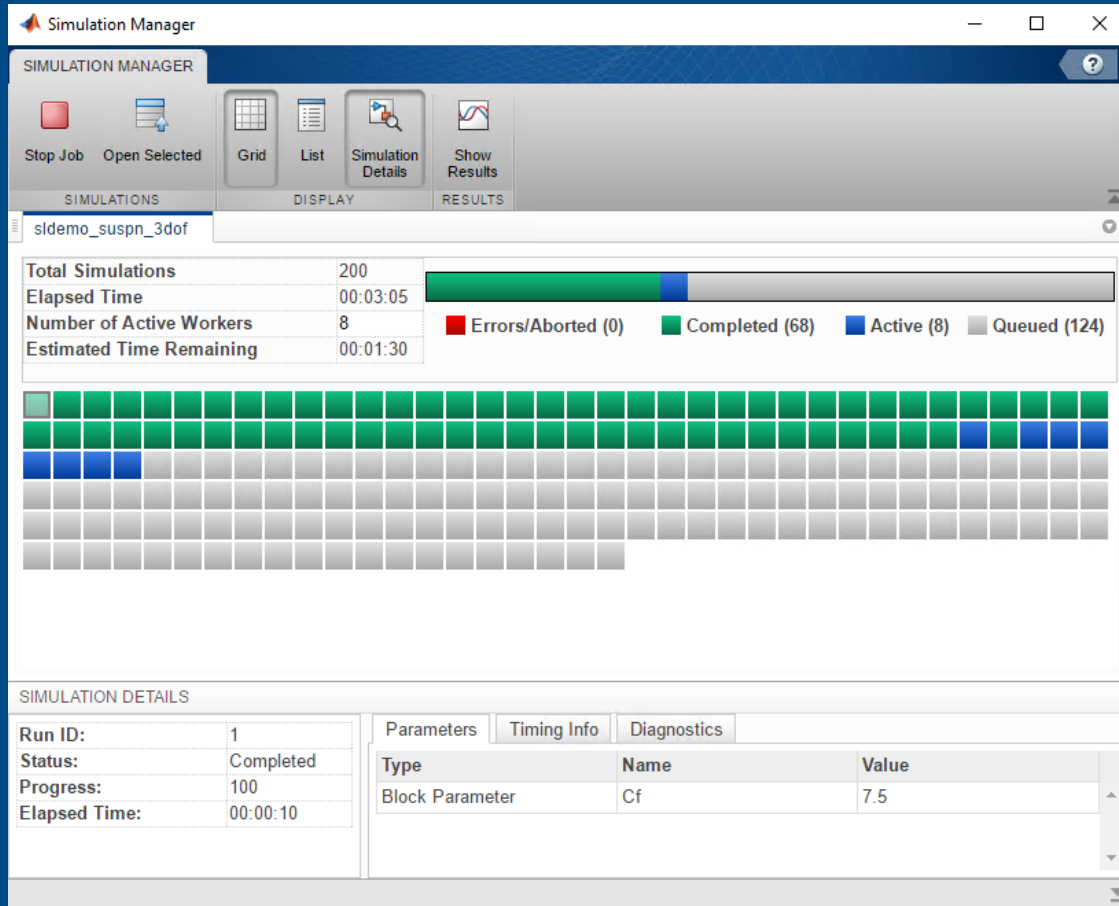
- Support to run MATLAB tests, present in the Jenkins workspace automatically. (This also includes the tests present in .prj files)
- Generate tests artifacts in JUnit, TAP & Cobertura code coverage formats.
- Support to run tests, using custom MATLAB command or custom MATLAB script file.

# Using Projects in MATLAB

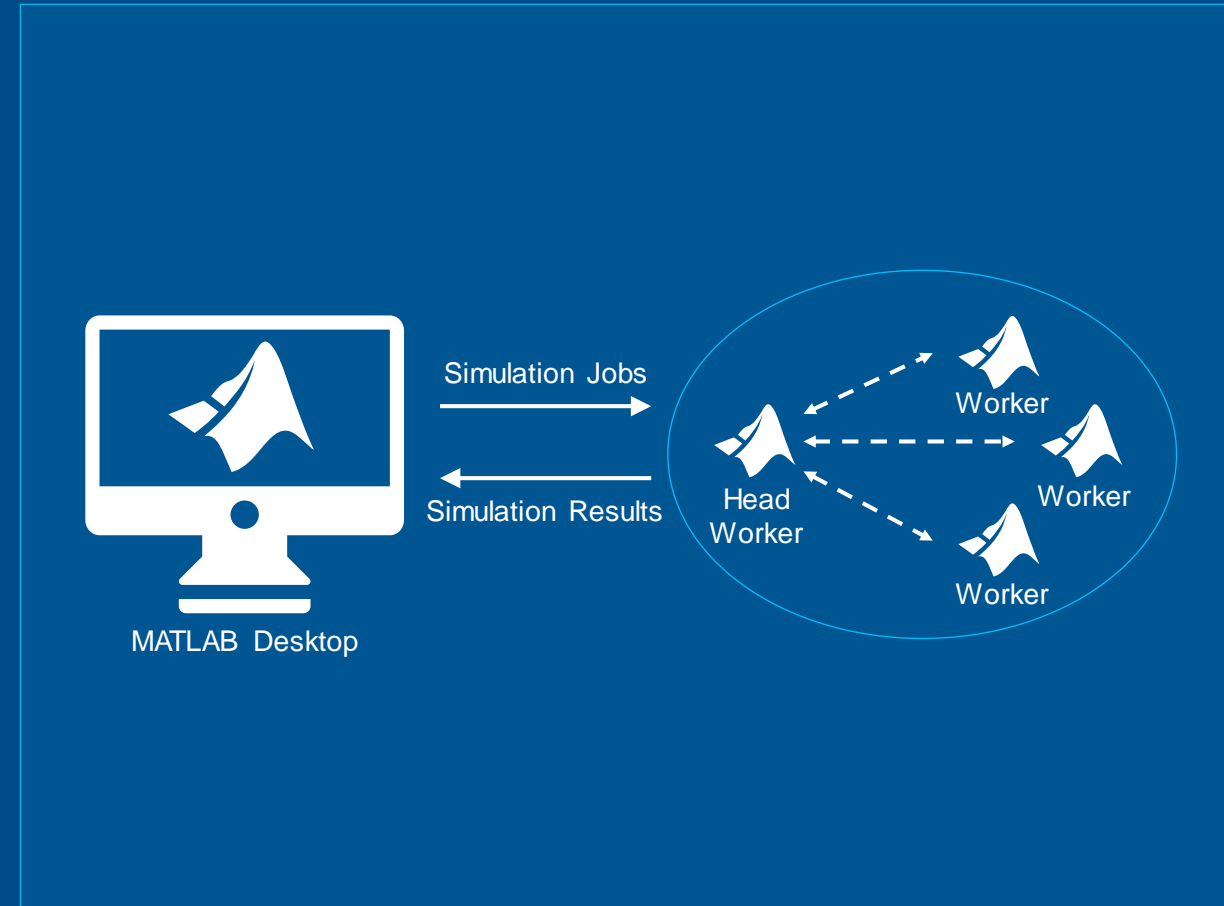
Name	Status	Git	Classification
+Test	✓	■	Test
ACI	✓	•	
Dashboard	✓	•	
Documents	✓	•	
Elasticsearch	✓	•	
MachineLearning	✓	■	
MATLAB_Kafka_Producer_Java	✓	•	
mps_stream	✓	■	
SimExecutable	✓	•	
Simulation	✓	•	
DocExample_MultiClassFaultDetectionUsi...	✓	●	Design
genPumpData.m	✓	●	Design
javasetup.m	✓	+	Design
Main_ExampleWorkflow.mlx	✓	●	Design
MLModels.mat	✓	●	Design
rawdata.mat	✓	●	Design
README.md	✓	●	

# Parallel Simulations in Simulink

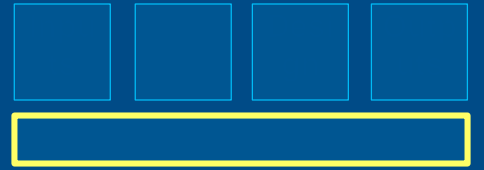
## Simulation Manager



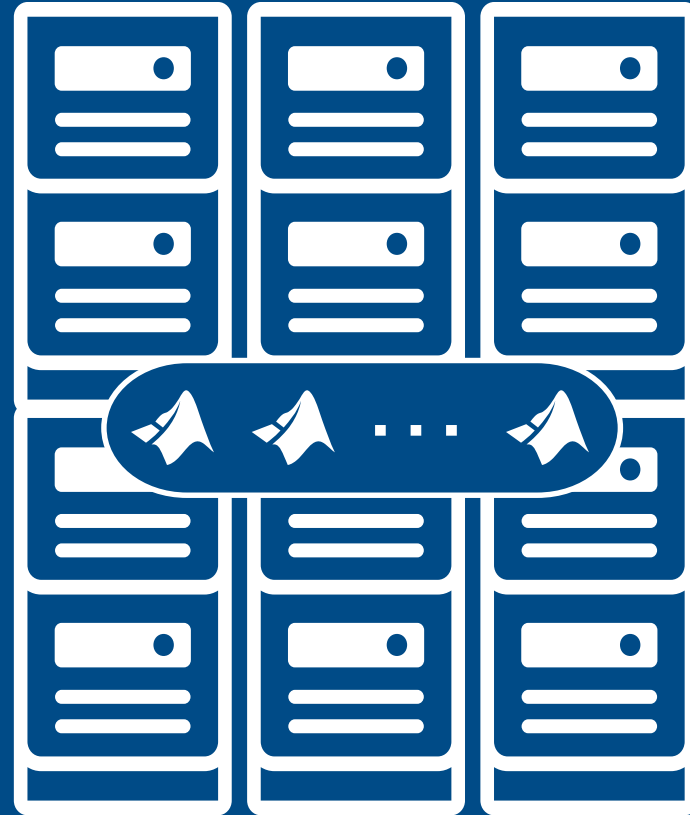
## batchsim



# Scaling Computations on Clusters and Clouds



MATLAB



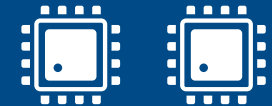
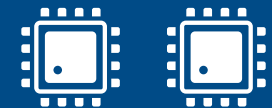
MATLAB Parallel Server



Cloud



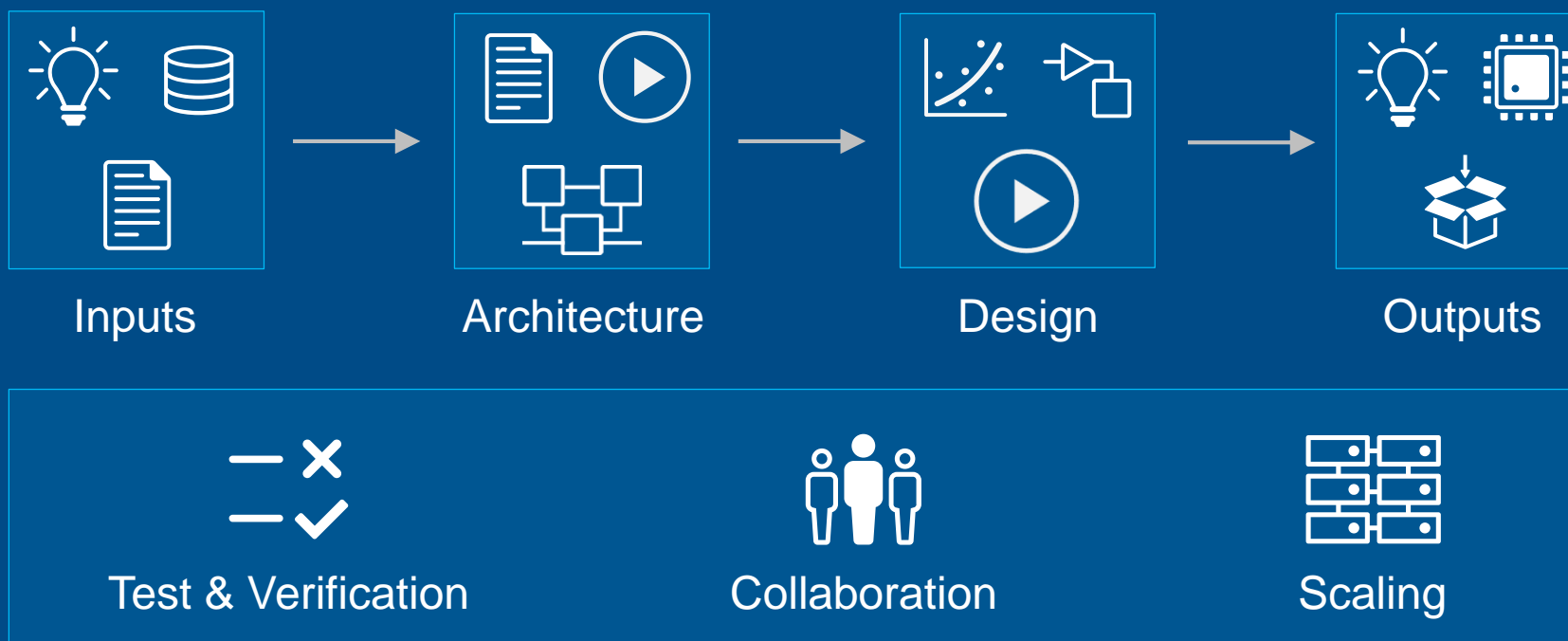
GPU



Multi-core CPU

Parallel Computing Toolbox

# Using MATLAB & Simulink to Build Algorithms in Everything



MATLAB® & SIMULINK®



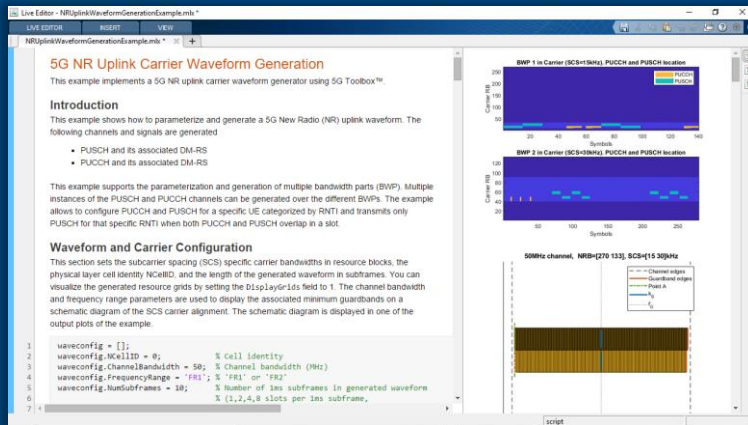
# Specialized Tools for Building Algorithms in Everything



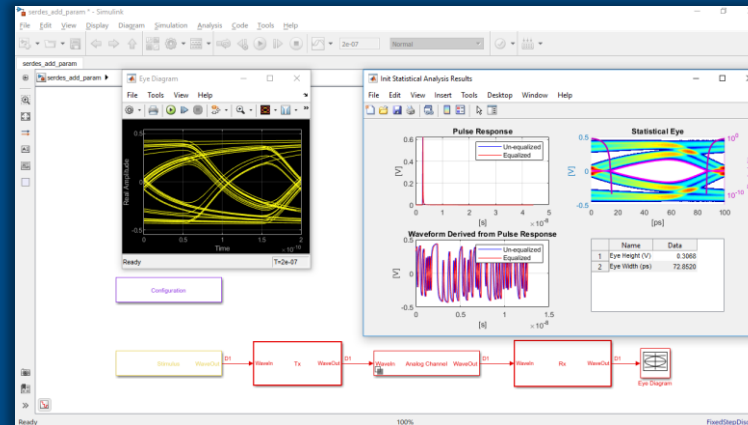
Communications

Physical interconnects

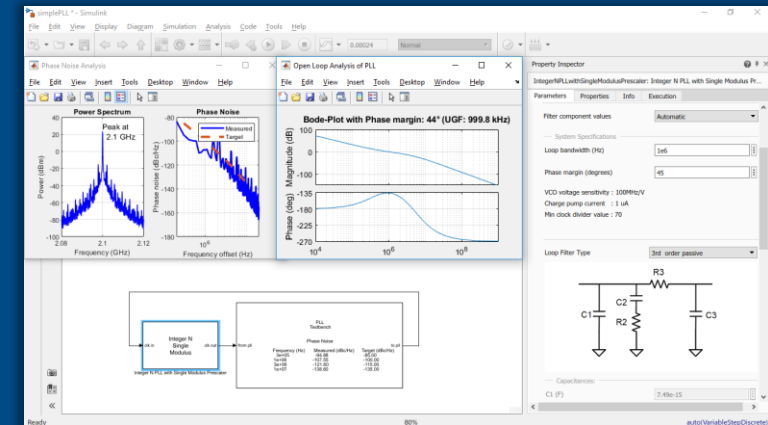
Analog Mixed-Signal



5G Toolbox

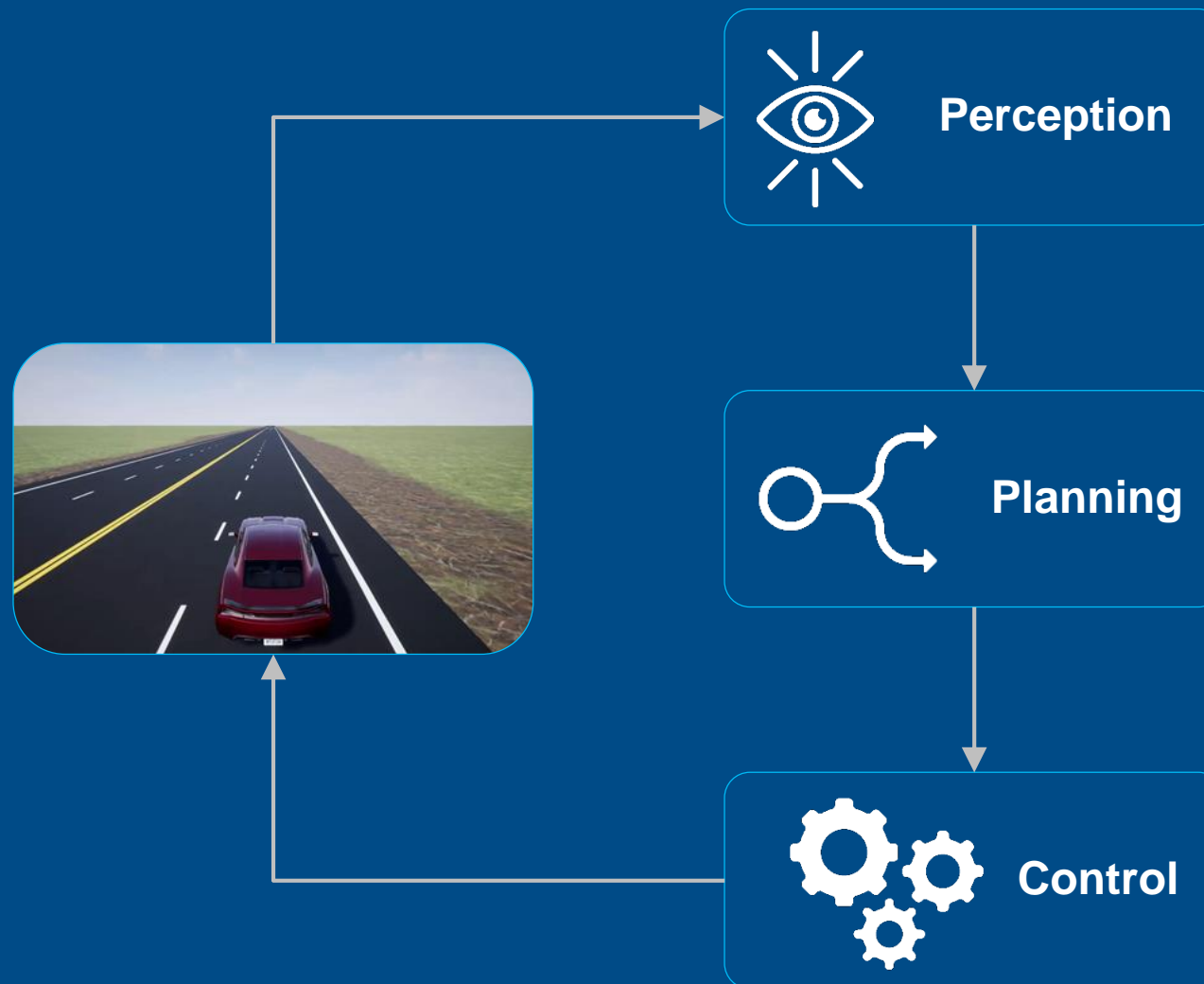


SerDes Toolbox

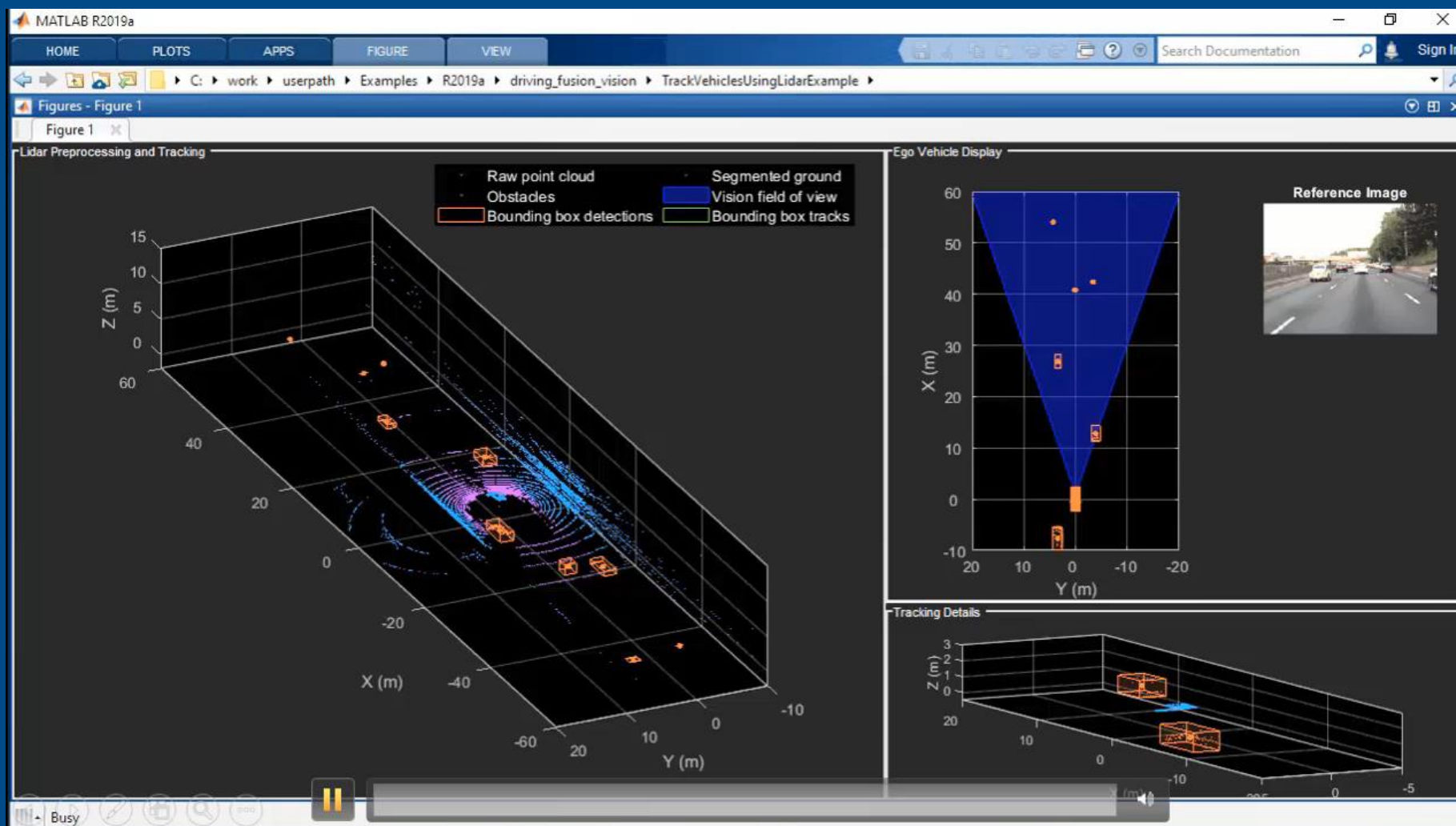
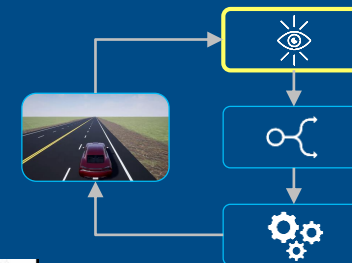


Mixed-Signal Blockset

# Developing Autonomous Systems

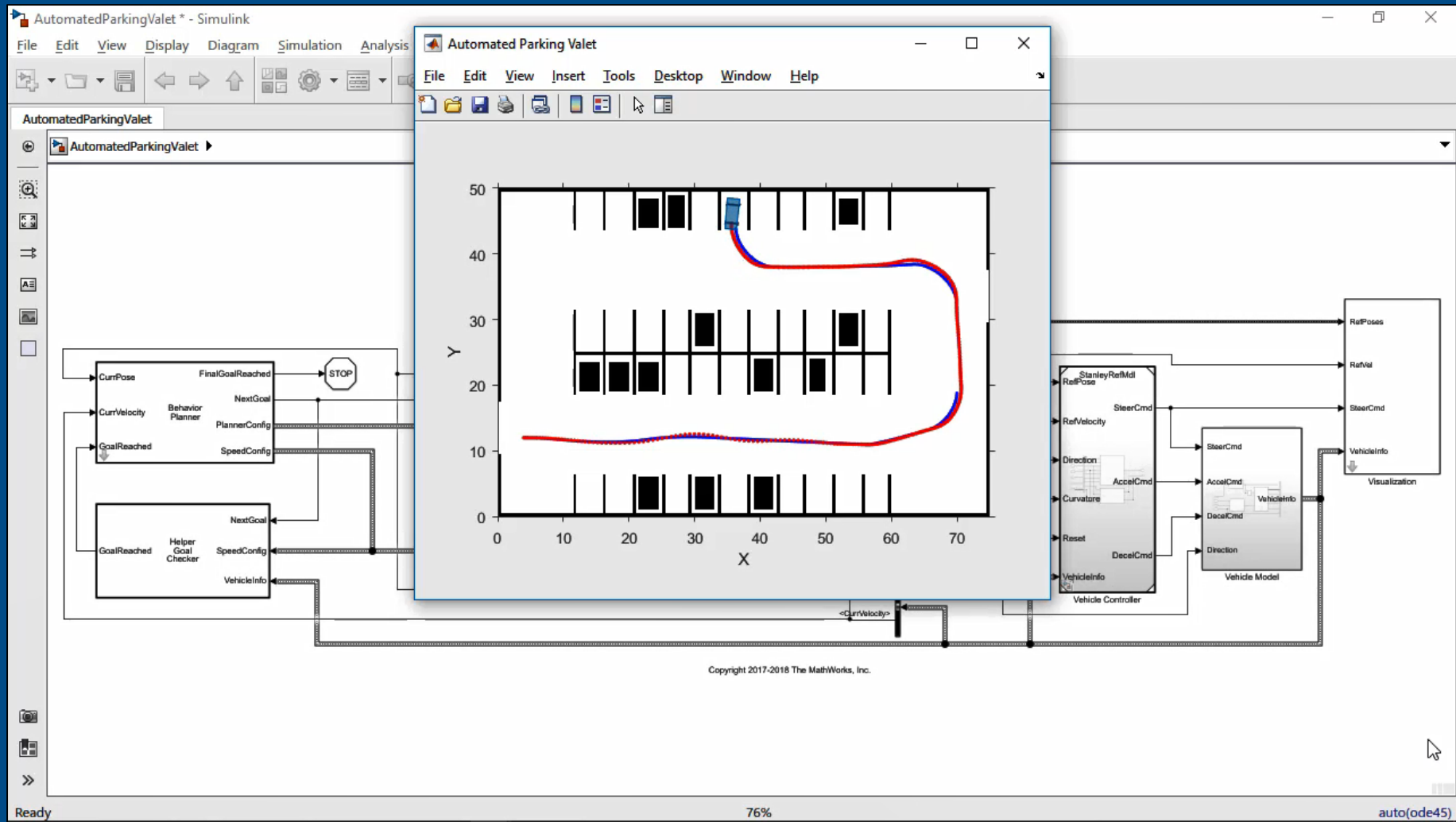
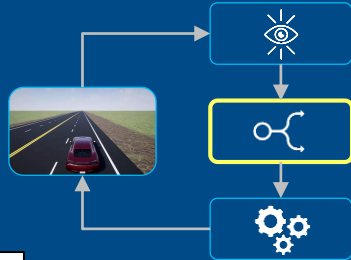


# Evaluate Sensor Fusion Architectures

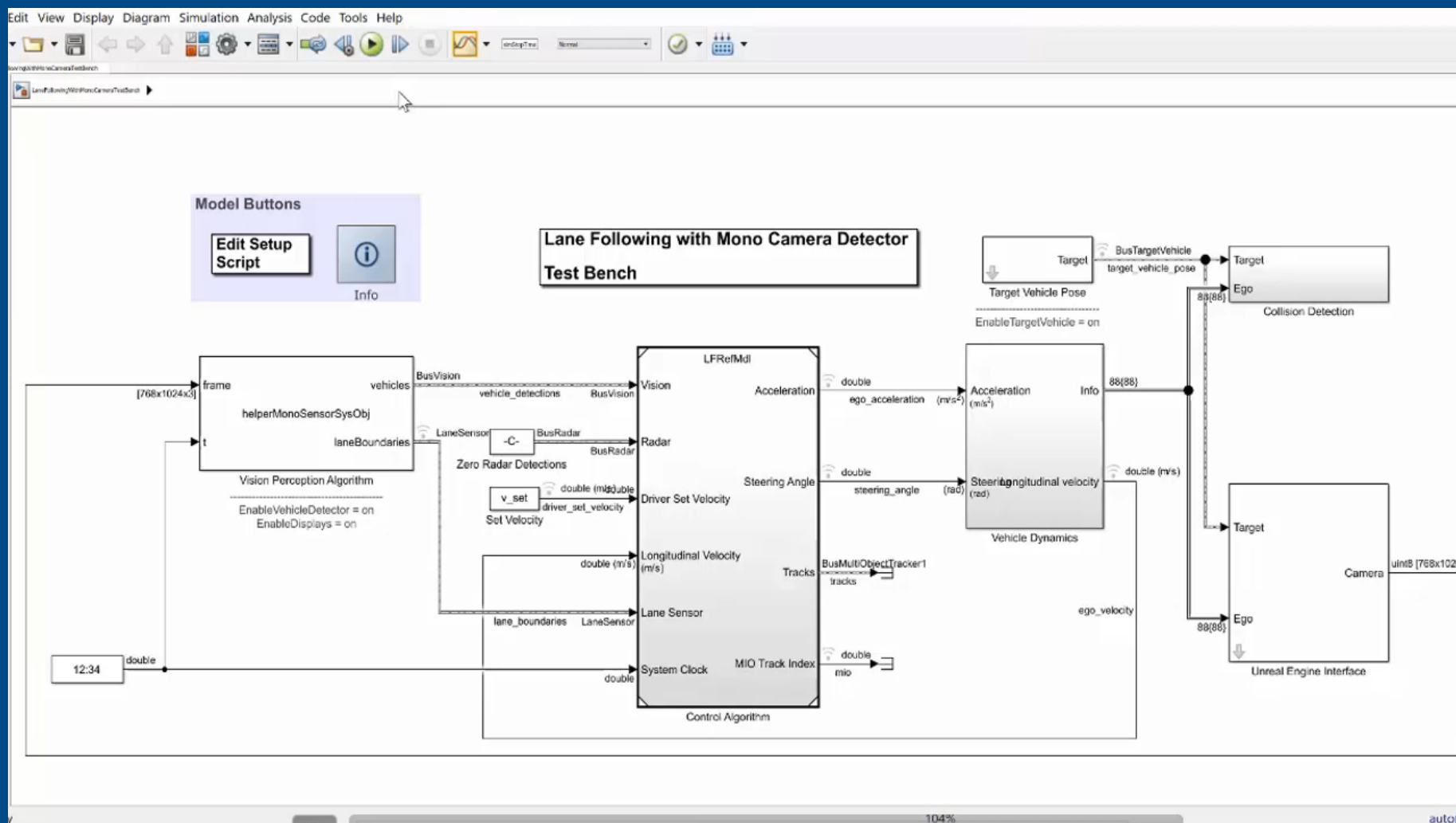
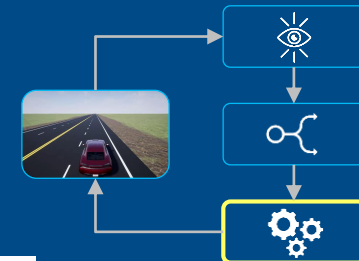




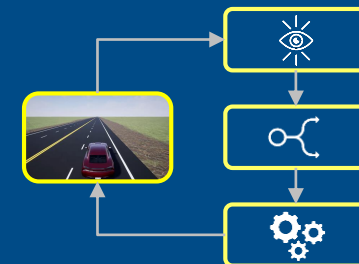
# Simulate Path Planning Algorithms



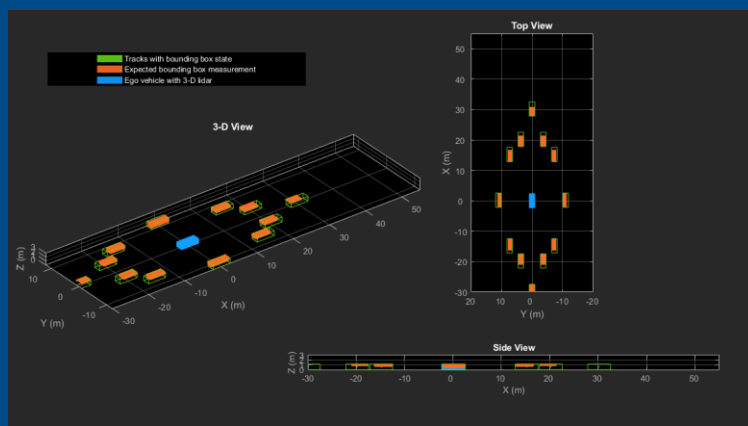
# Design Lane-following and Spacing Control Algorithms



# Developing Autonomous Systems

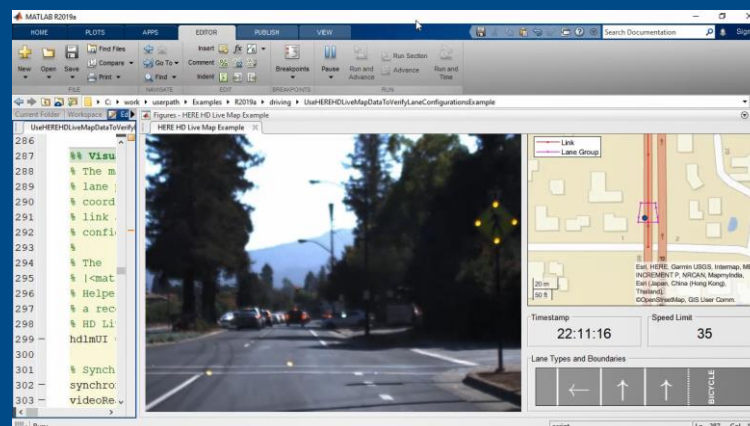


## Lidar Processing & Tracking



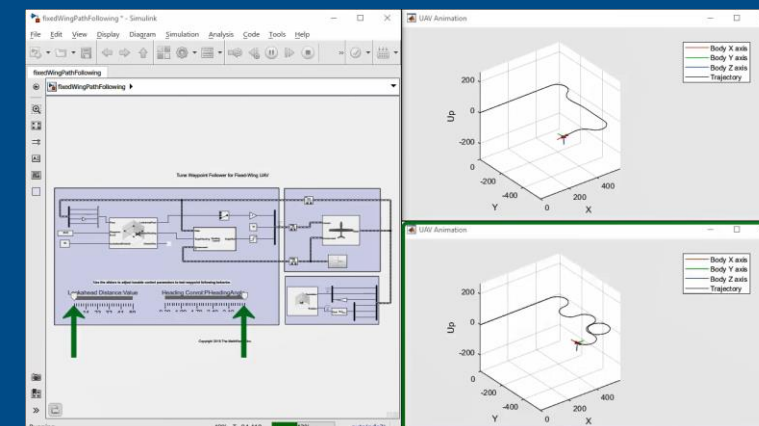
Computer Vision Toolbox

## HERE HD Maps & OpenDRIVE Roads



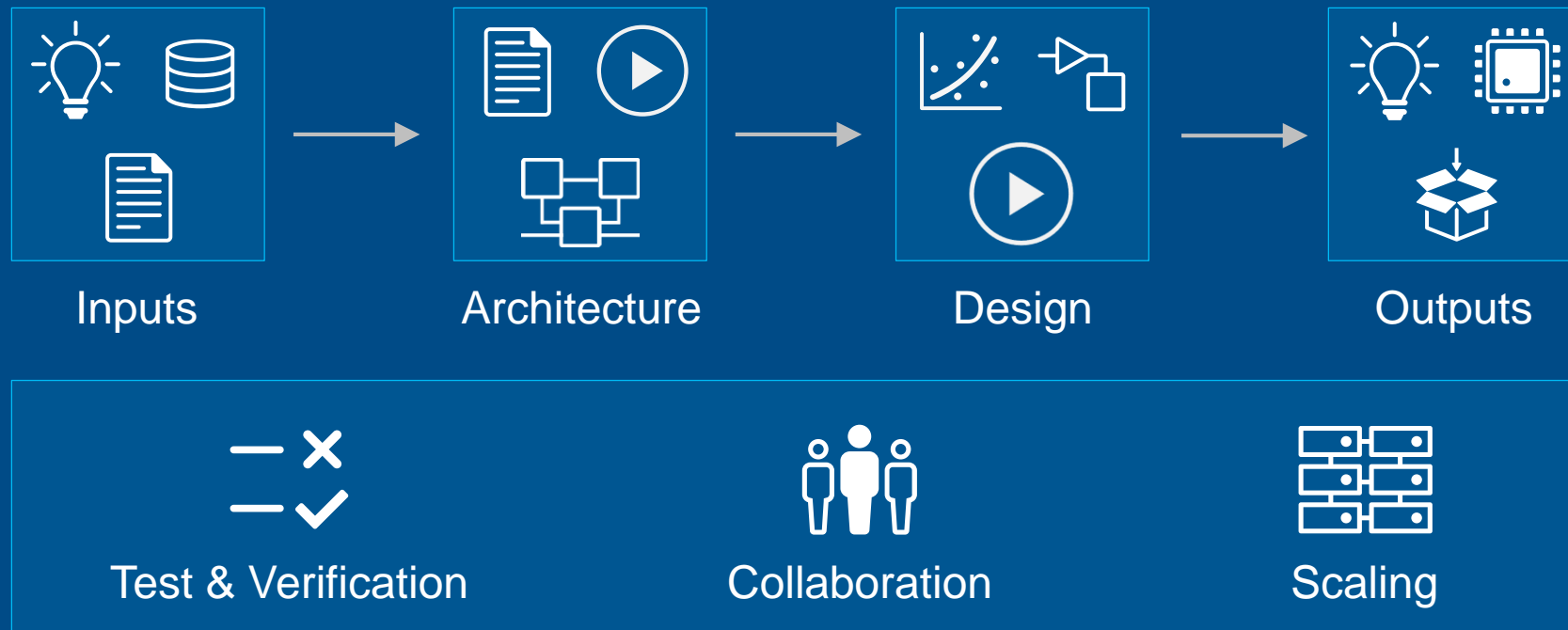
Automated Driving Toolbox

## UAV Algorithms



Robotics System Toolbox

# Using MATLAB & Simulink to Build Algorithms in Everything



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# Read the Release Notes

R2019a at a Glance

Search MathWorks.com



## Explore What's New

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[Download release now](#)



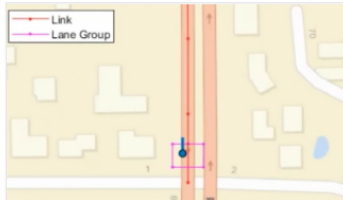
## Release Highlights



### Deep Learning

Develop controllers and decision making systems using reinforcement learning, train deep learning models on NVIDIA DGX and cloud platforms, and apply deep learning to 3-D data.

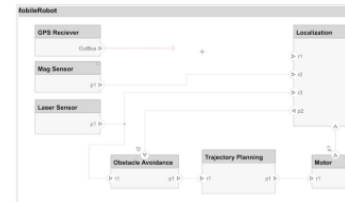
» [Learn more](#)



### Automotive

Design and simulate AUTOSAR software, interface with HERE HD maps, and generate energy balance reports.

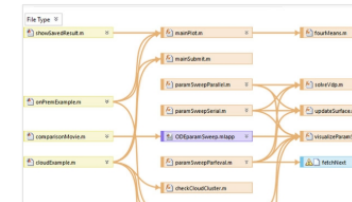
» [Learn more](#)



### Systems Engineering

Design and analyze system and software architectures with System Composer.

» [Learn more](#)

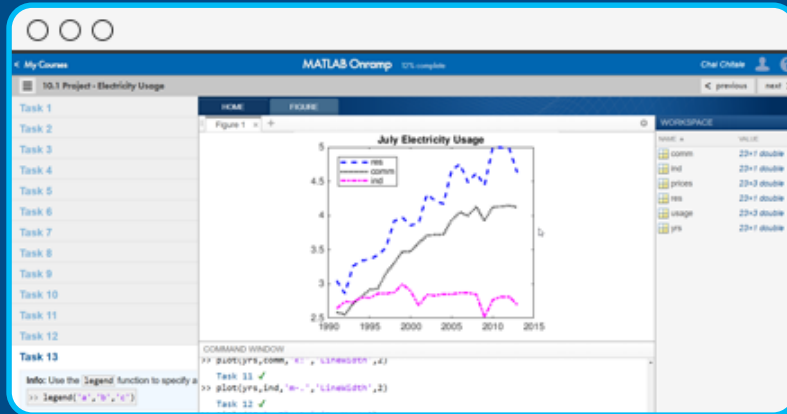


### Projects

Use projects in MATLAB and Simulink to organize, manage, and share your work.

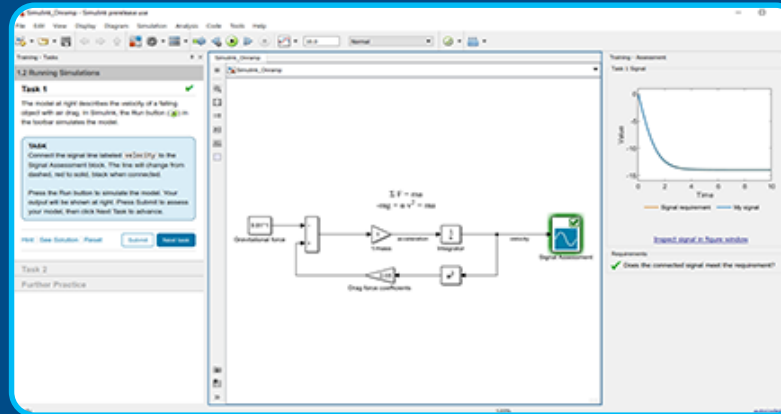
» [Learn more](#)

# Get Started



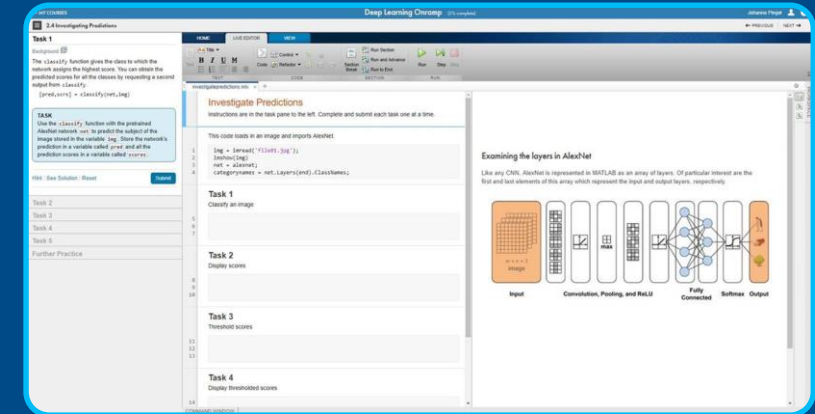
## MATLAB Onramp

Quickly learn the essentials of MATLAB.



## Simulink Onramp

Learn to create, edit, and troubleshoot Simulink models.



## Deep Learning Onramp

Learn to use deep learning techniques in MATLAB for image recognition.