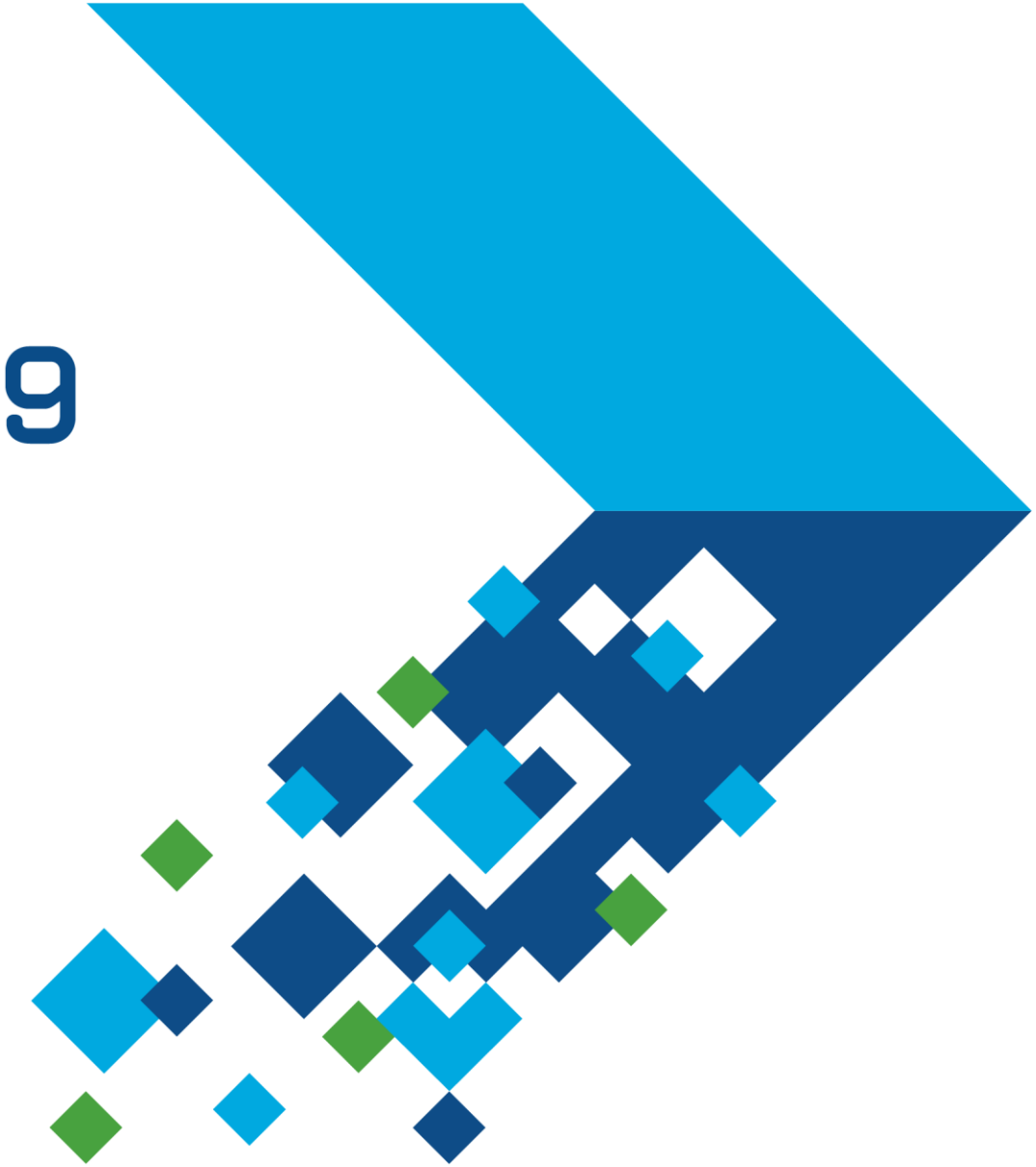
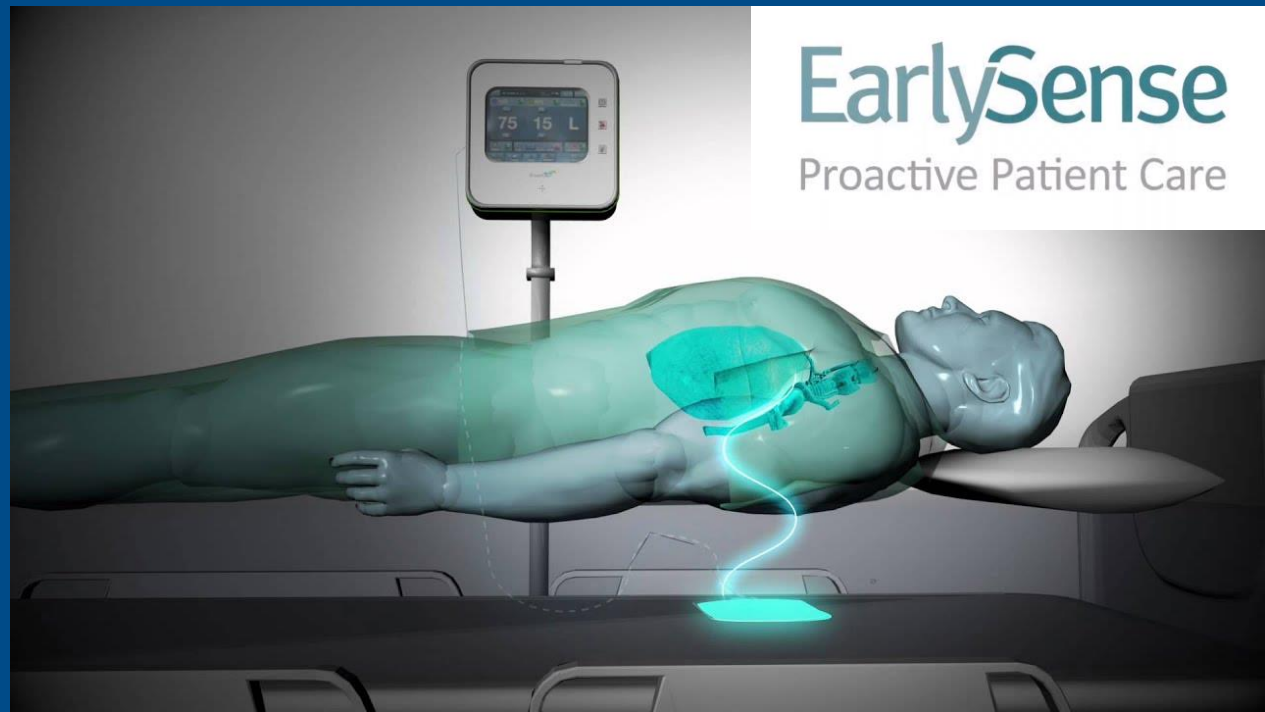
# MATLAB EXPO 2019

## What's New in MATLAB and Simulink

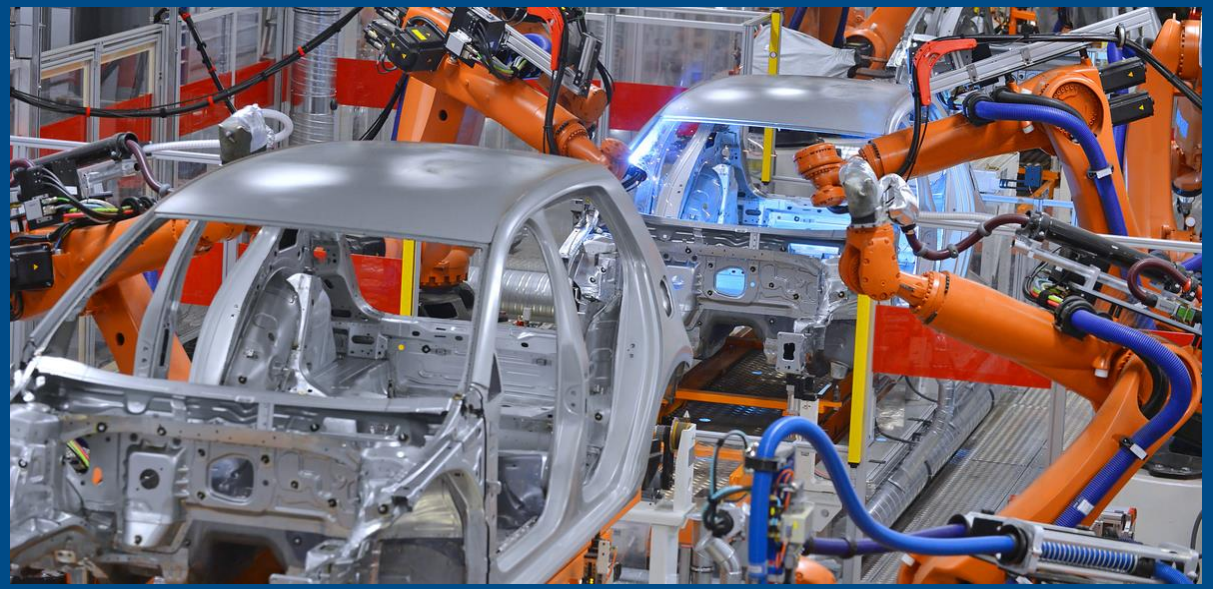
Cynthia Cudicini

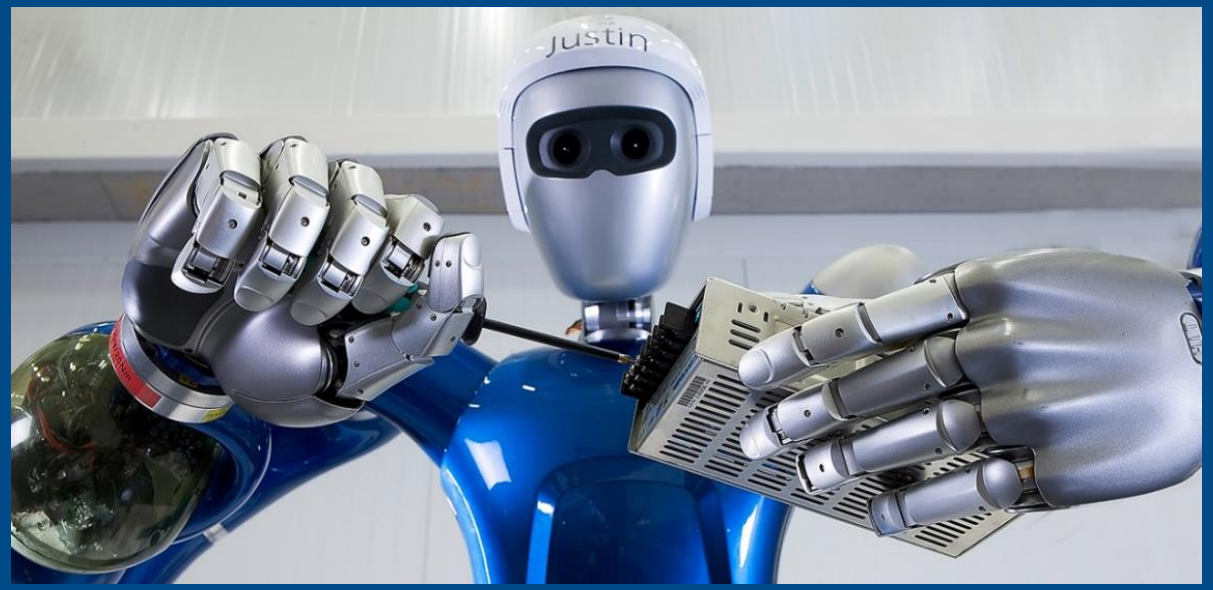



VOYAGE


75 15 L
EarlySense
Proactive Patient Care

# Algorithms in Everything



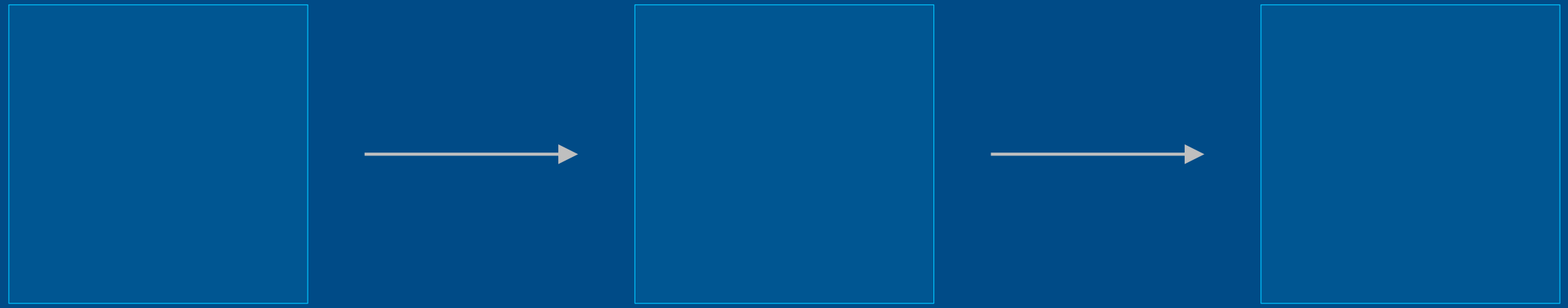
# Using MATLAB & Simulink to Build Algorithms in Everything

**Simplifying your work…**

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

# Using MATLAB & Simulink to Build Algorithms in Everything

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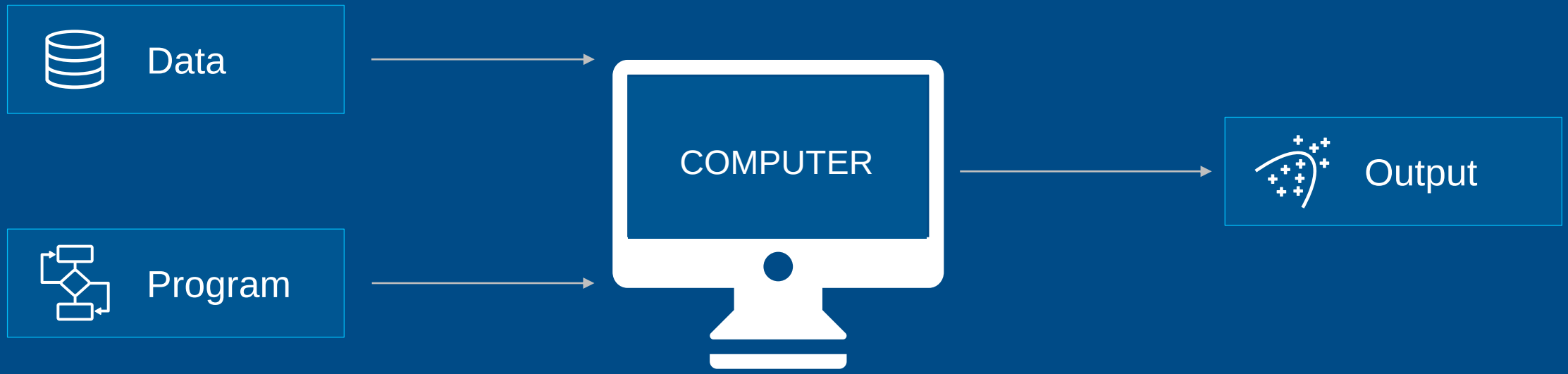
# Artificial Intelligence

*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

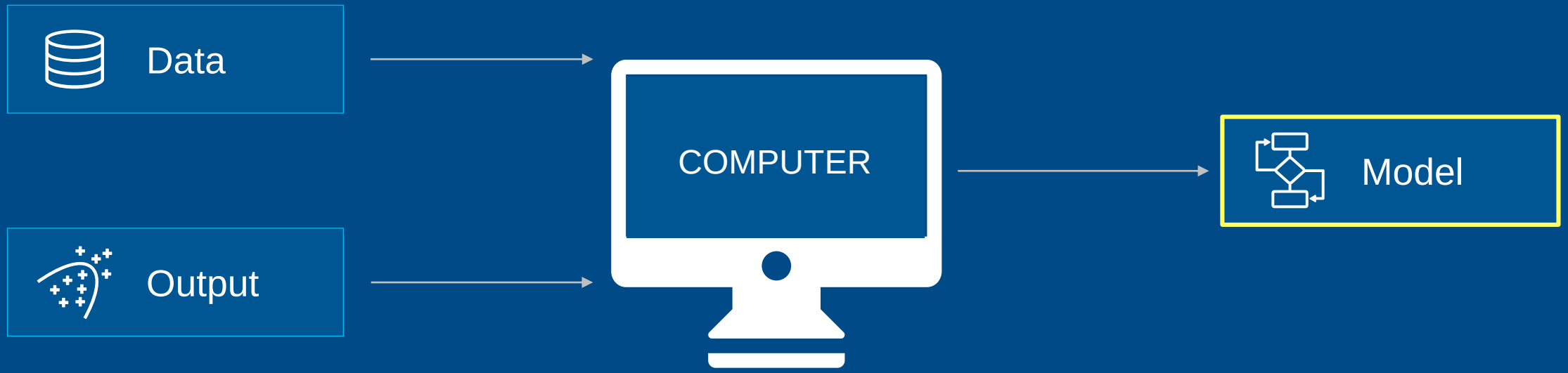
## Traditional Programming



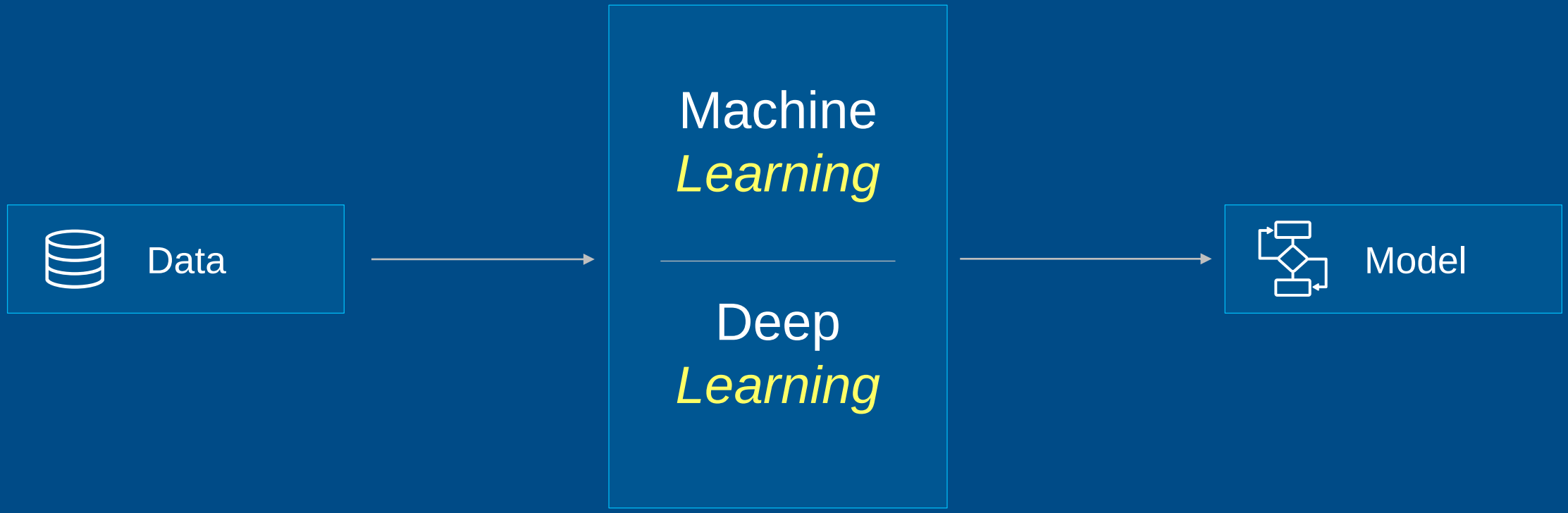
# There are two ways to get a computer to do what you want

## Machine Learning



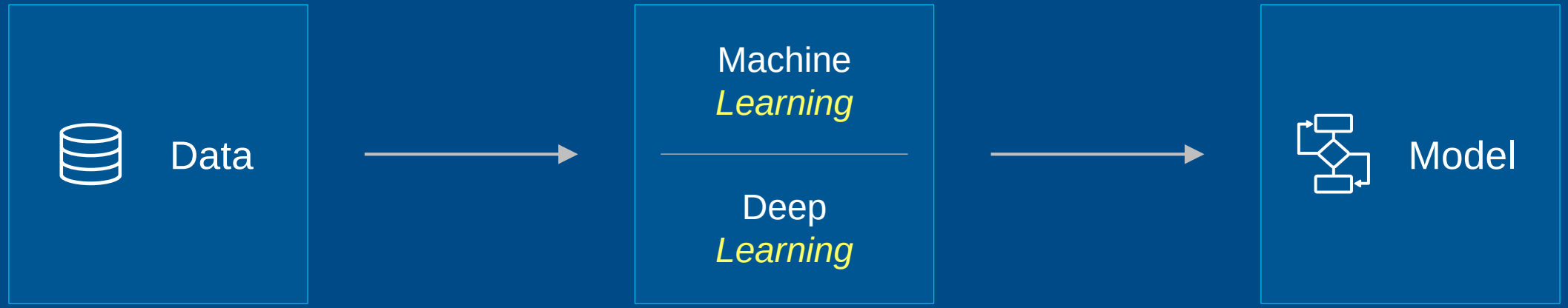

 

# Artificial Intelligence



# Using MATLAB and Simulink to Build Deep Learning Models

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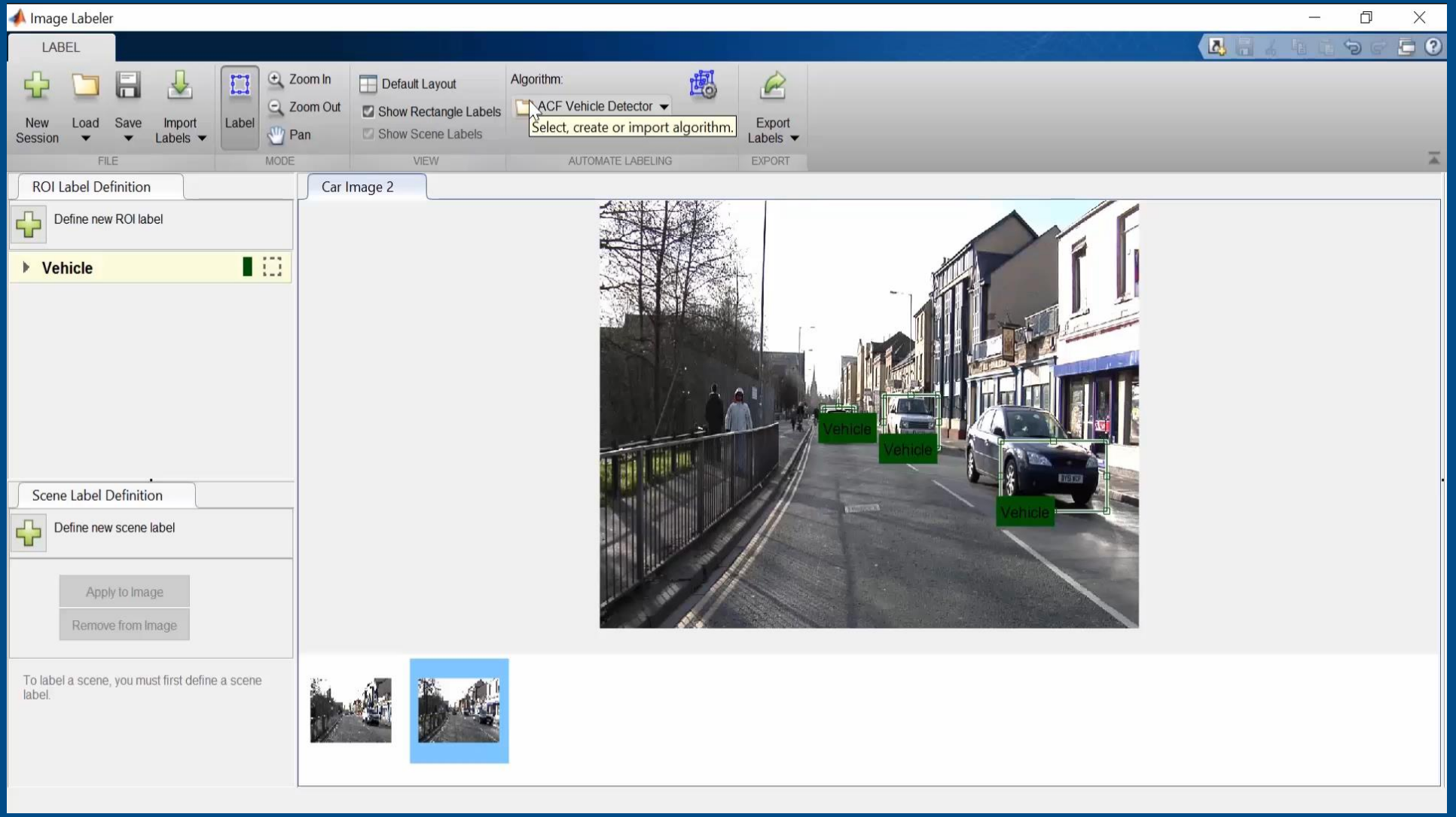
# Using Apps for Ground Truth Labeling

## Image and Video Data

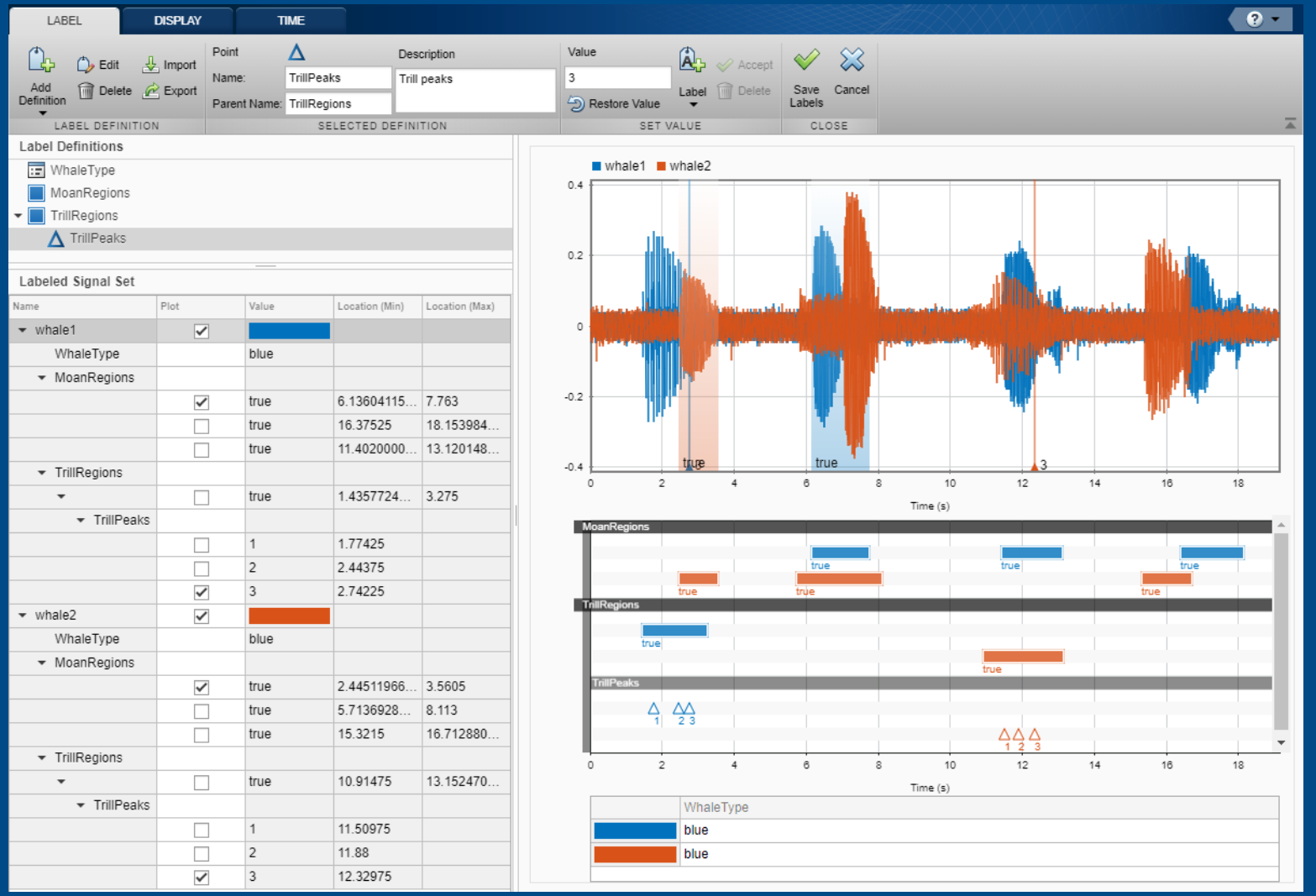



Computer Vision Toolbox

# Using Apps for Ground Truth Labeling

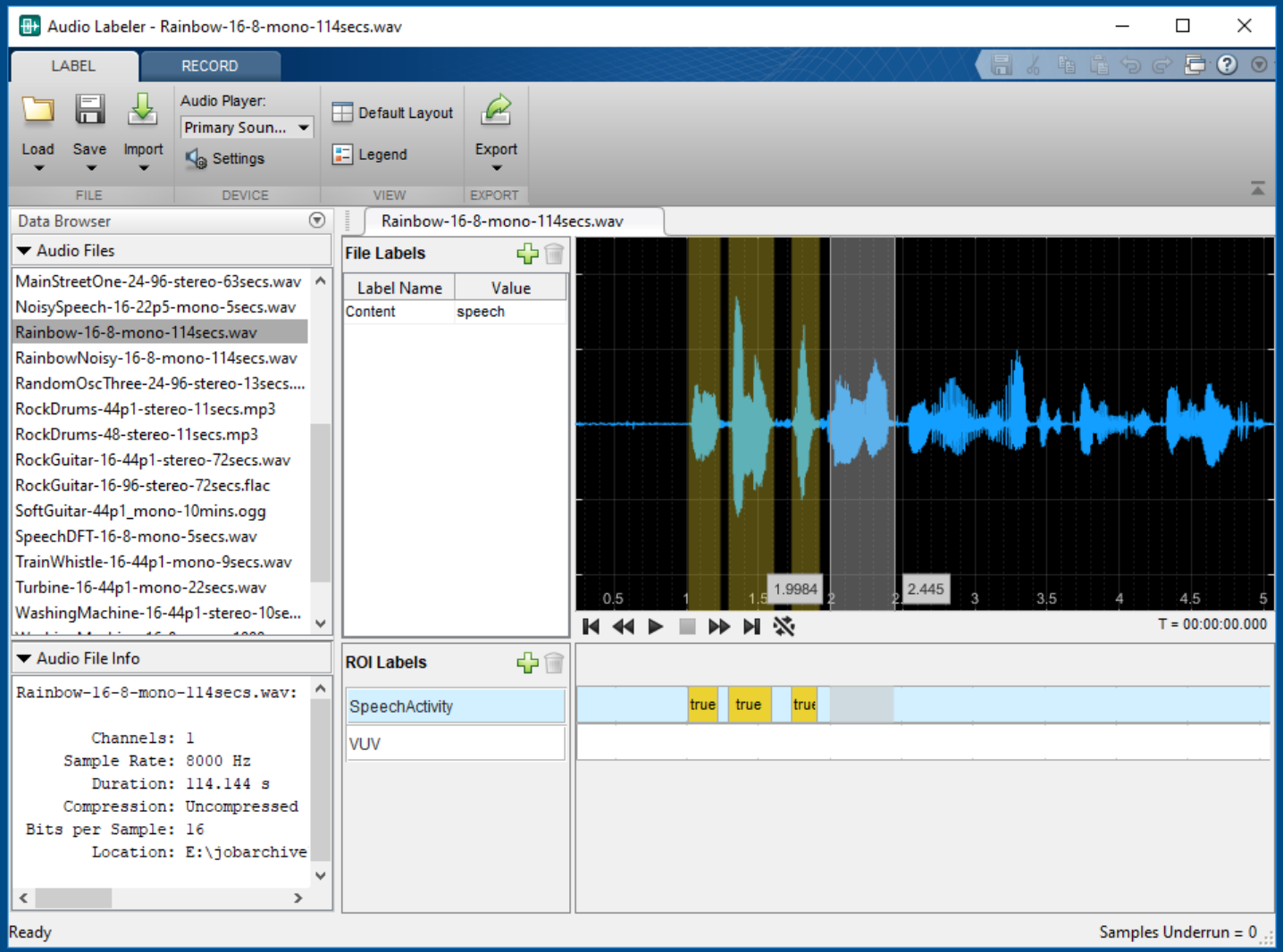
## Signal Data




Signal Processing Toolbox

# Using Apps for Ground Truth Labeling

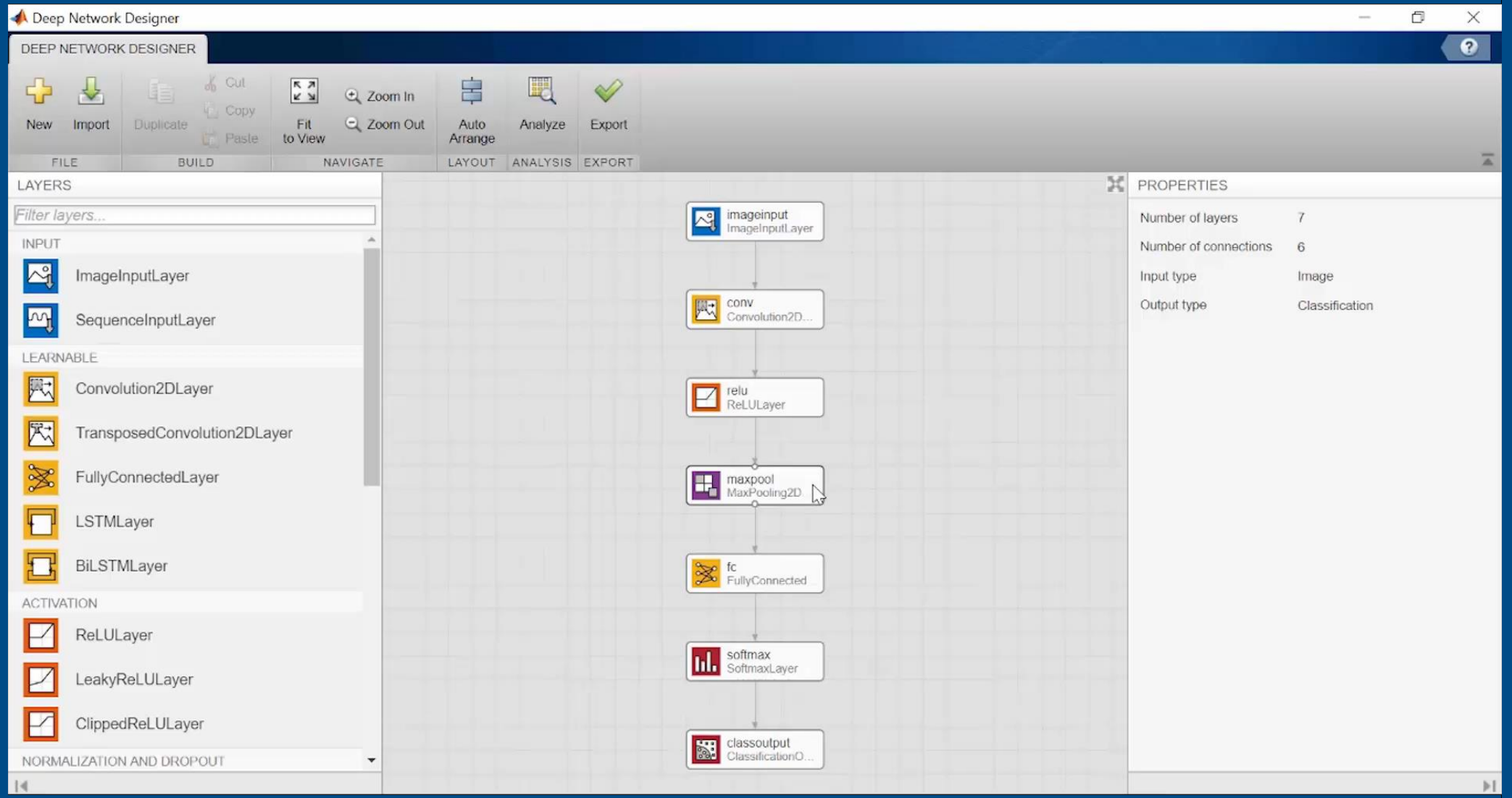
## Audio Data





# Using Apps for Designing Deep Learning Networks




Deep Learning Toolbox

# Using Transfer Learning with Pre-trained Models

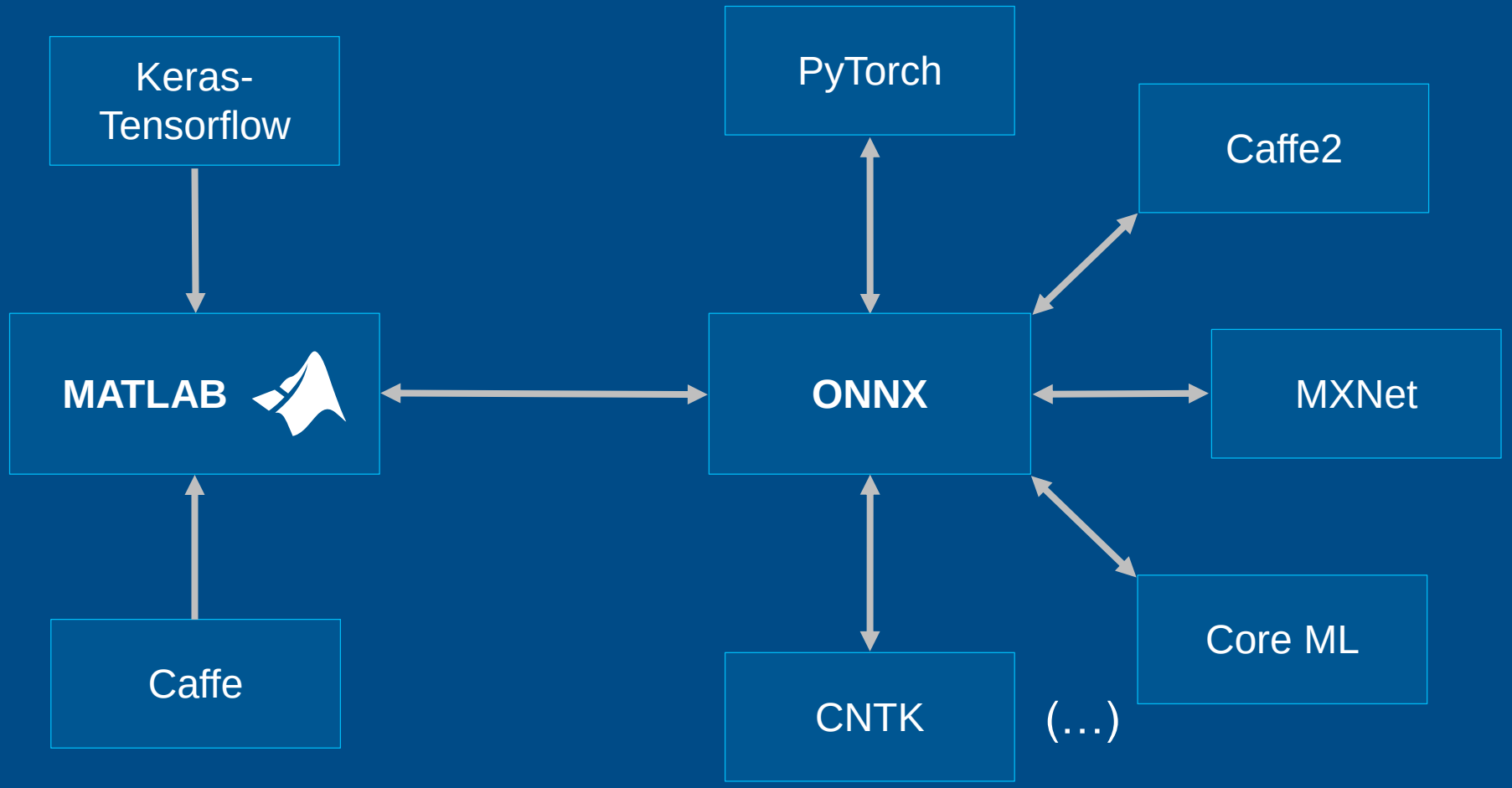
| | | | |
|---|---|---|---|
| Inception-v3 | ResNet-101 | VGG-16 | Inception-ResNet-v2 |
| ResNet-18 | GoogLeNet | DenseNet-201 | VGG-19 |
| SqueezeNet | AlexNet | ResNet-50 | Xception |

MobileNetV2

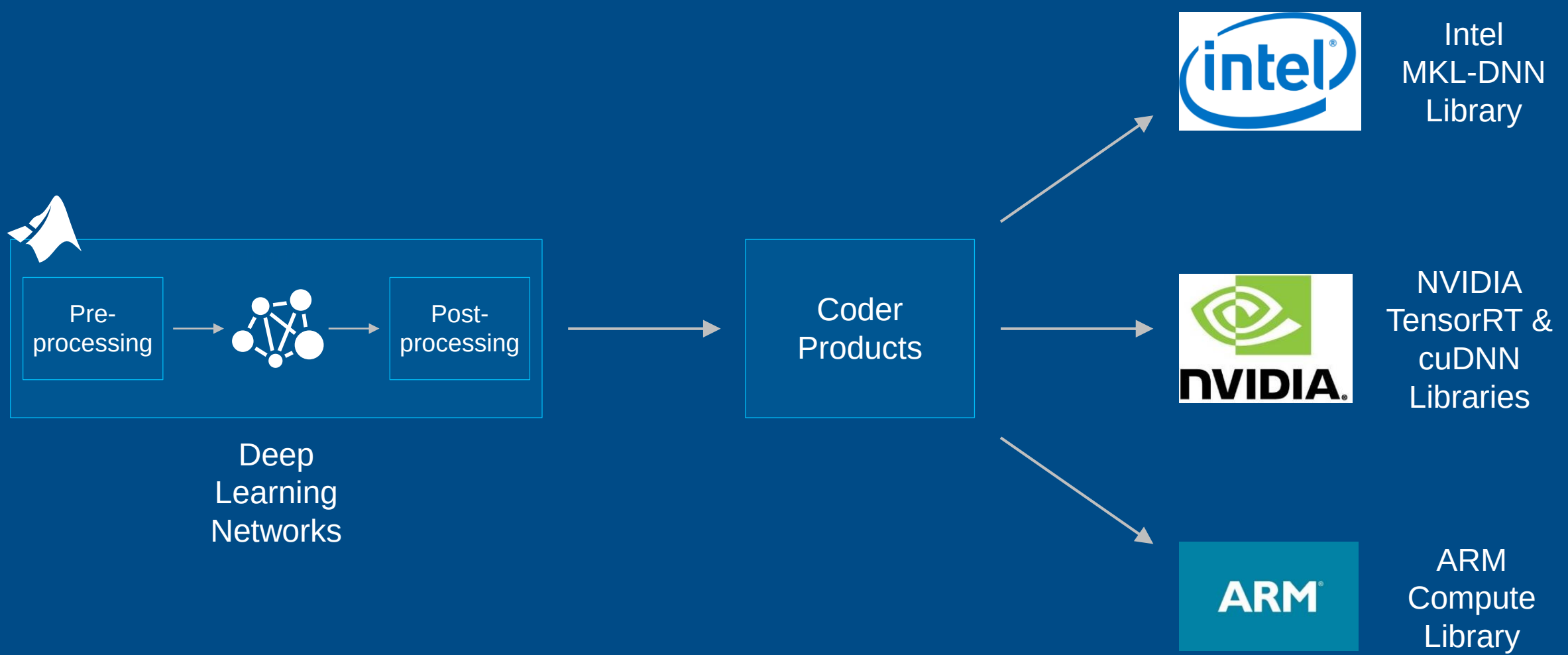


# Using Models from Other Frameworks

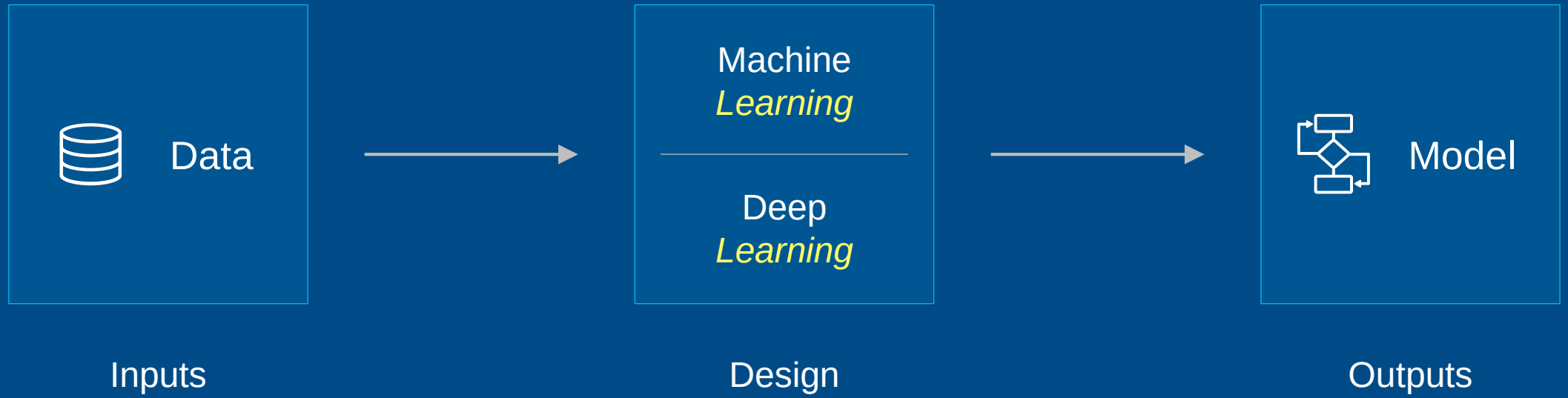


# Deploying Deep Learning Applications




**MATLAB Coder**
**GPU Coder**

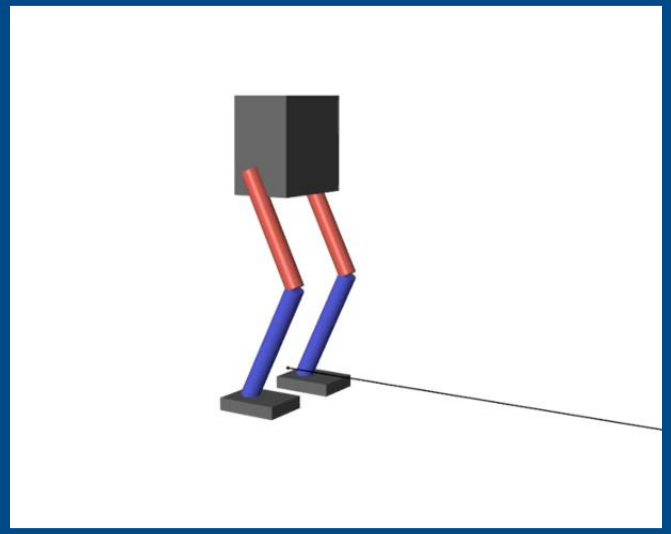
# Using MATLAB and Simulink for Reinforcement Learning

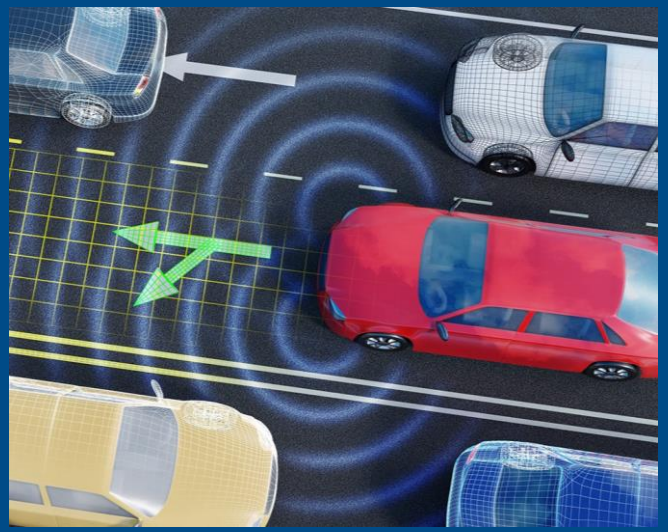



MATLAB&SIMULINK®

**Reinforcement Learning Toolbox**

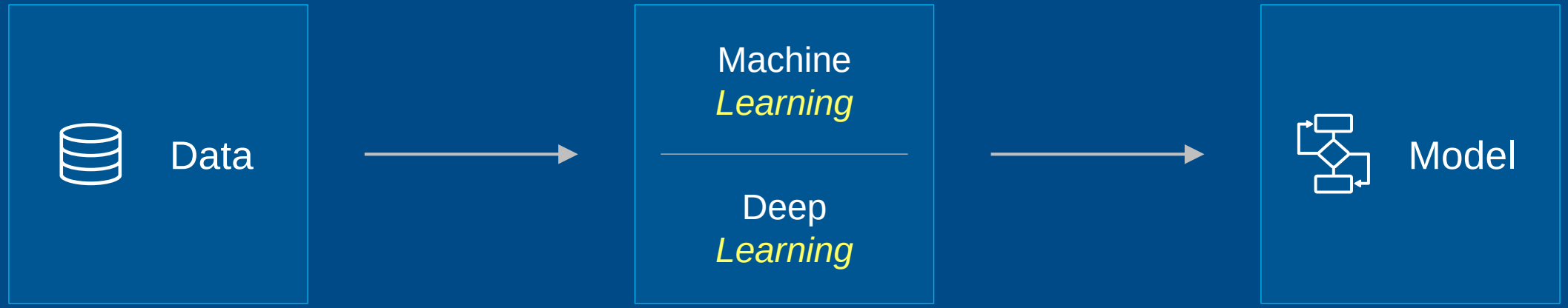
# Using MATLAB and Simulink for Reinforcement Learning





**Reinforcement Learning Toolbox**

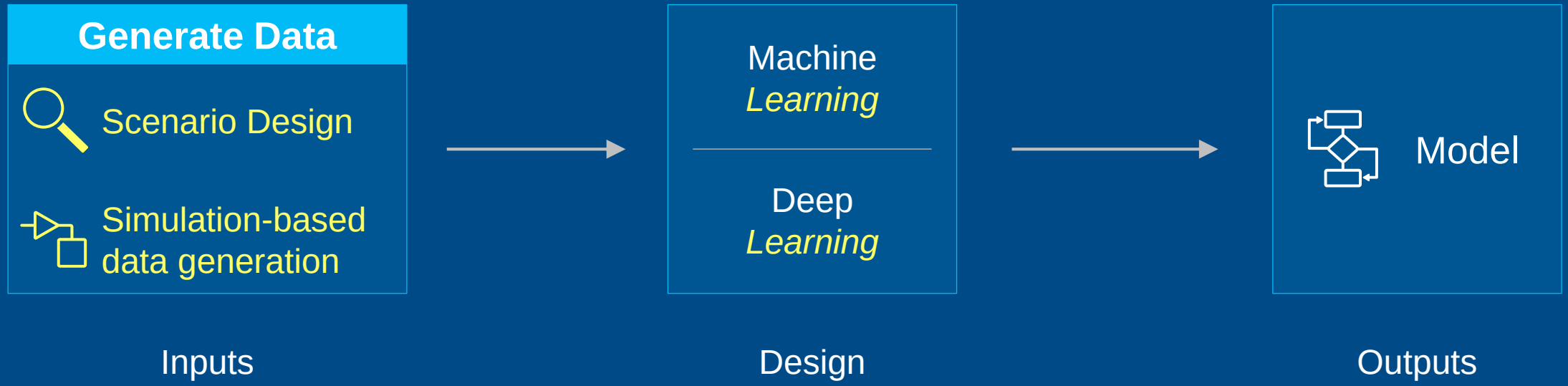
# Using MATLAB and Simulink for Reinforcement Learning




MATLAB&SIMULINK®

**Reinforcement Learning Toolbox**

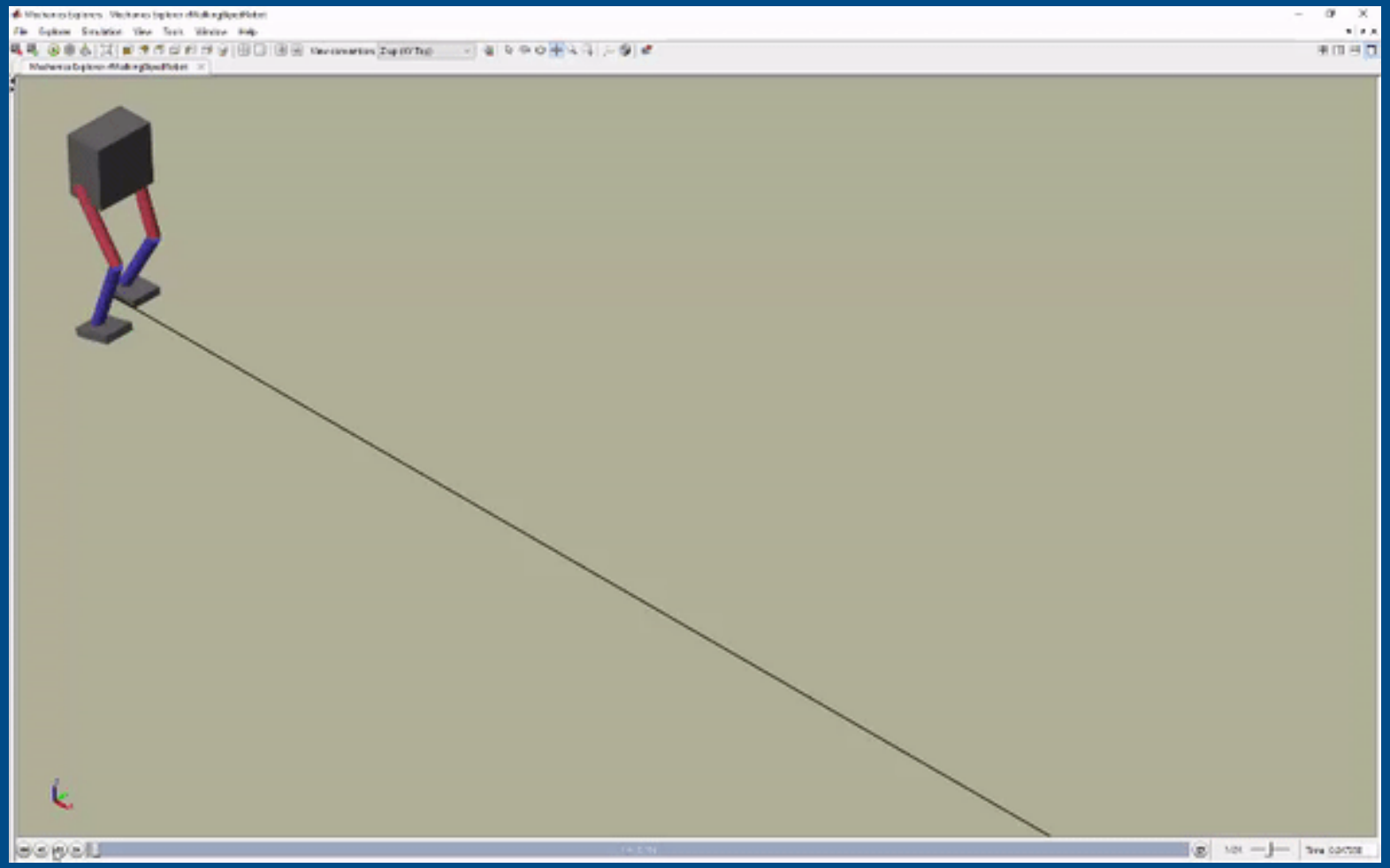
# Using MATLAB and Simulink for Reinforcement Learning




MATLAB&SIMULINK®

**Simulink**
**Reinforcement Learning Toolbox**

# Using MATLAB and Simulink for Reinforcement Learning



**Reinforcement Learning Toolbox**

# Using MATLAB & Simulink to Build Algorithms in Everything

Inputs

Design

Outputs

MATLAB&SIMULINK®

# Working with Text Data

Vehicle_Repairs.csv

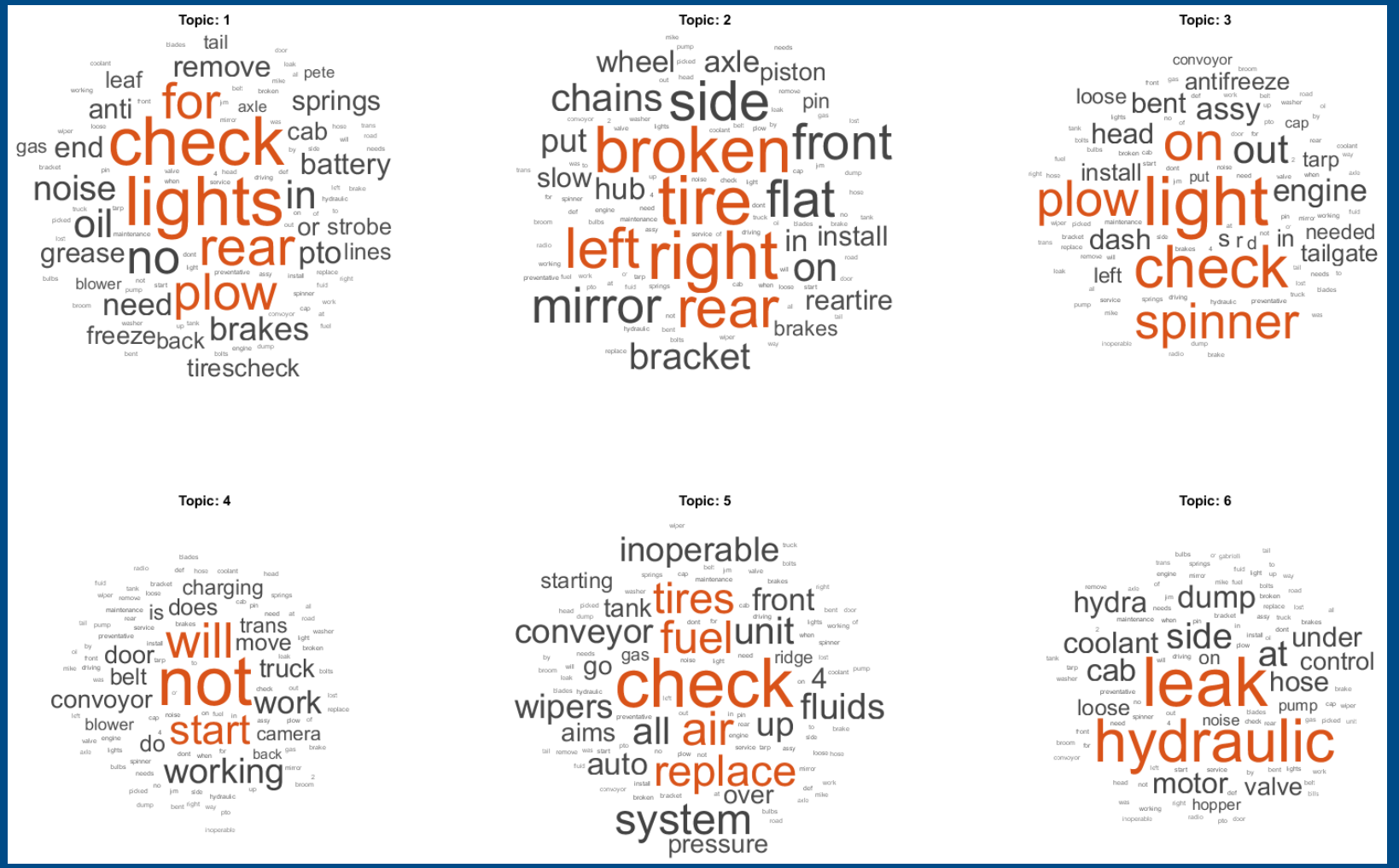
```
Dept,JobDate,jobno,Vehicleid,UnitNo,Reason,Notes,CostParts,CostLabor,CostTotal
1020,01/06/2015 12:00:00 AM,14073,118743,14,04    DRIVER'S REPORT,"PM SERVICE, CHECK TURN SIGNAL, CLUNKING NOISE WHEN DRIVING",493.85,0,493.85
1020,01/14/2015 12:00:00 AM,14232,230973,13,08    PM SERVICE             ***,"SERVICEROB,EXT,5604",38.869999999999997,0,38.869999999999997
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,O01469      ,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 SERVIVE",4697.55,0,
```

# Working with Text Data

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

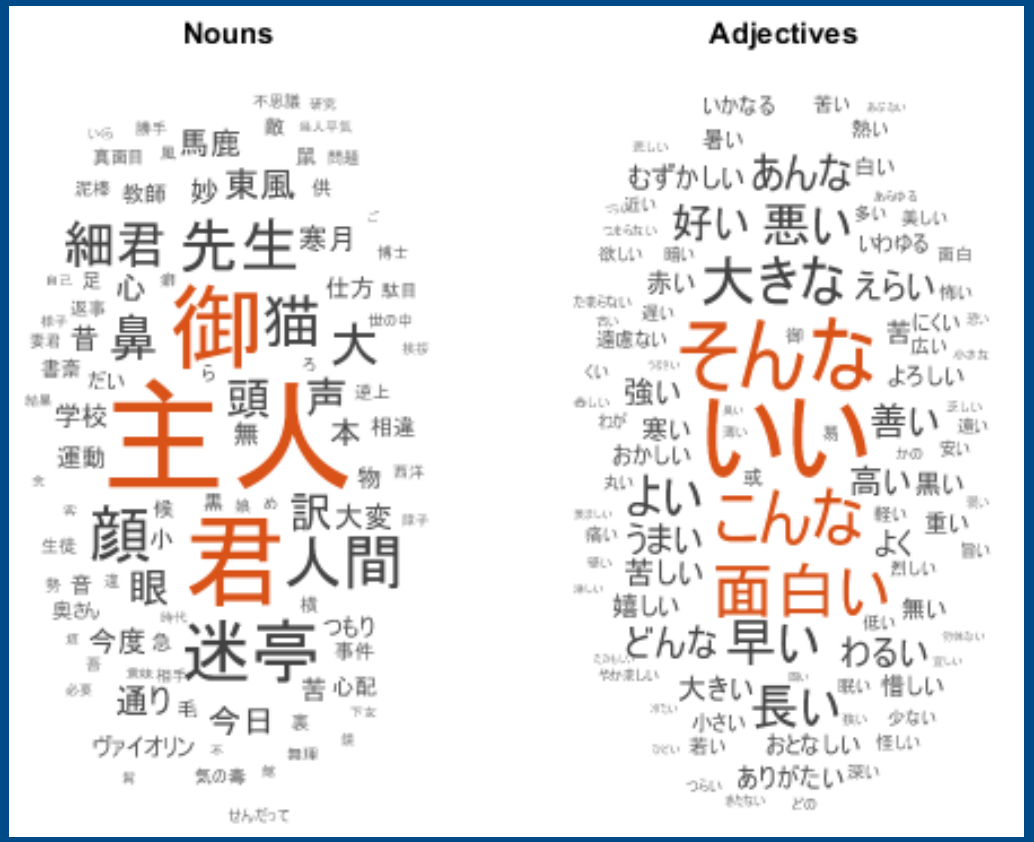
| Reason | | Notes |
|---|---|---|
| "04 DRIVER'S REPORT" | | "PM SERVICE, CHECK TURN SIGNAL, CLUNKING NOISE WHEN DRIVING" |
| "08 PM SERVICE | ***" | "SERVICEROB,EXT,5604" |
| "04 DRIVER'S REPORT" | | "NEED 4 PLOW PINS" |
| "04 DRIVER'S REPORT" | | "INSTALL SPINNER ASSY" |
| "13 SNOW BREAKDOWN" | | "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" |

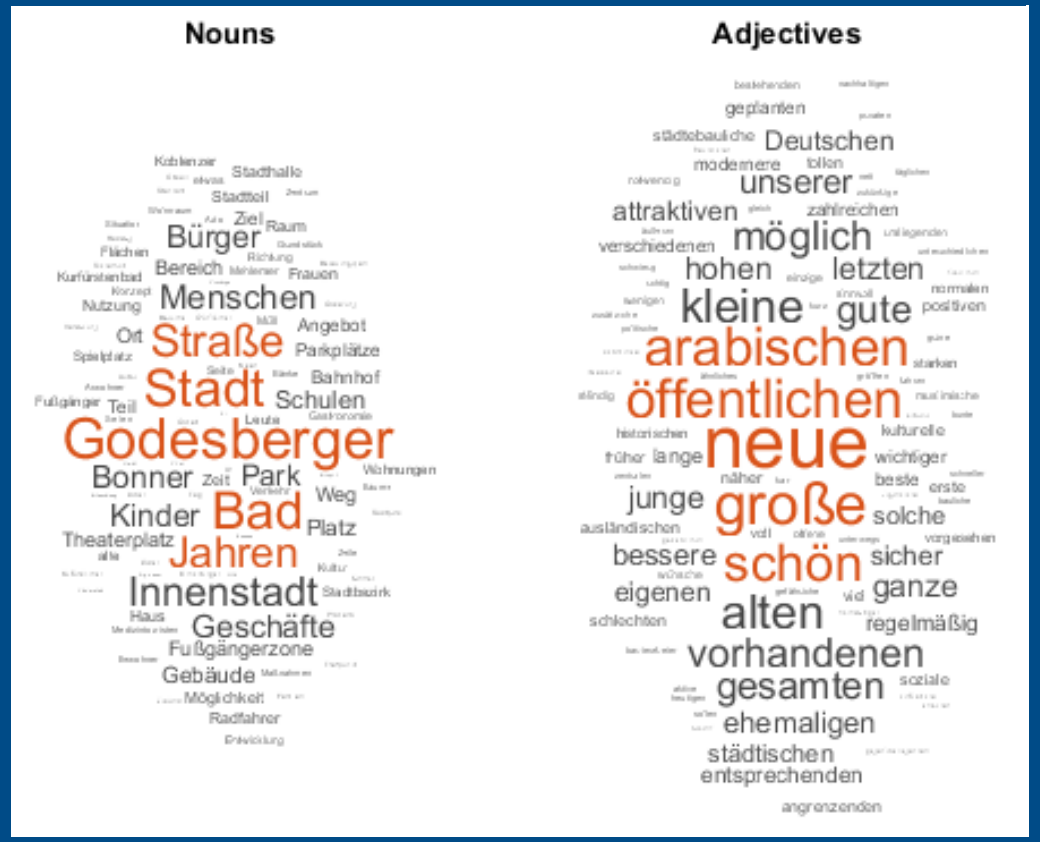
# Working with Text Data




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

# Working with Text Data

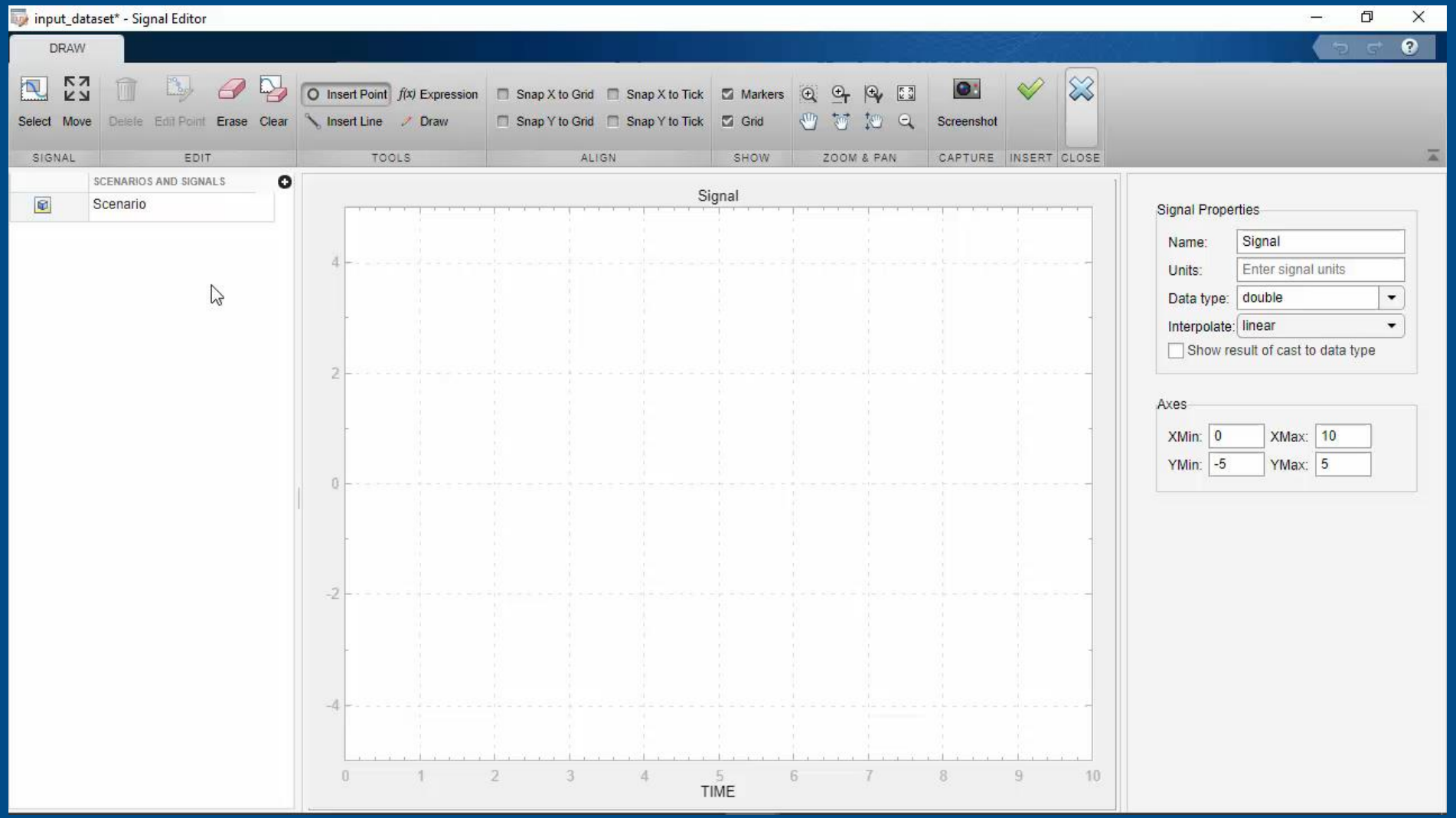



**Text Analytics Toolbox**
**MATLAB**

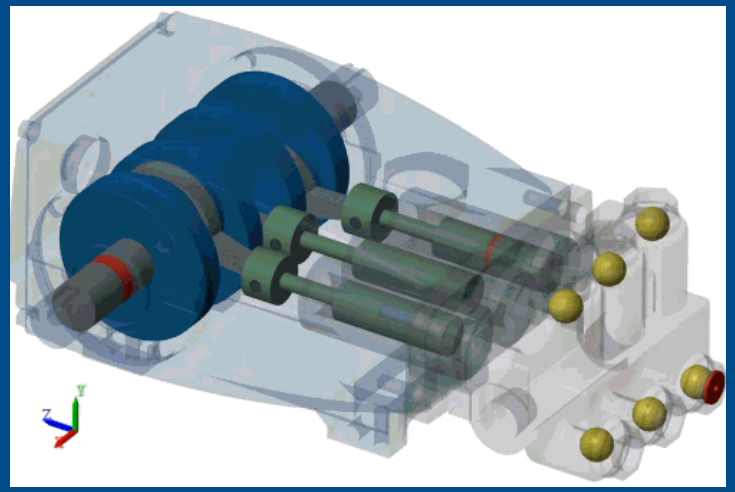
 

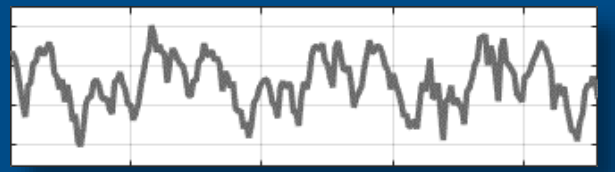
# Creating Your Own Data





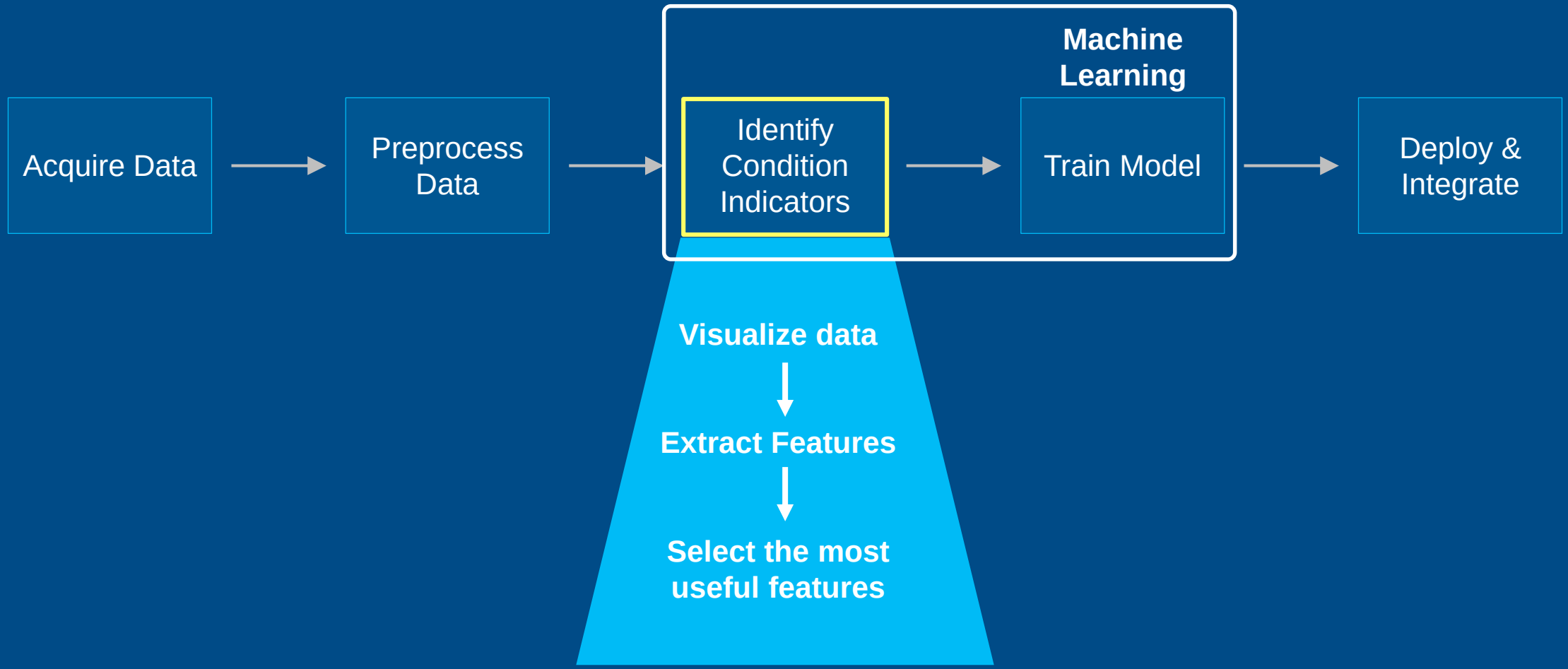

 



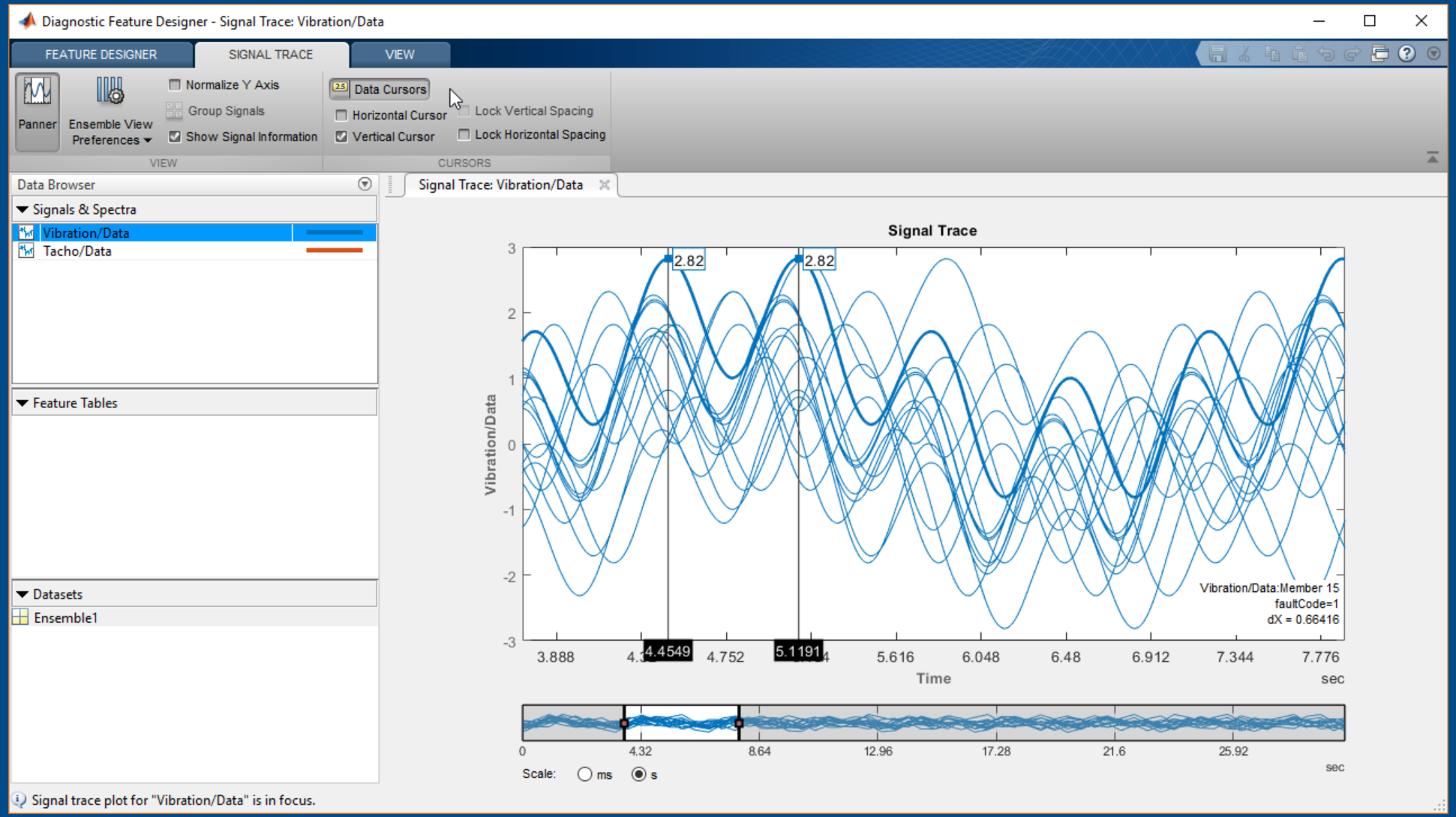


# Identifying the Useful Data

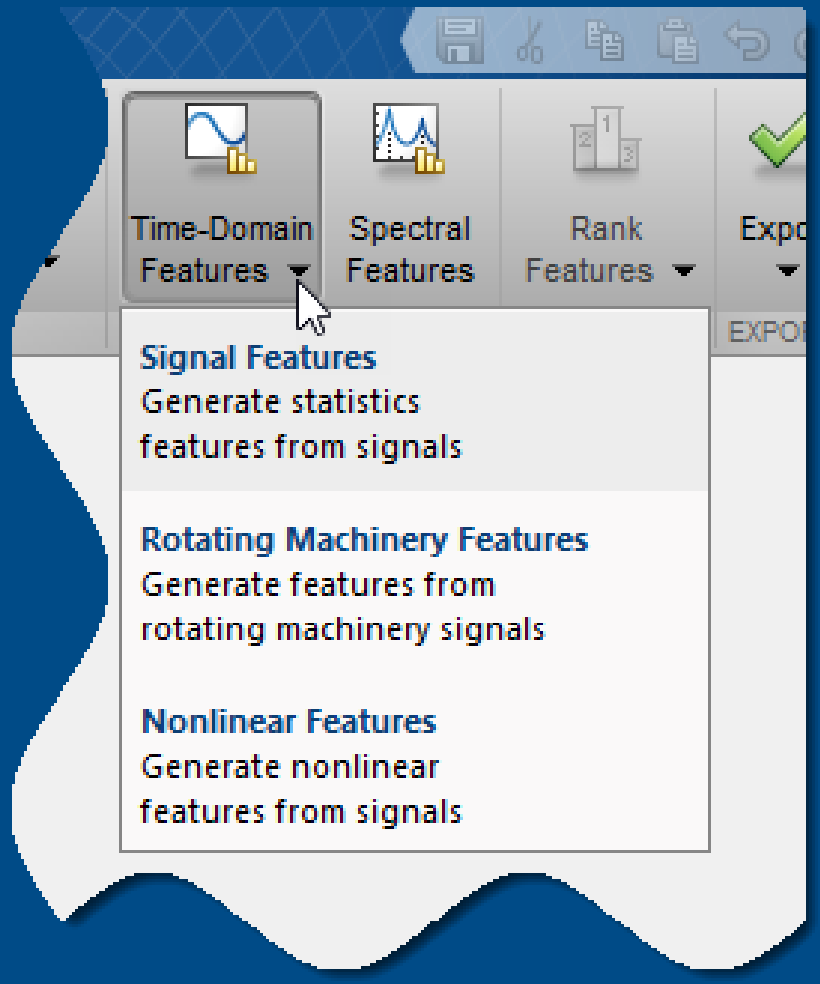


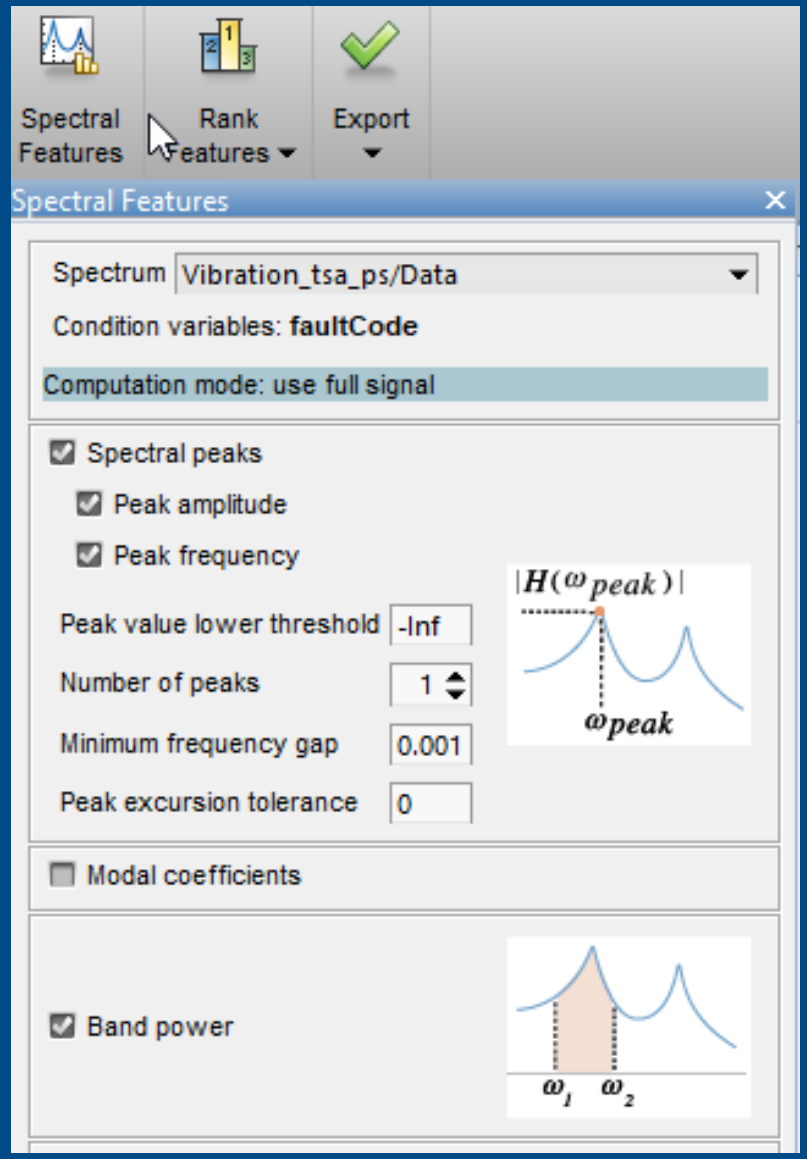
# Identifying the Useful Data




**Predictive Maintenance Toolbox**

# Identifying the Useful Data

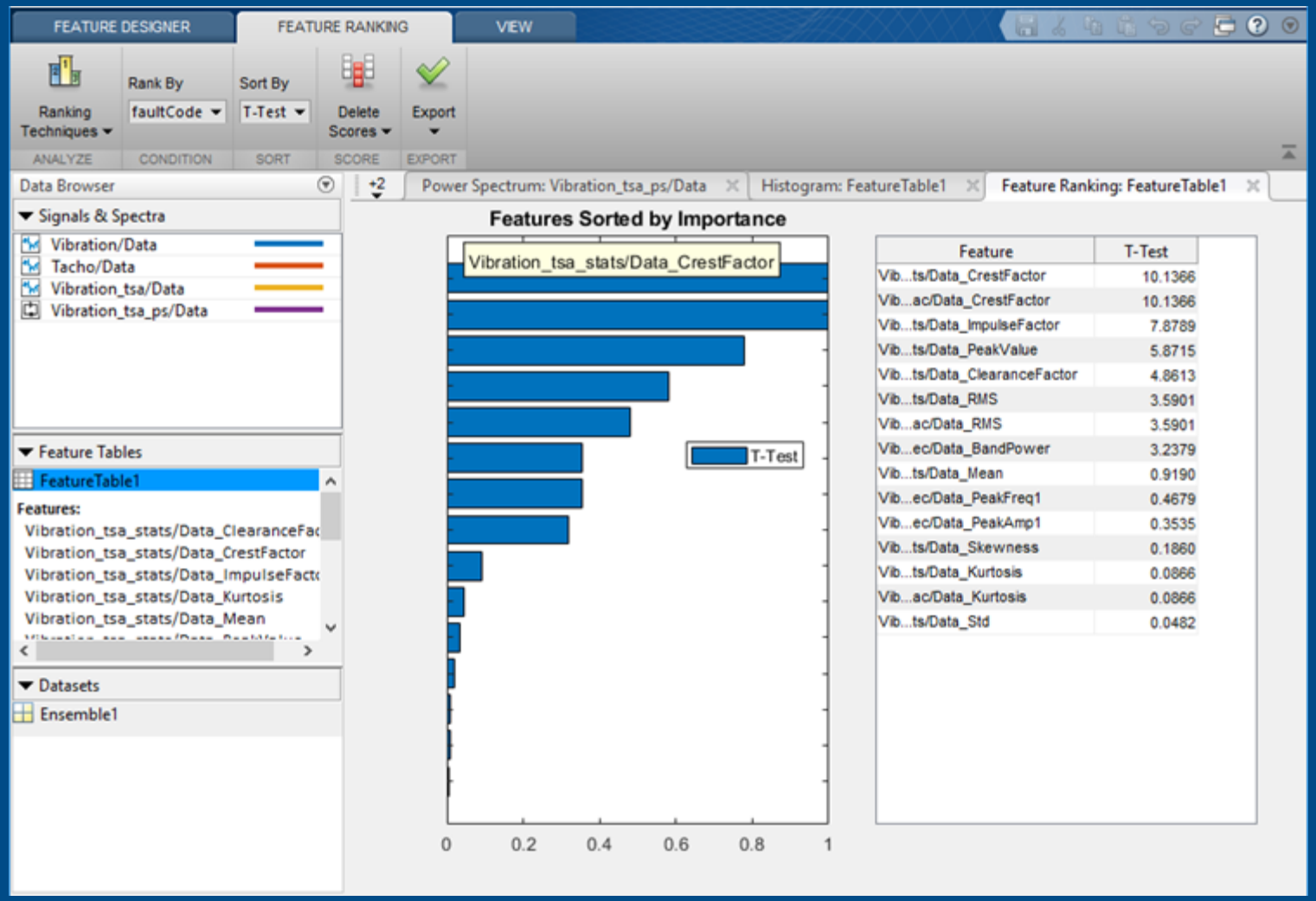




# Identifying the Useful Data

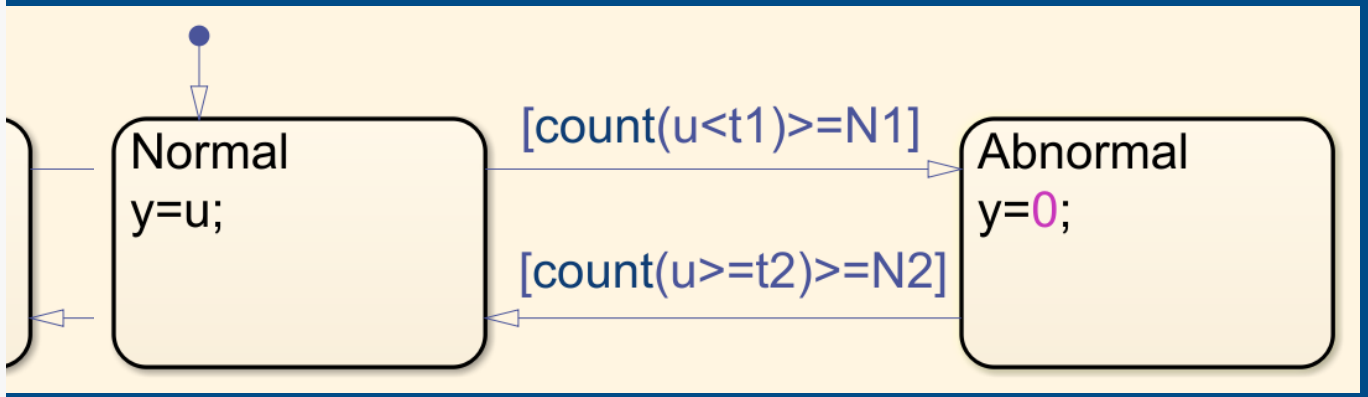




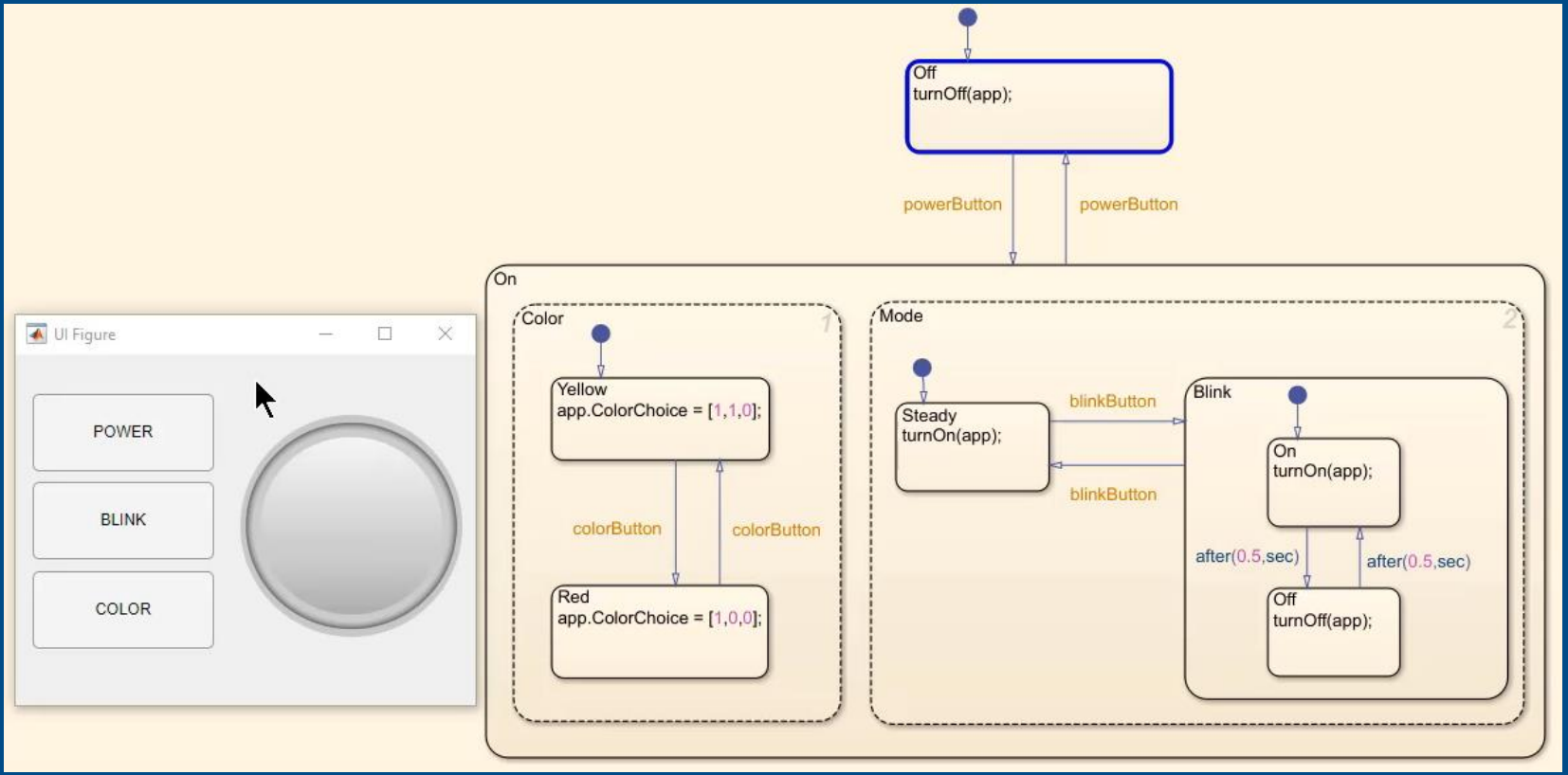
# Designing Decision Logic with Stateflow

```
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
```




Stateflow
MATLAB

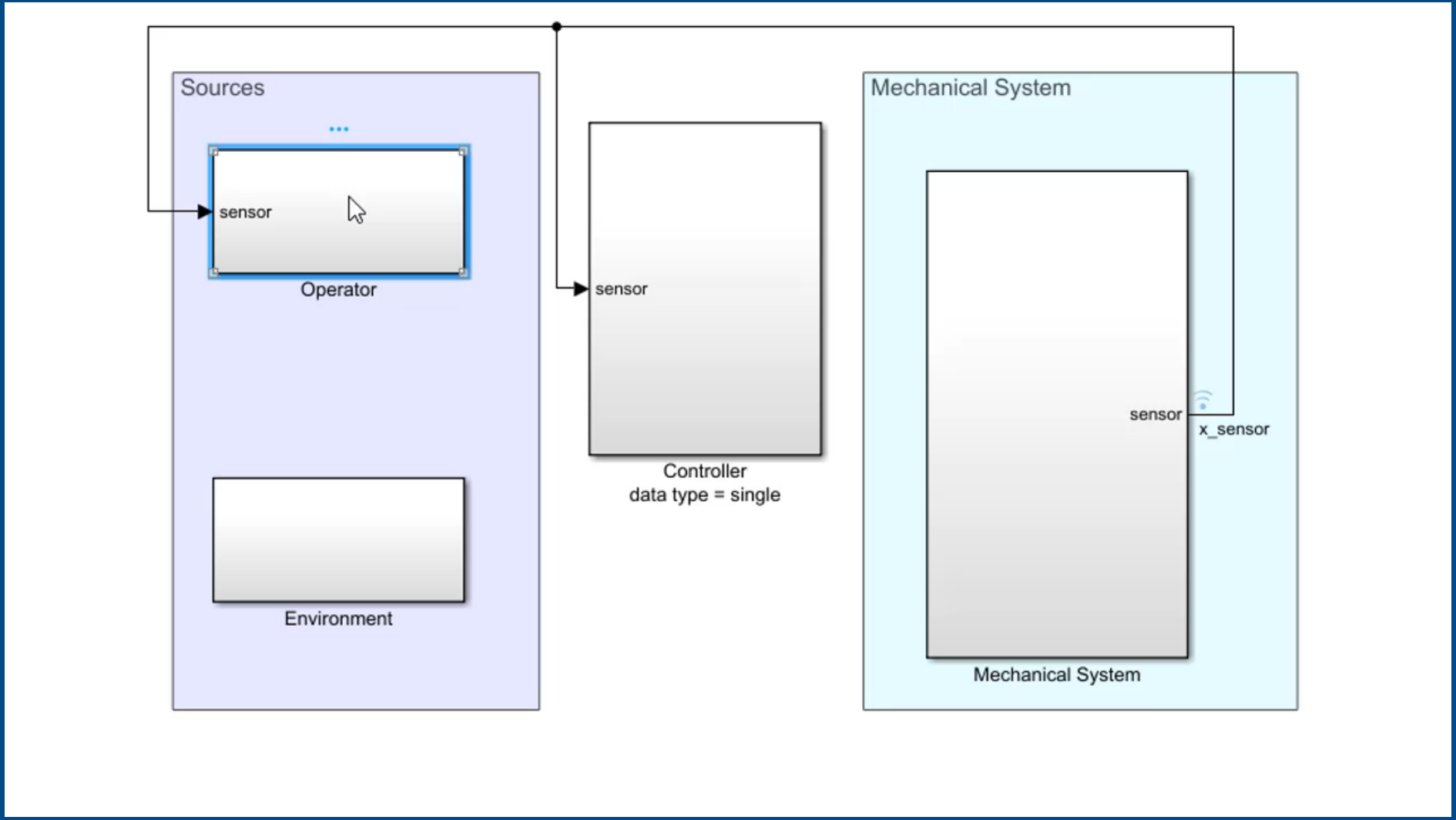
# Using Stateflow in MATLAB



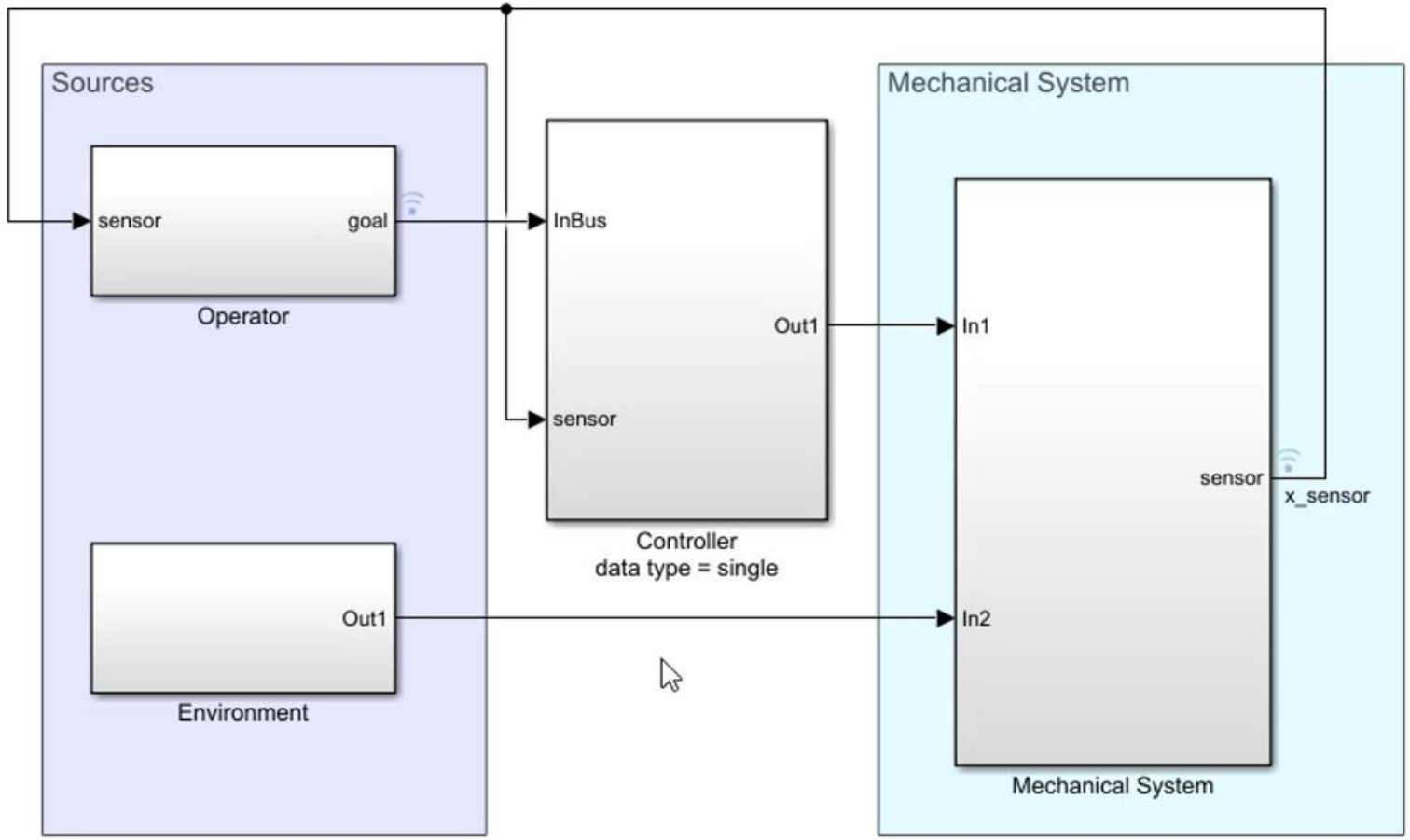

```
    % Callbacks that handle component events
    methods (Access = private)

        % 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
```

**Stateflow**
**MATLAB**

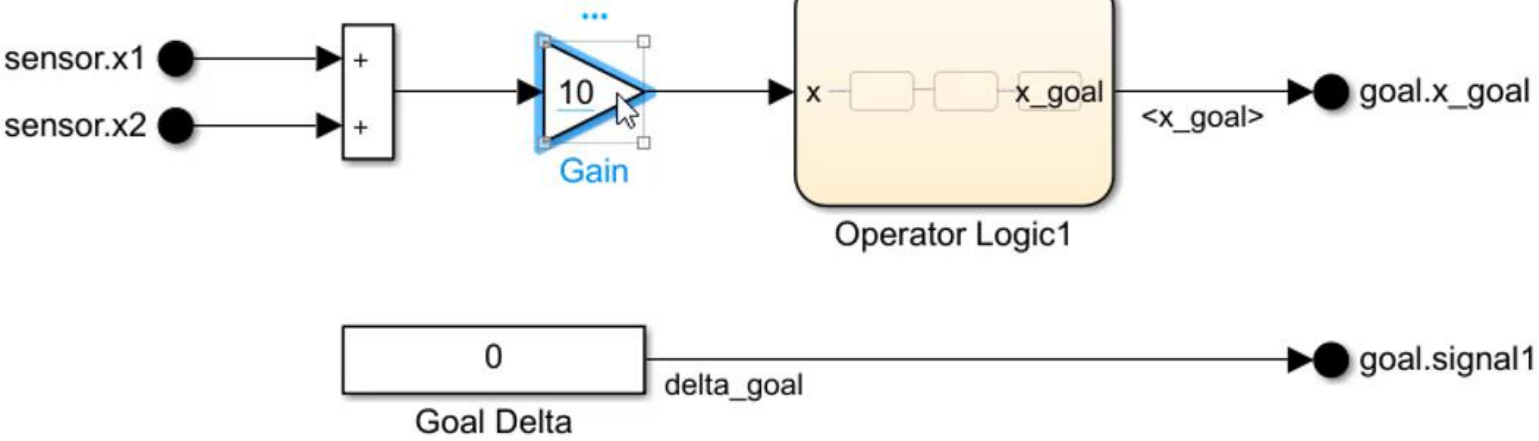
# Editing at the Speed of Thought



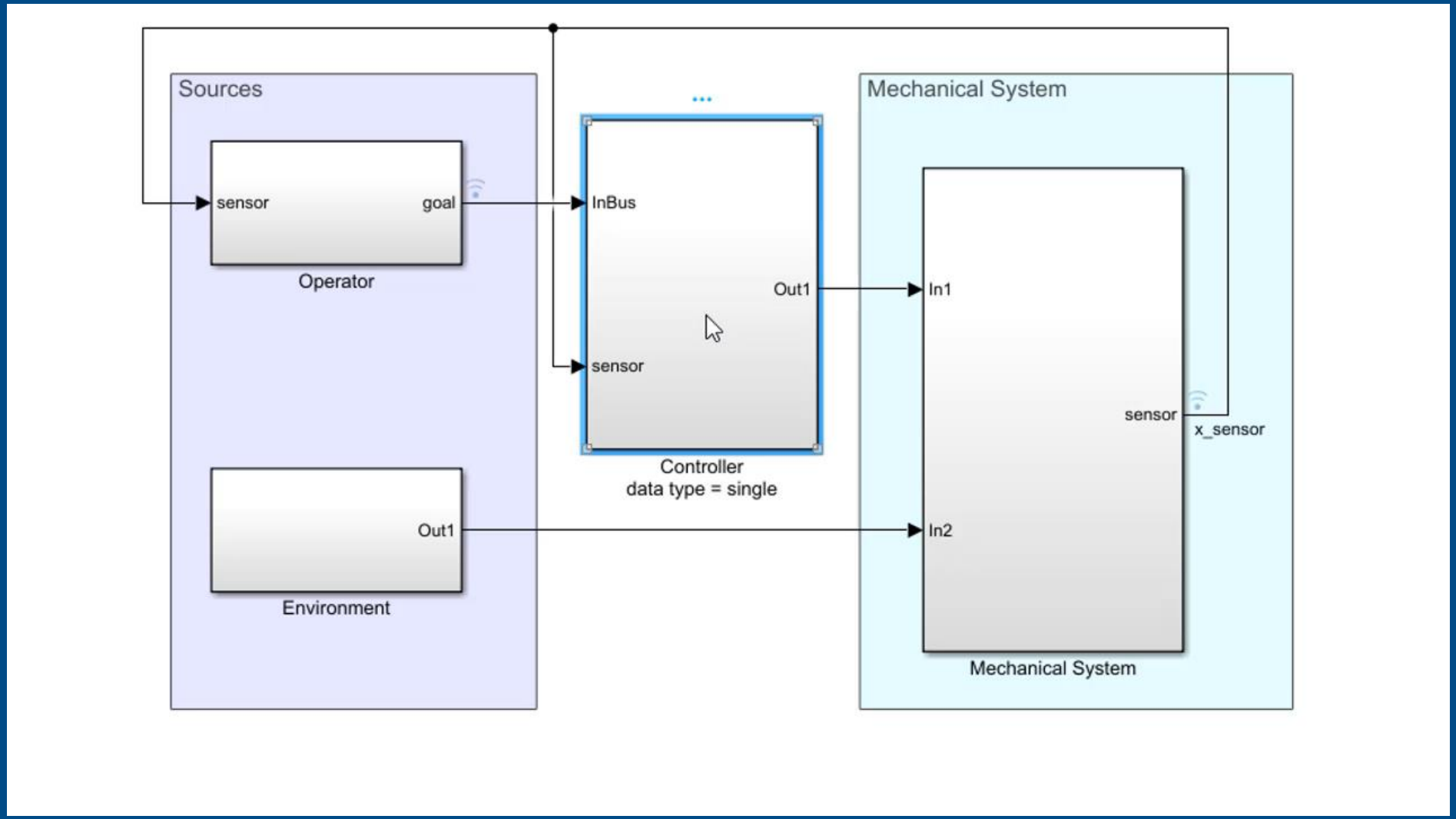
# Editing at the Speed of Thought



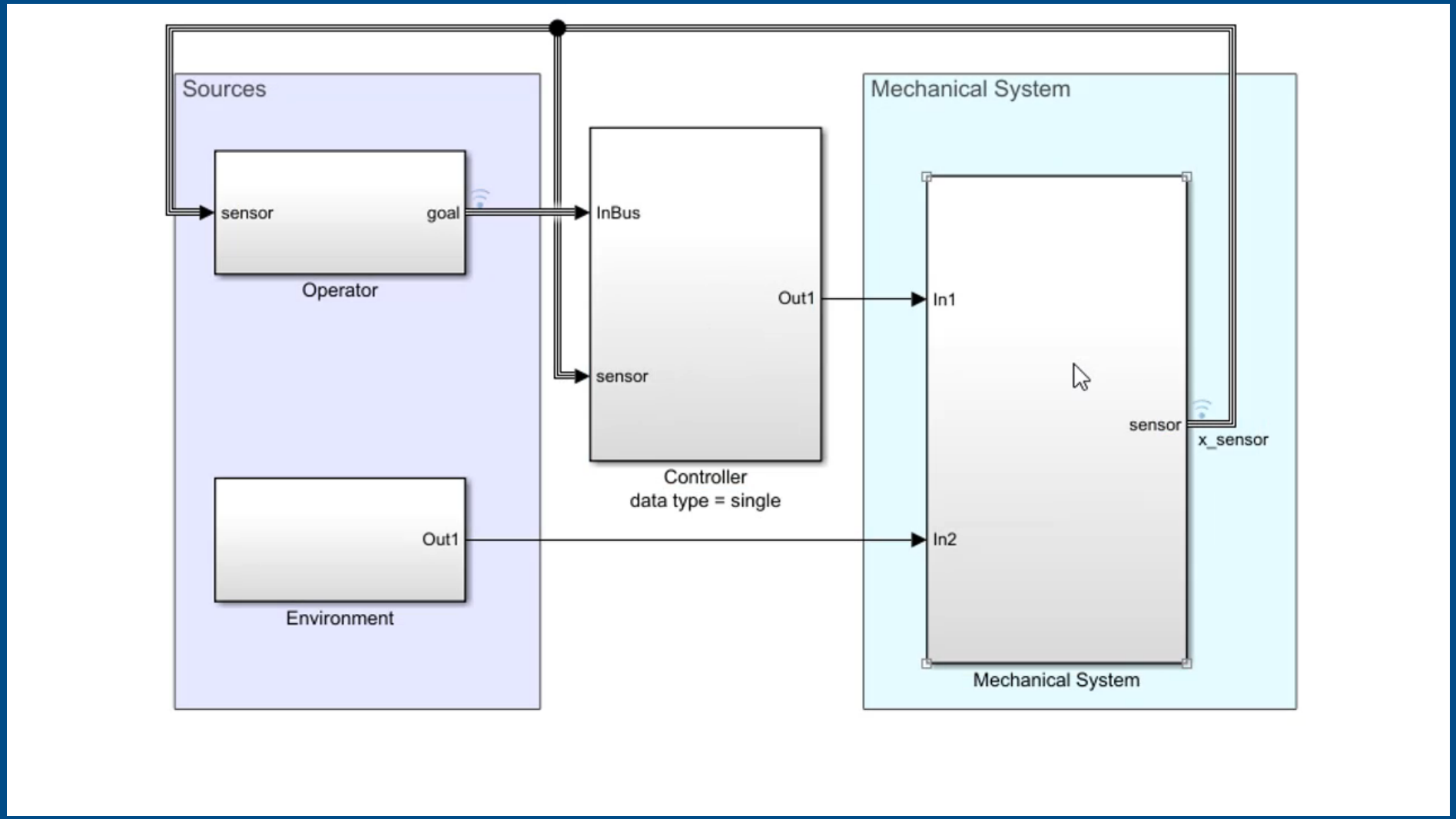
# Editing at the Speed of Thought



# Editing at the Speed of Thought

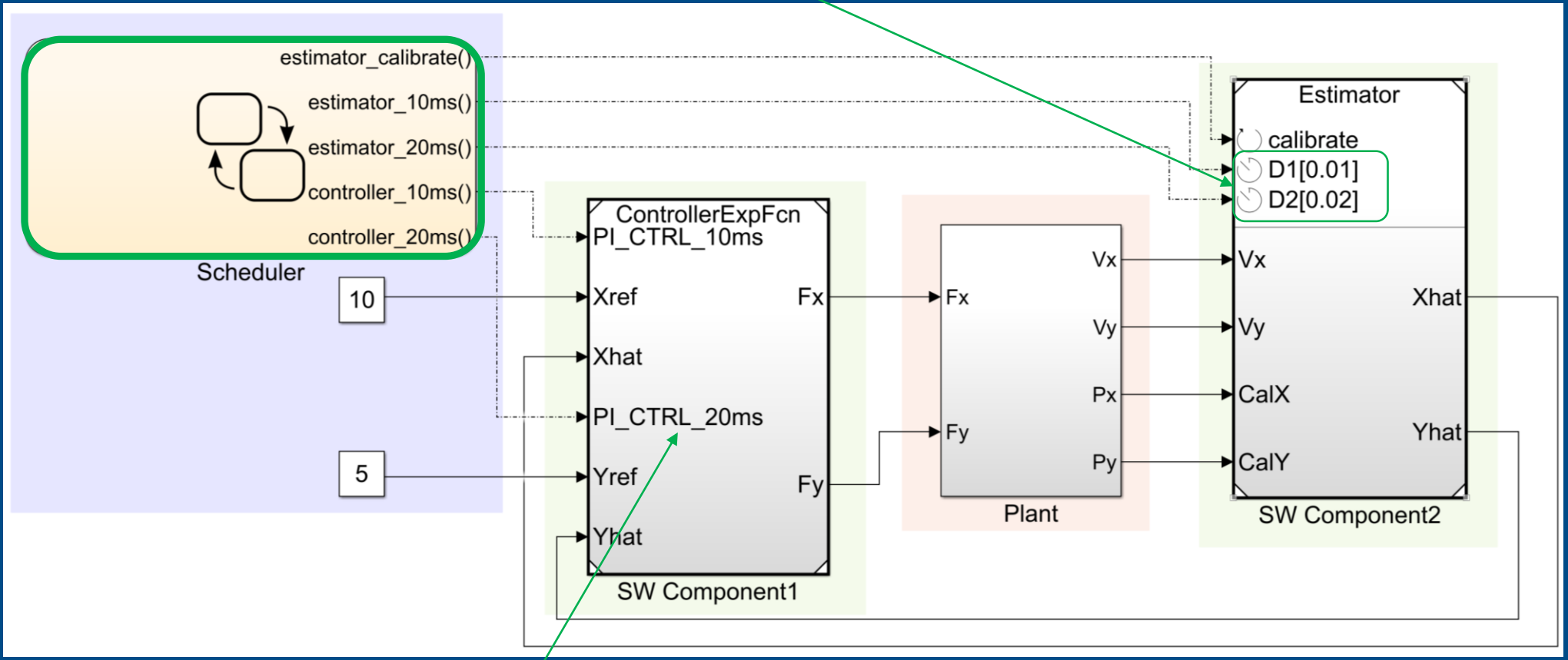


# Editing at the Speed of Thought



# Controlling the Execution of Model Components

Schedulable Rate-Based Model

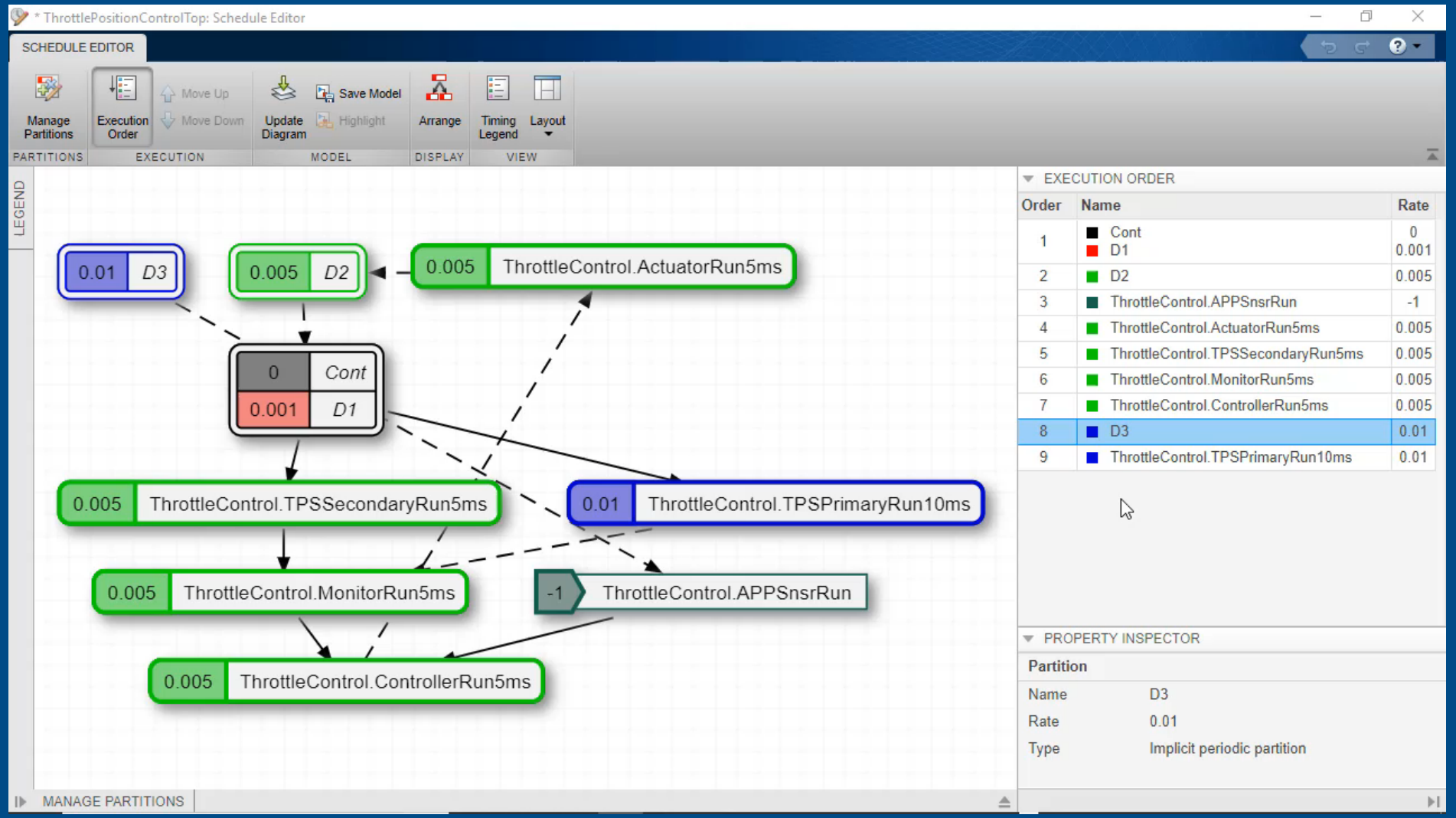



Export Function Model



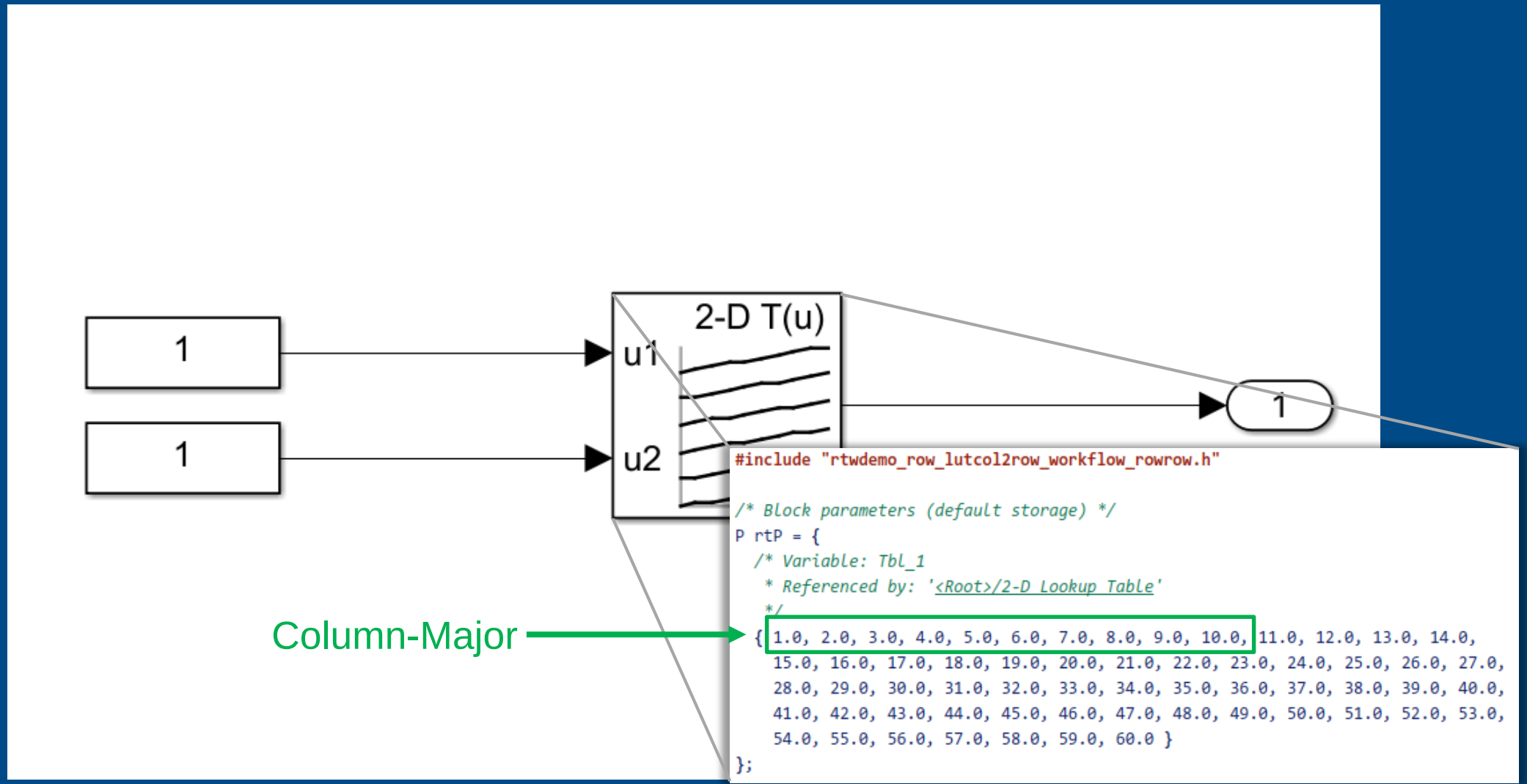
# Controlling the Execution of Model Components



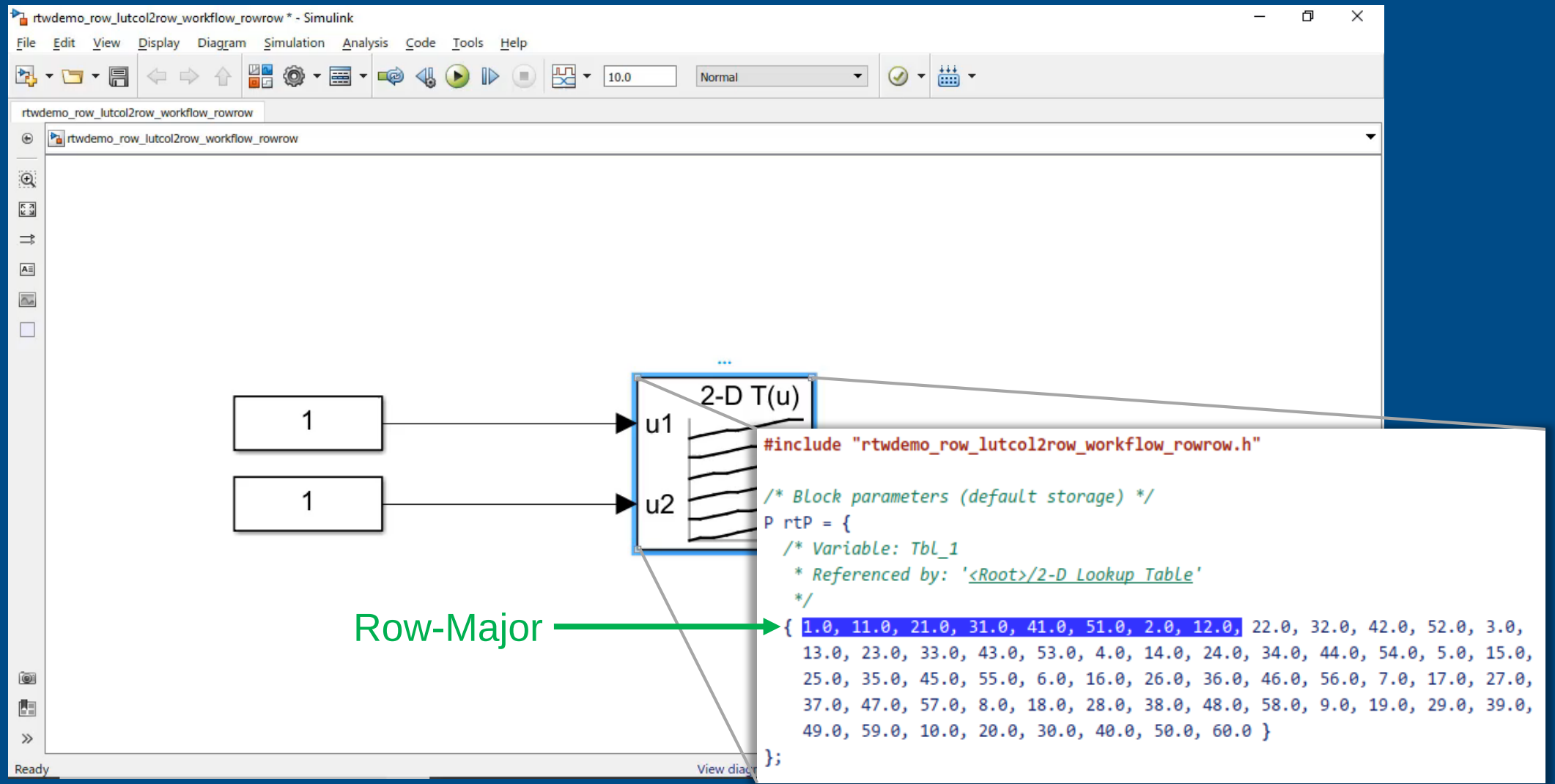


# Simplifying Integration with External C/C++ Code



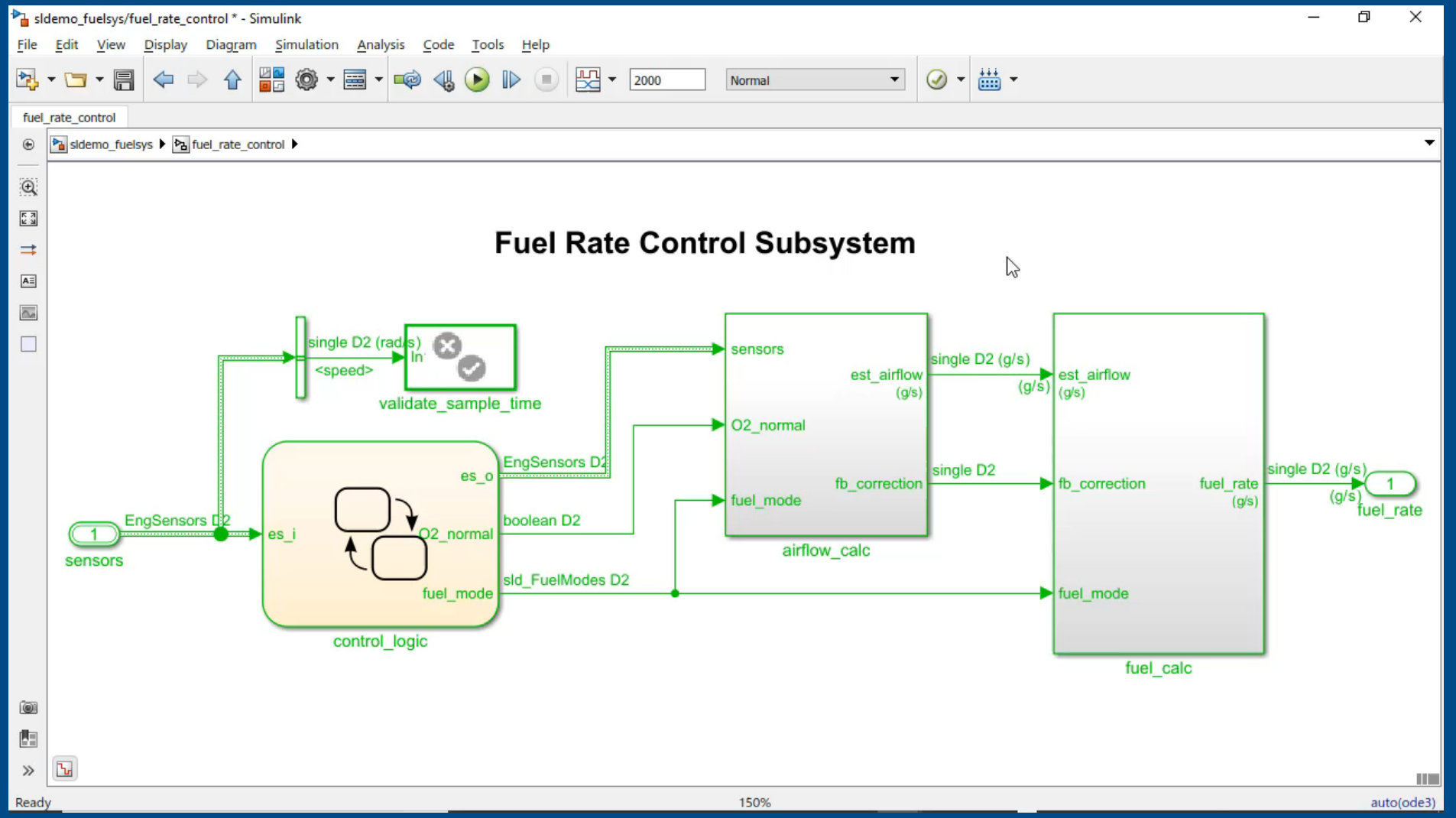
# Simplifying Integration with External C/C++ Code





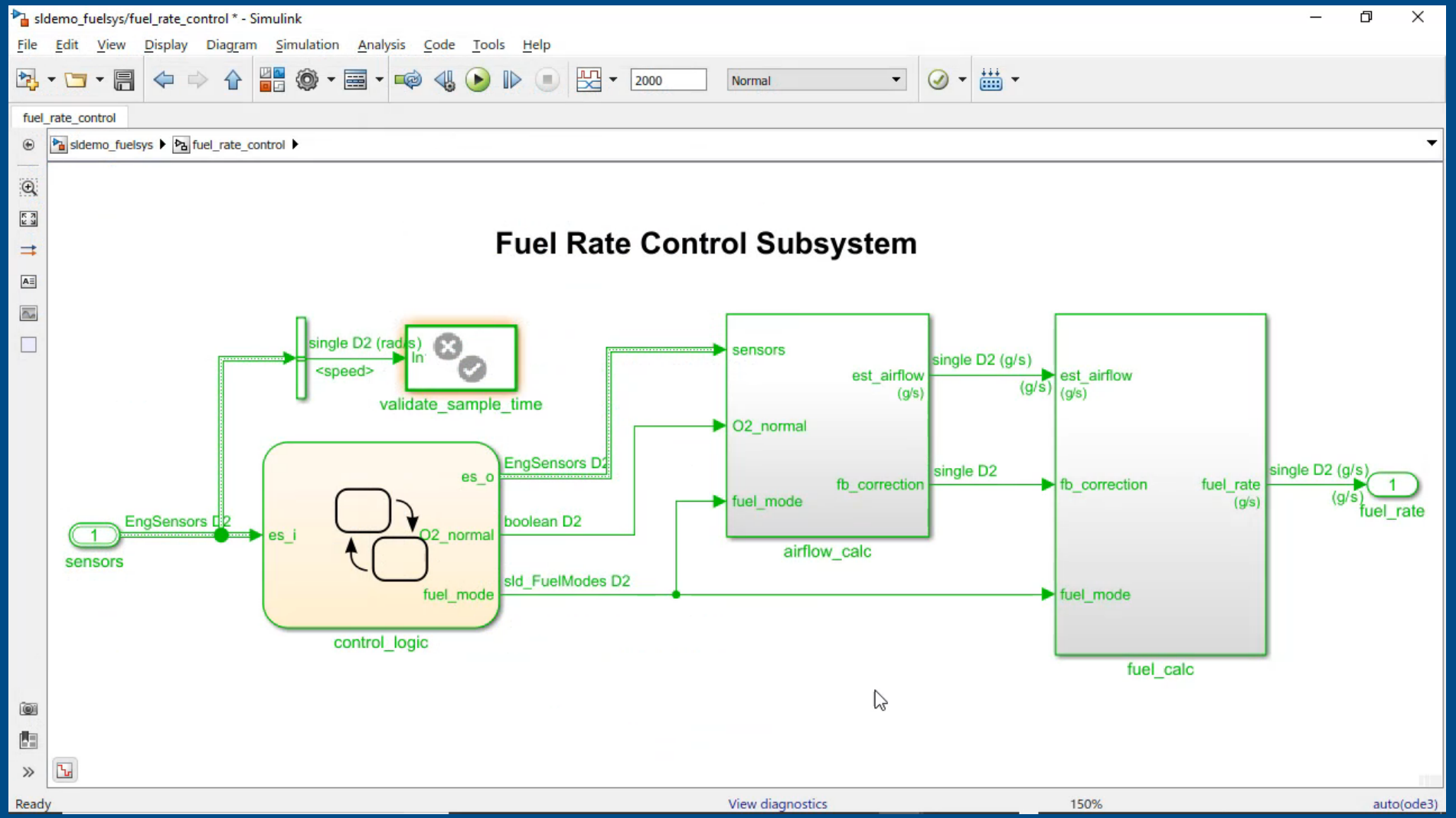
# Viewing Generated Code Alongside the Model




Embedded Coder

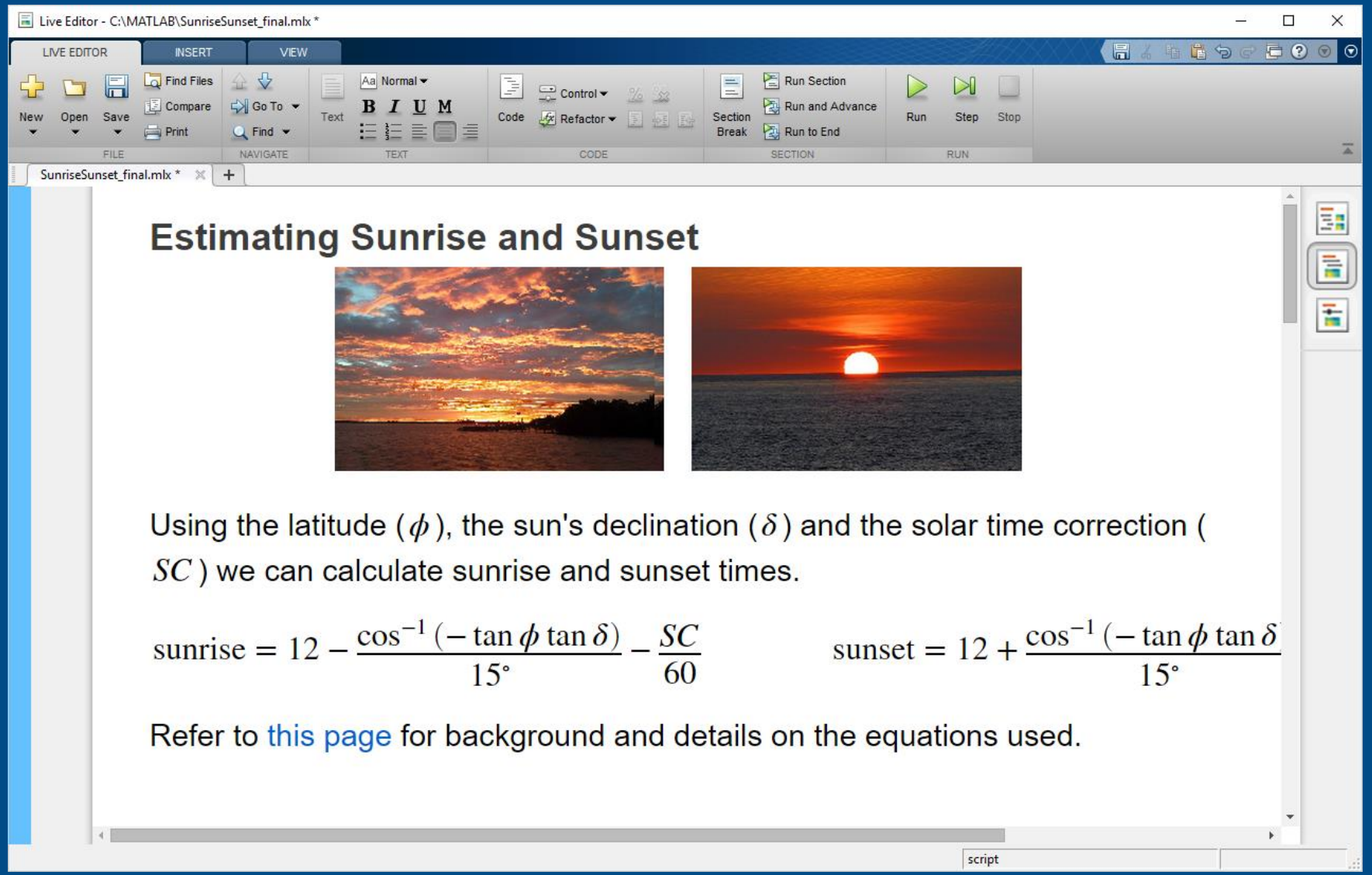
# Viewing Generated Code Alongside the Model




Embedded Coder

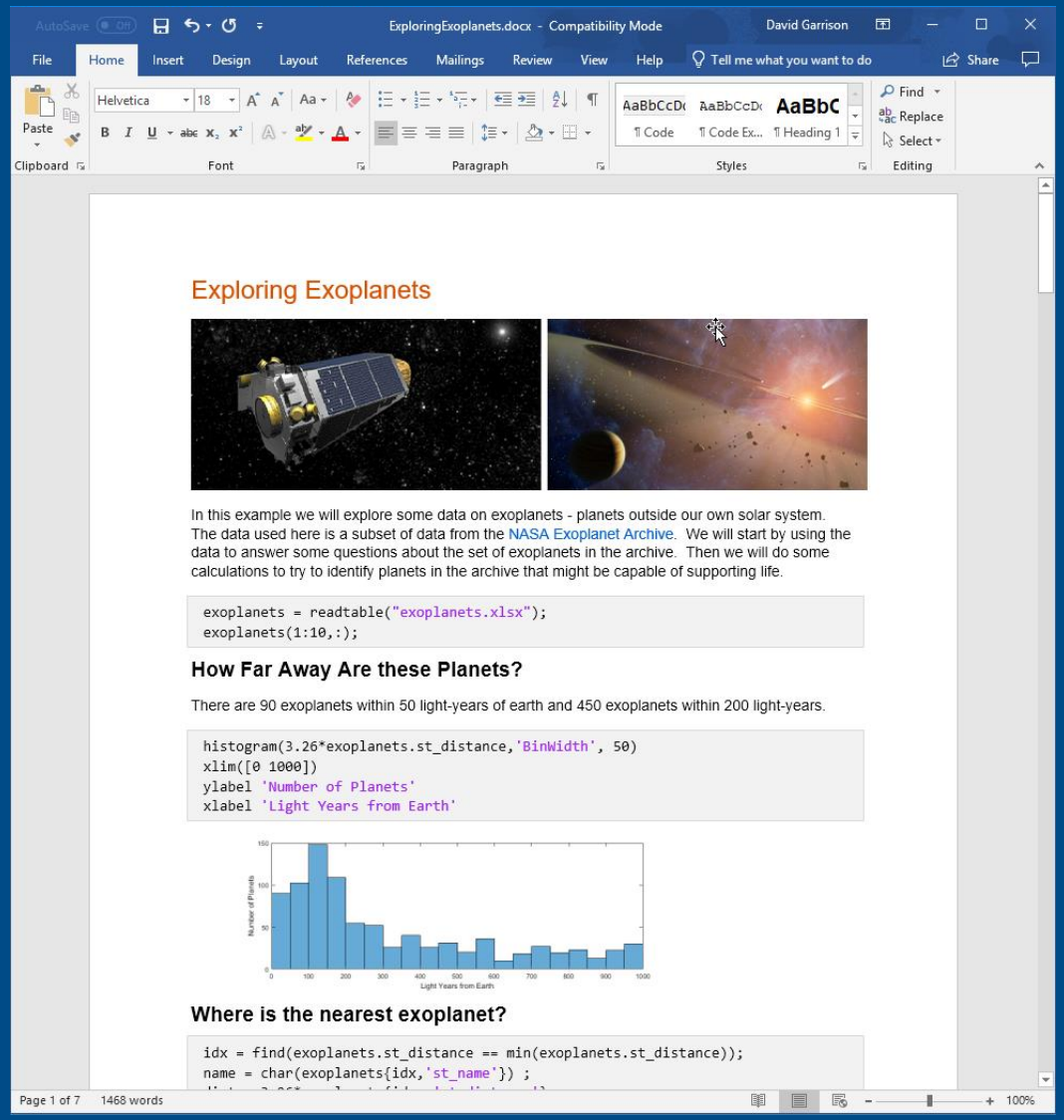
# Sharing Live Scripts





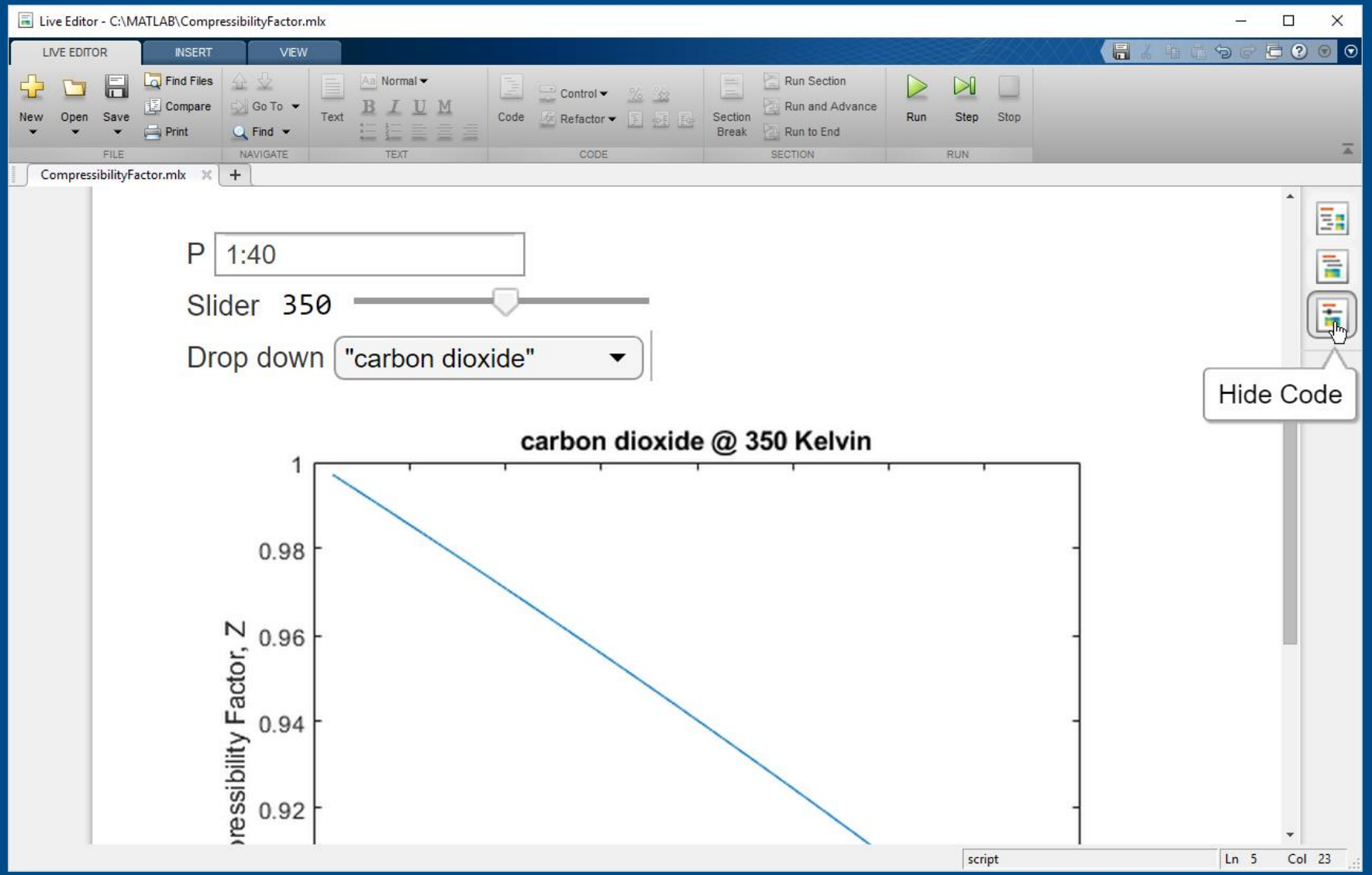
# Sharing Live Scripts





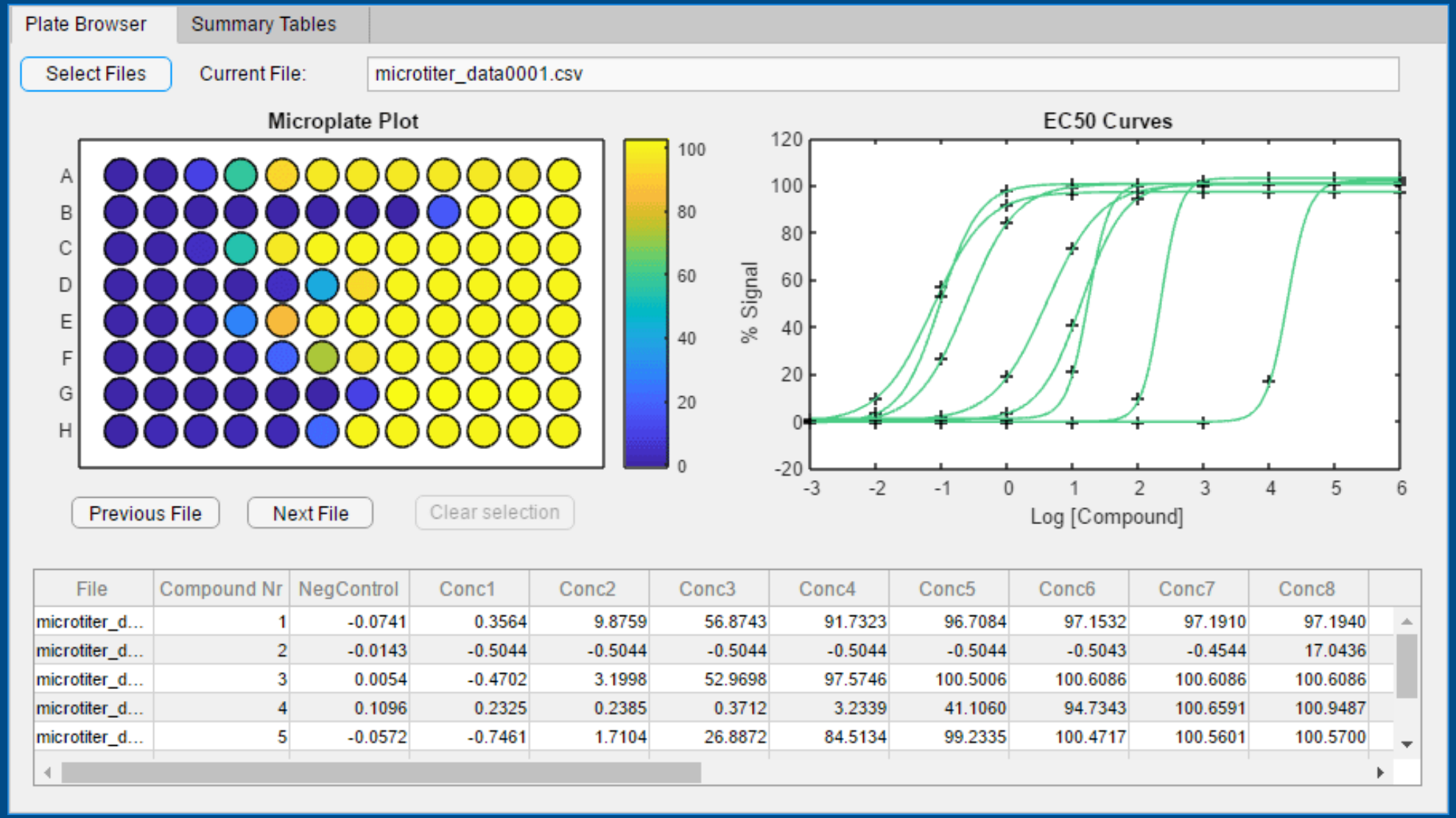
# Sharing Live Scripts





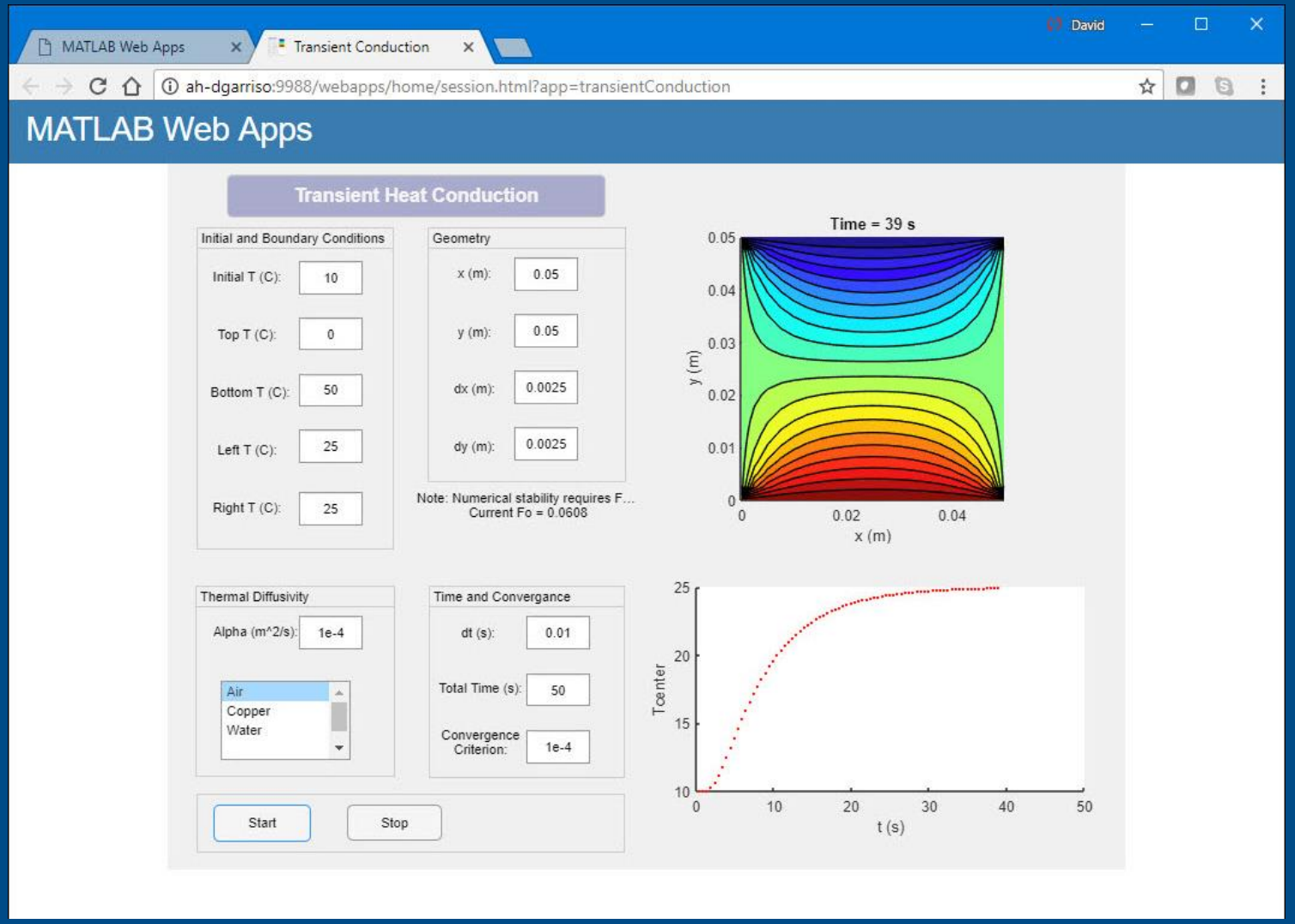

 

# Creating Apps




| File | Compound Nr | NegControl | Conc1 | Conc2 | Conc3 | Conc4 | Conc5 | Conc6 | Conc7 | Conc8 |
|---|---|---|---|---|---|---|---|---|---|---|
| microtiter_d... | 1 | -0.0741 | 0.3564 | 9.8759 | 56.8743 | 91.7323 | 96.7084 | 97.1532 | 97.1910 | 97.1940 |
| microtiter_d... | 2 | -0.0143 | -0.5044 | -0.5044 | -0.5044 | -0.5044 | -0.5044 | -0.5043 | -0.4544 | 17.0436 |
| microtiter_d... | 3 | 0.0054 | -0.4702 | 3.1998 | 52.9698 | 97.5746 | 100.5006 | 100.6086 | 100.6086 | 100.6086 |
| microtiter_d... | 4 | 0.1096 | 0.2325 | 0.2385 | 0.3712 | 3.2339 | 41.1060 | 94.7343 | 100.6591 | 100.9487 |
| microtiter_d... | 5 | -0.0572 | -0.7461 | 1.7104 | 26.8872 | 84.5134 | 99.2335 | 100.4717 | 100.5601 | 100.5700 |

# Deploying Web Apps





# Using MATLAB & Simulink to Build Algorithms in Everything

Inputs

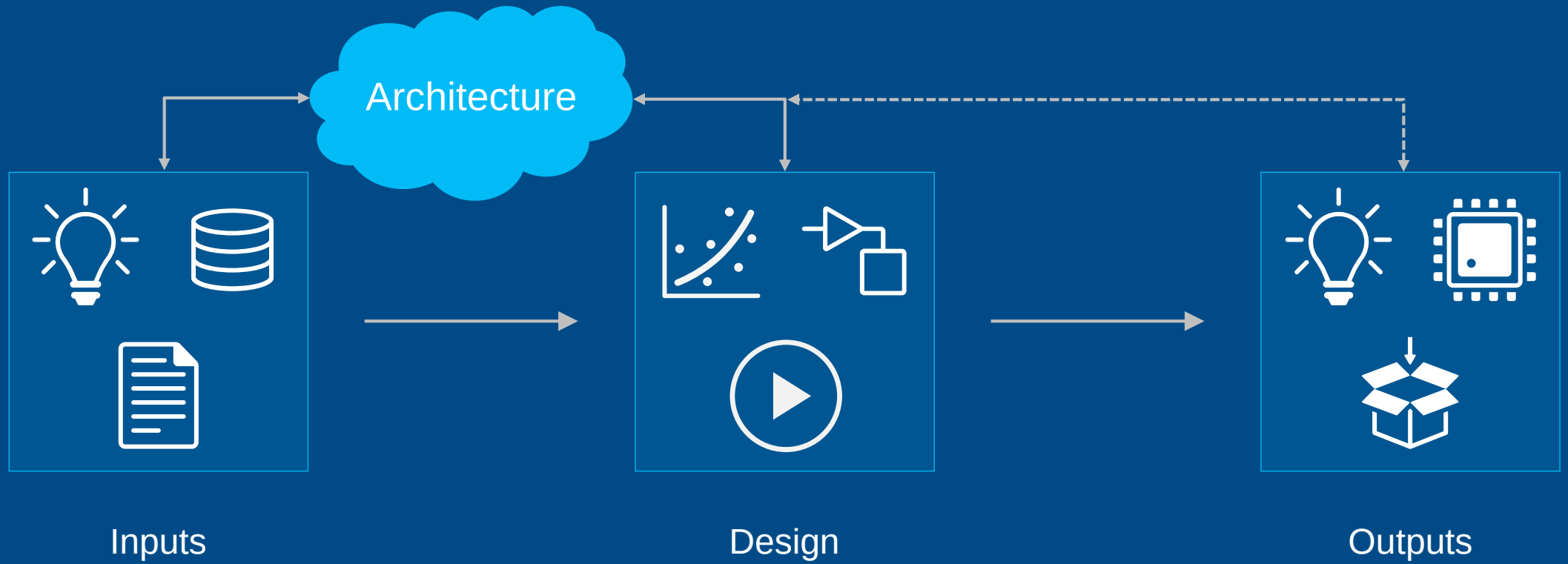
Design

Outputs

MATLAB&SIMULINK®

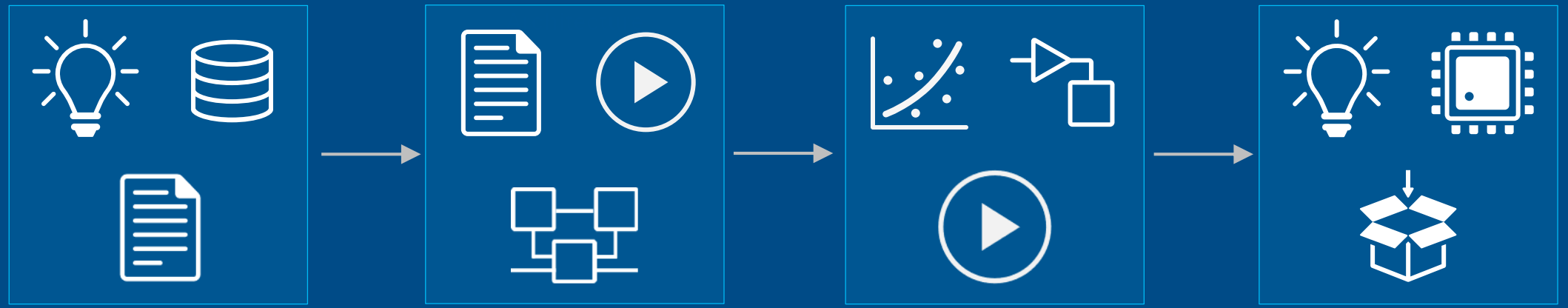
 

# Evaluating Architectures




MATLAB&SIMULINK®

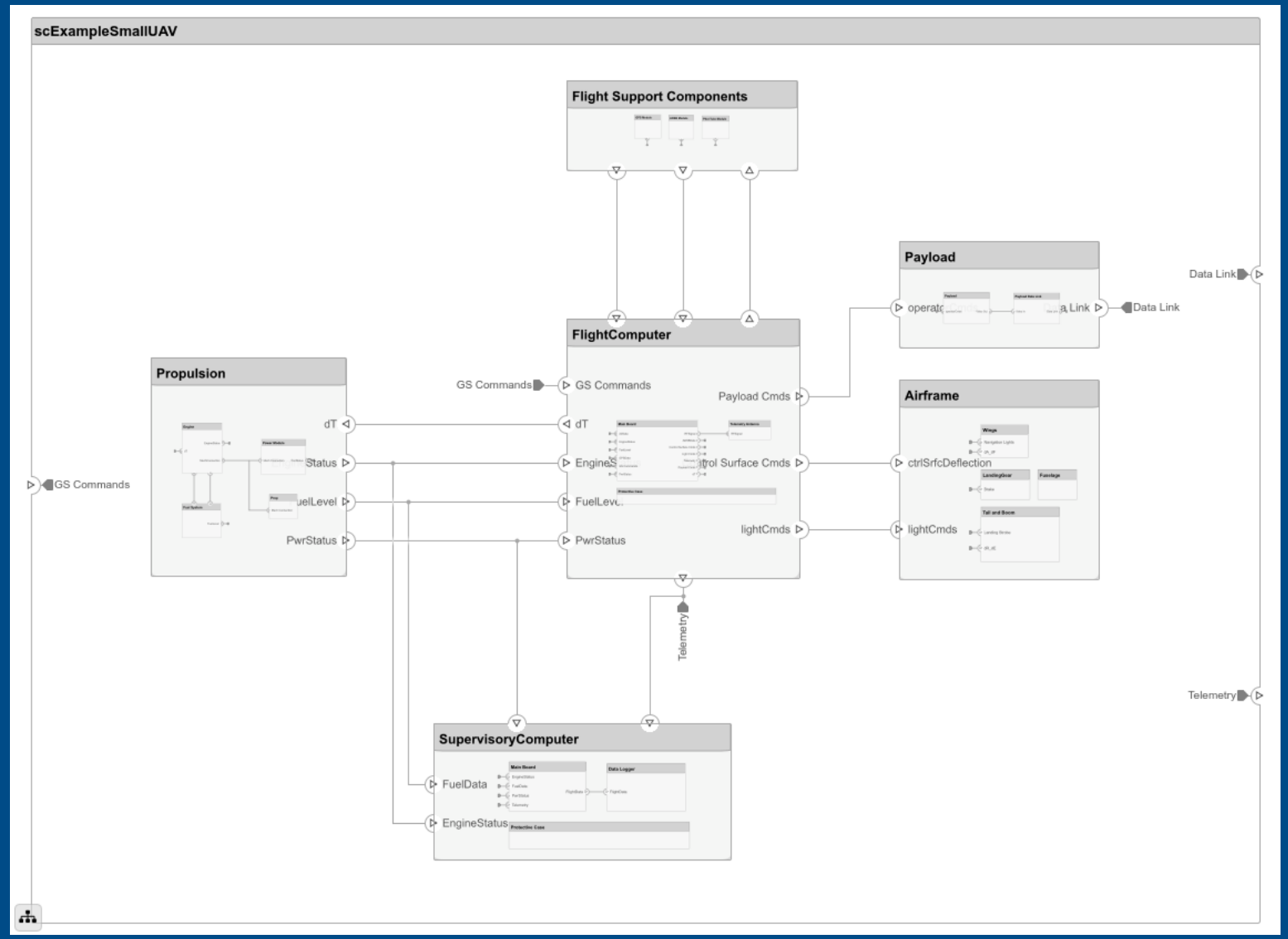
# Evaluating Architectures




MATLAB&SIMULINK

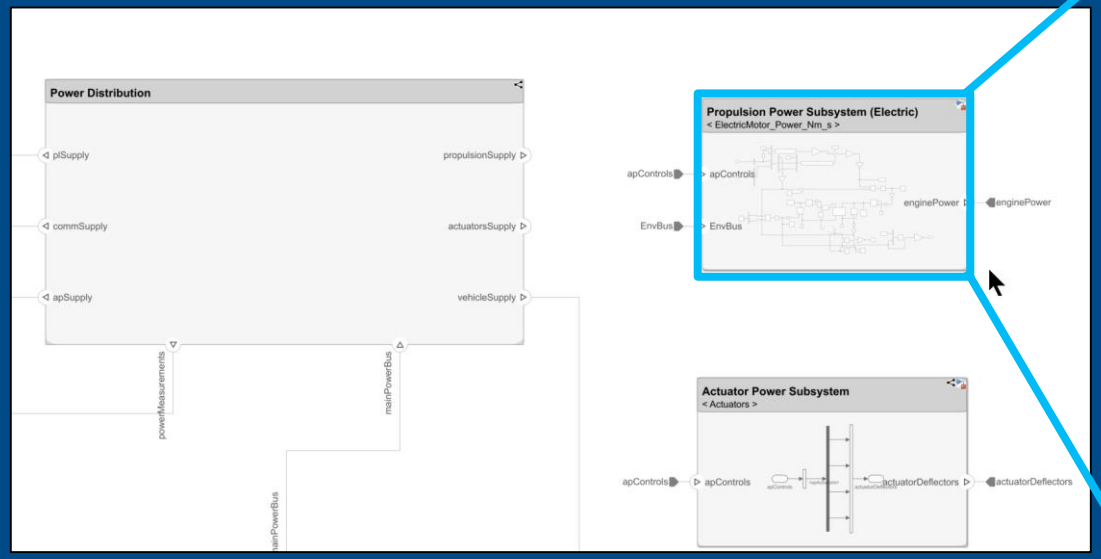
# Designing System and Software Architectures

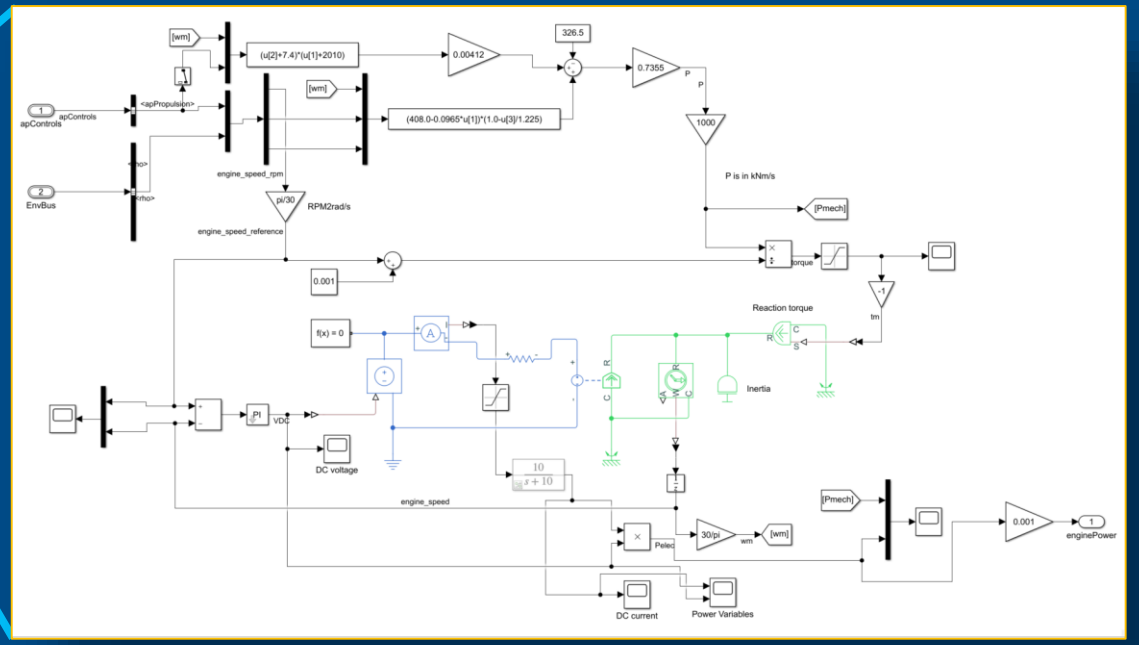



System Composer

# Designing System and Software Architectures



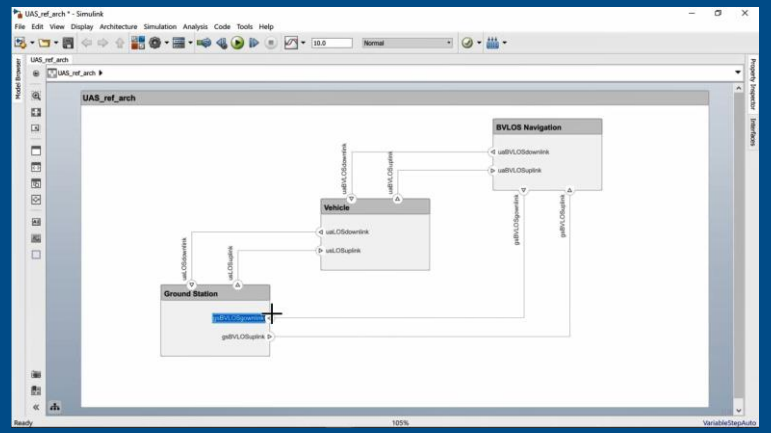




**System Composer**

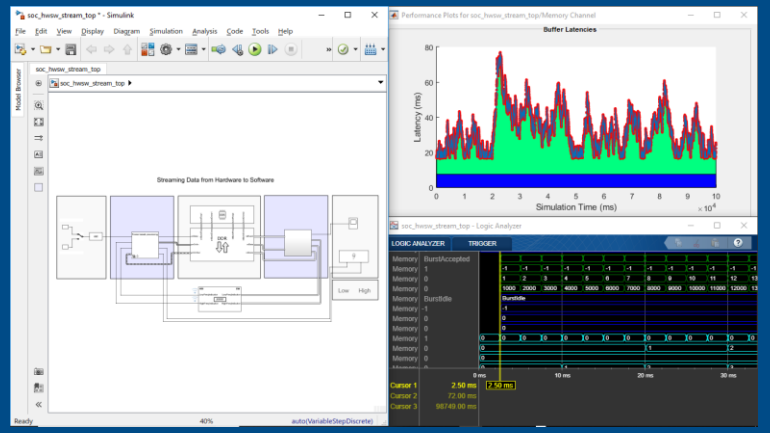
# Designing Beyond System and Software Architectures

## Systems and Software



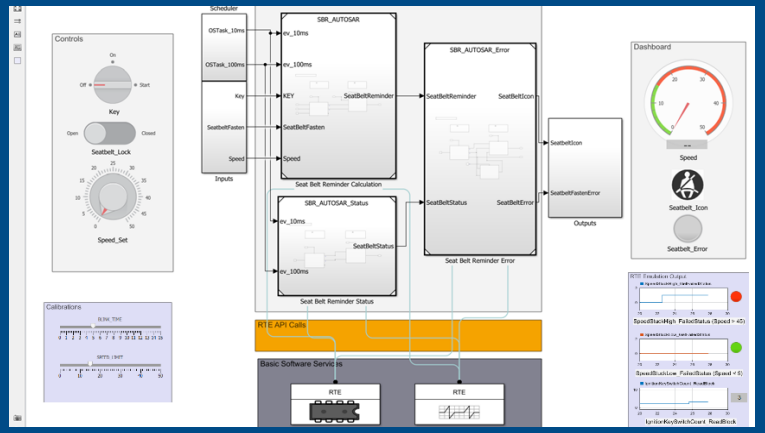

System Composer

## SoC Hardware and Software




SoC Blockset

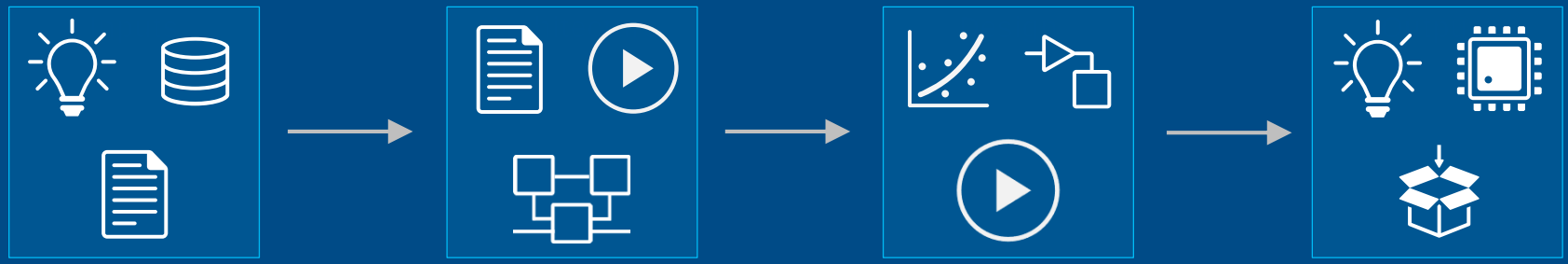
## AUTOSAR Software




AUTOSAR Blockset

# Using MATLAB & Simulink to Build Algorithms in Everything



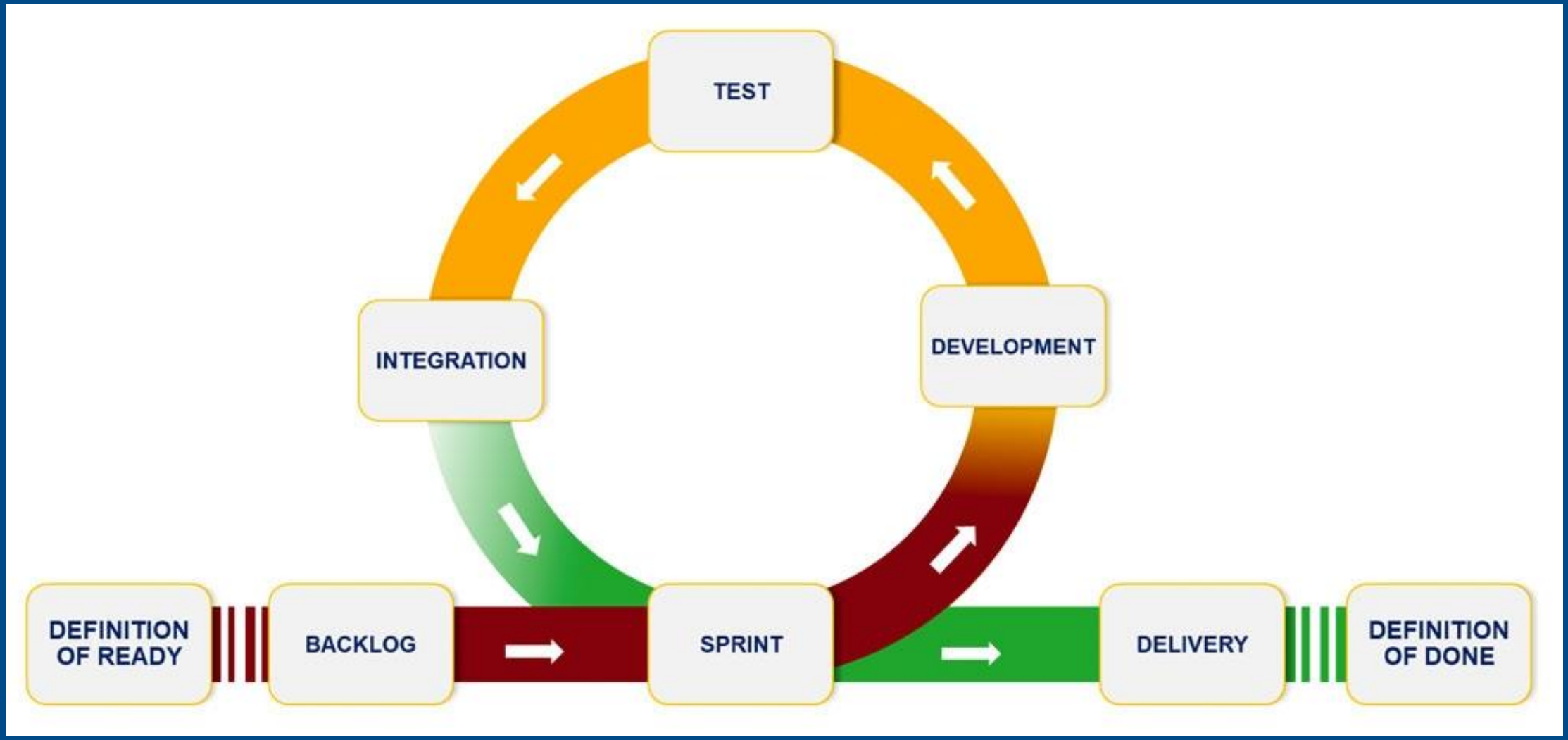

Test & Verification

Collaboration

Scaling

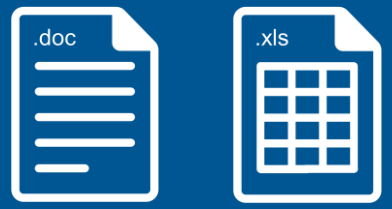
MATLAB&SIMULINK®

# Using MATLAB & Simulink to Build Algorithms in Everything



# Integrating with Third-party Requirements Tools

## External Requirements




Requirements Management Tools

R2019a


**ReqIF**

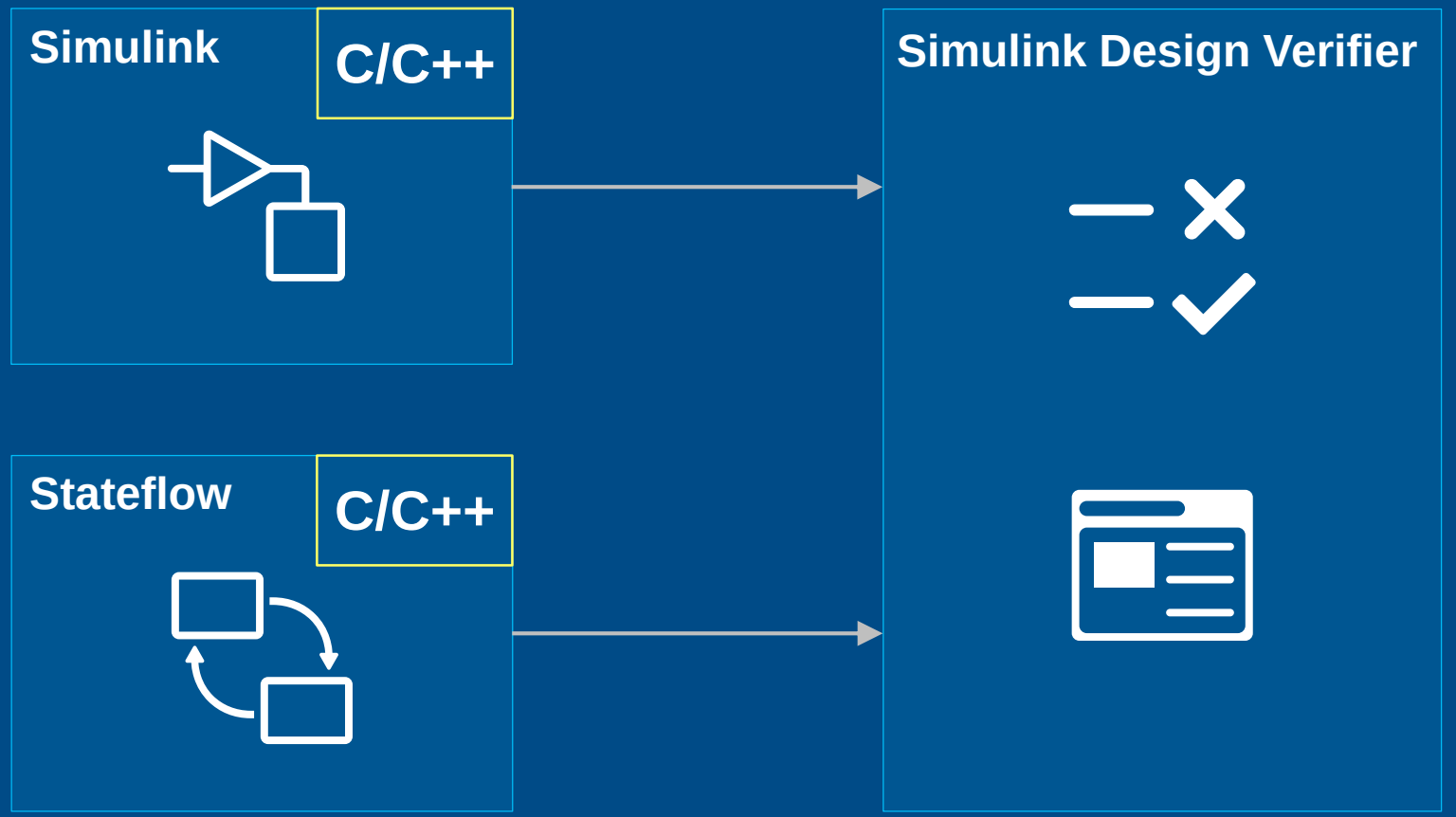
## Simulink Requirements

External Requirements

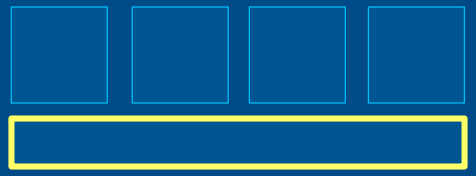
Authored Requirements

**Simulink Requirements**

# Include Custom Code in Test & Verification



# Using the MATLAB Unit Test Framework



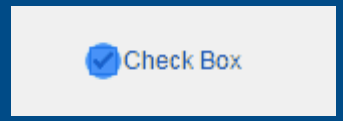
```
>> result.table
ans =
  2×6 table
                                Name                                Passed    Failed    Incomplete    Duration    Details
    ____________________________________________________________    ______    ______    __________    ________    _____________
    'test_Predictions/Test_ModelType'                               true      false       false       0.12241     [1×1 struct]
    'test_Predictions/Test_Prediction'                              false     true        true        0.11542     [1×1 struct]
```



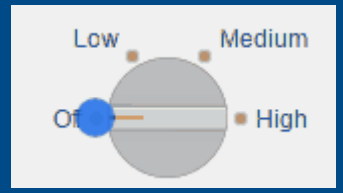
 

# Using the MATLAB App Testing Framework

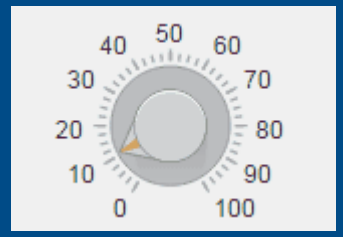
```
testCase.press(myApp.checkbox)
```



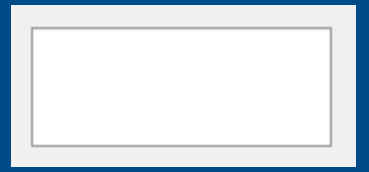

```
testCase.choose(myApp.discreteKnob, "Medium")
```



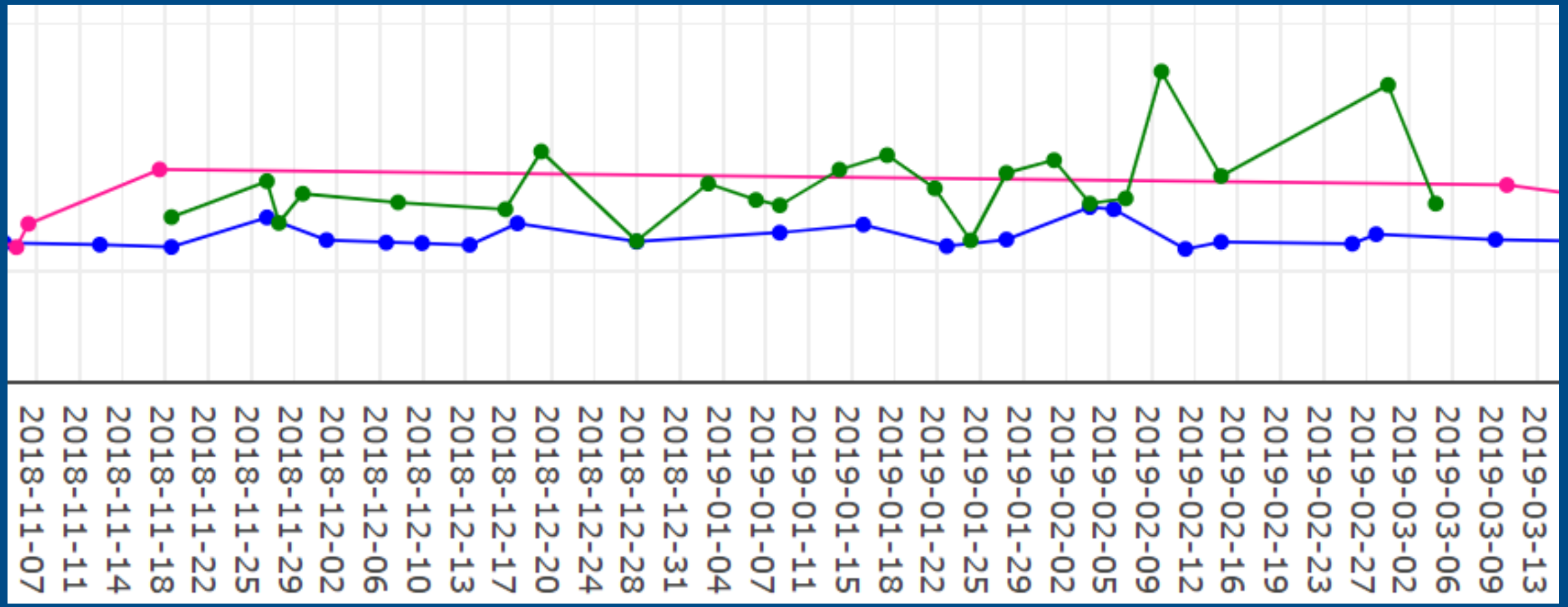

```
testCase.drag(myApp.continuousKnob, 10, 90)
```




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



# Using the MATLAB Performance Testing Framework





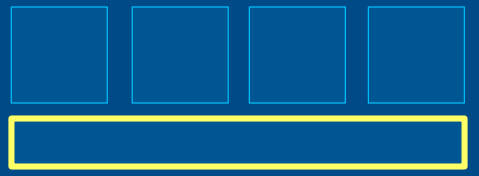

 

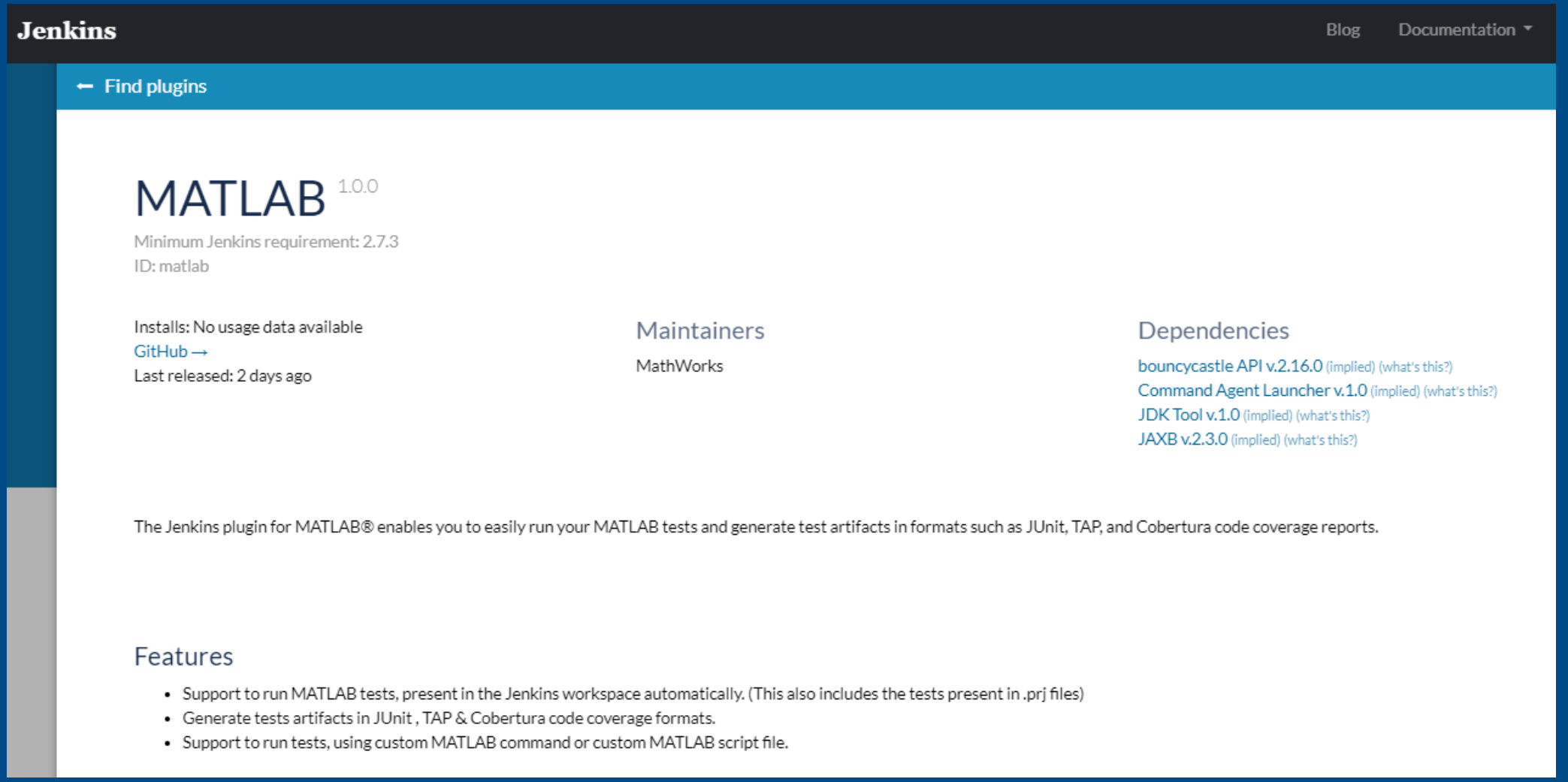
# Using Continuous Integration


MATLAB https://plugins.jenkins.io/

# Using Continuous Integration

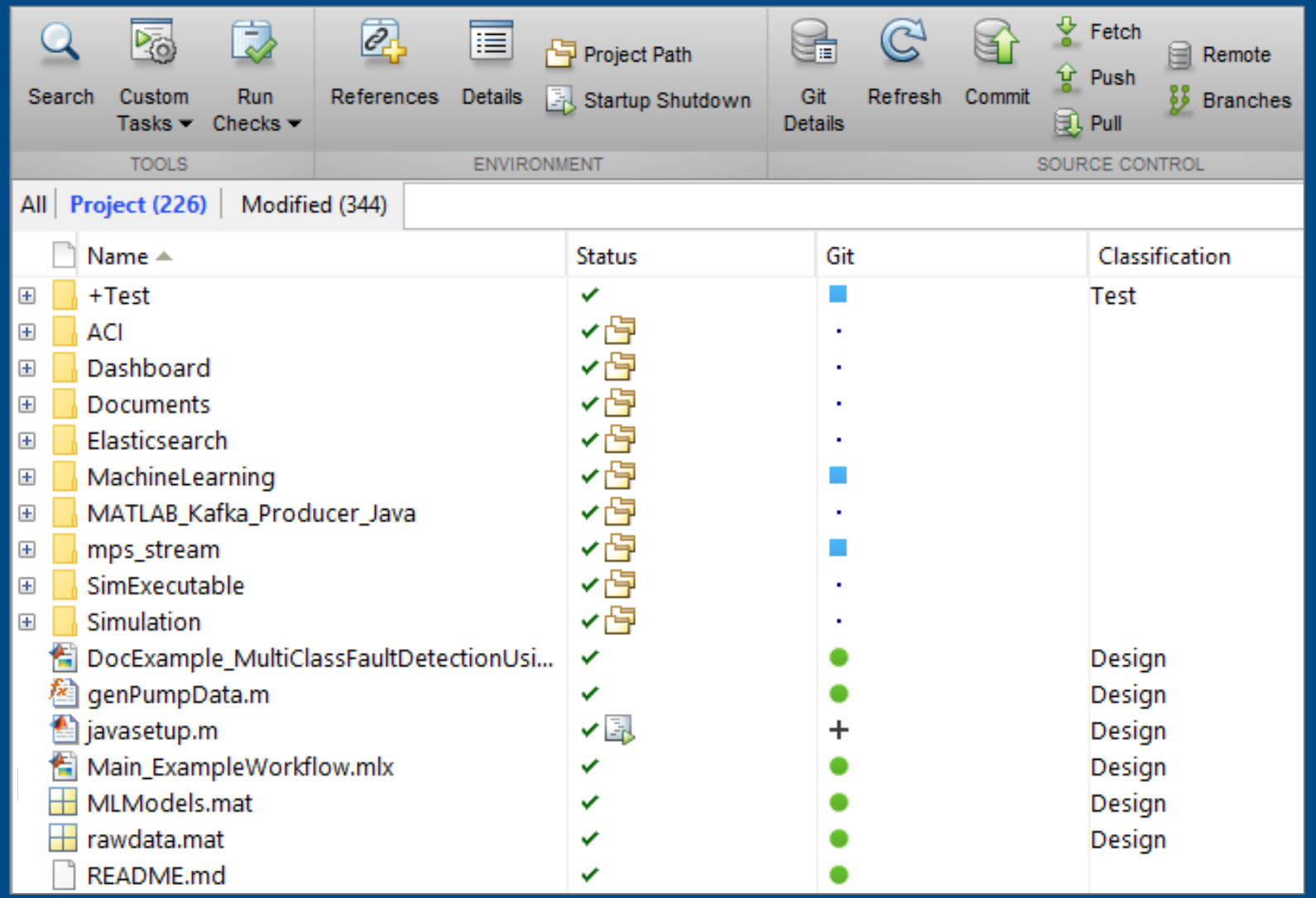





**MATLAB** **https://plugins.jenkins.io/matlab**

# Using Projects in MATLAB

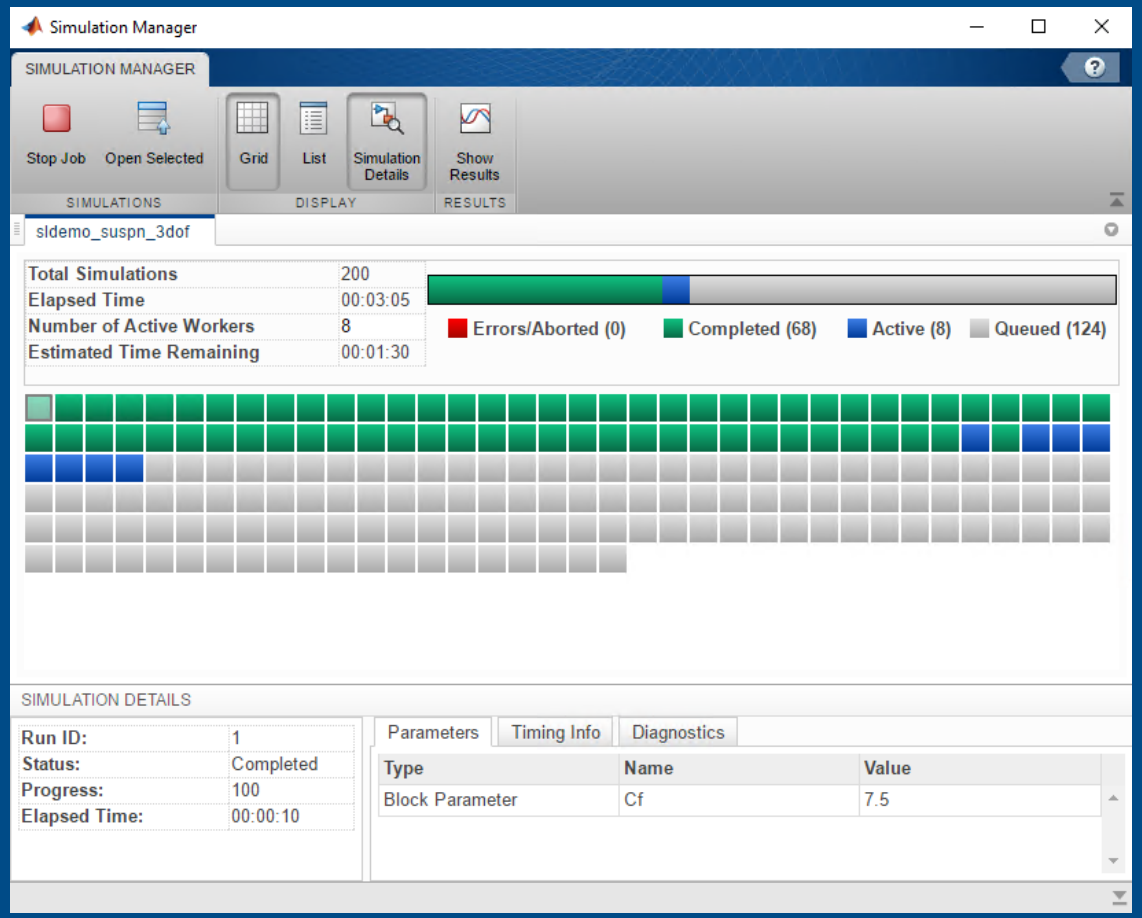




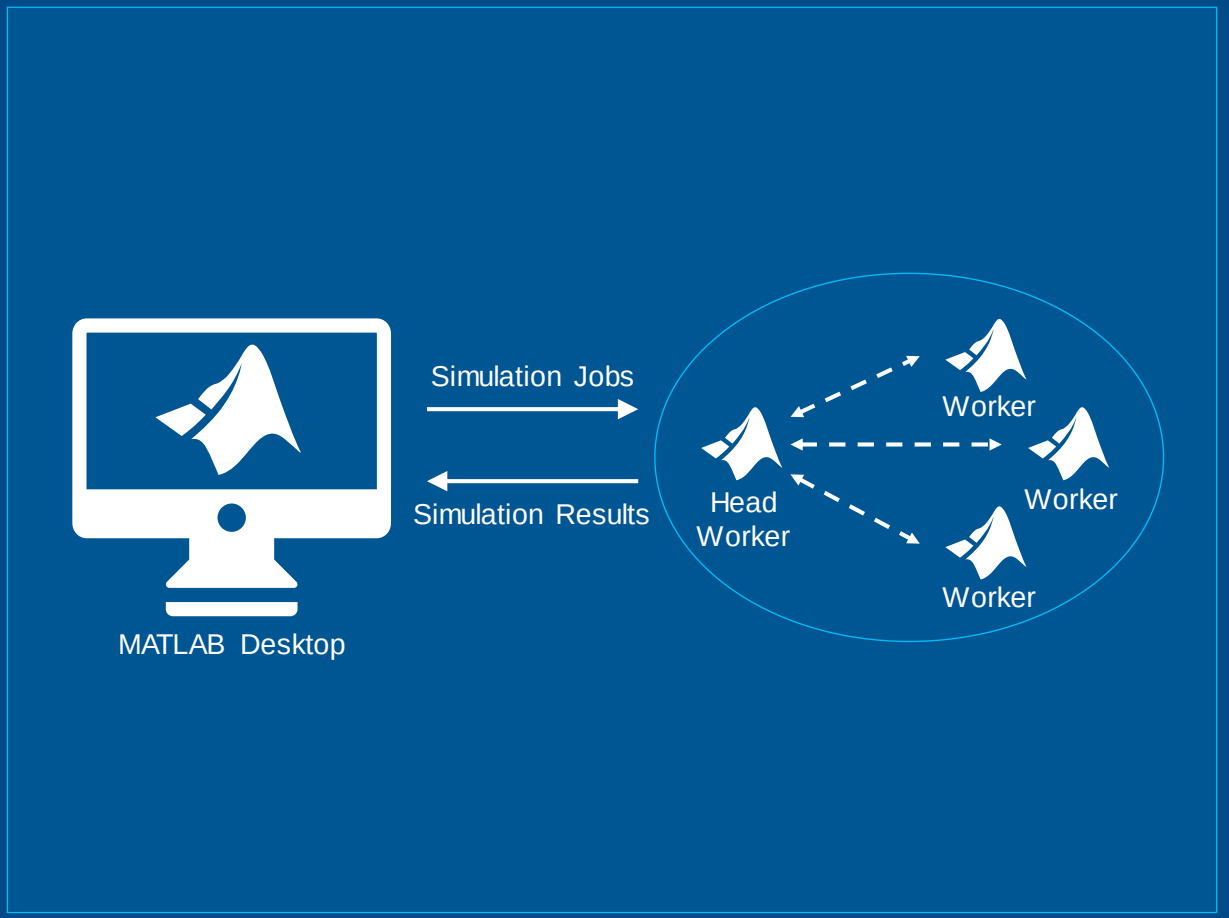

 

# Parallel Simulations in Simulink

## Simulation Manager

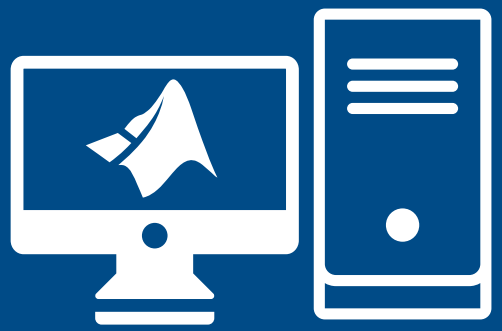



## batchsim

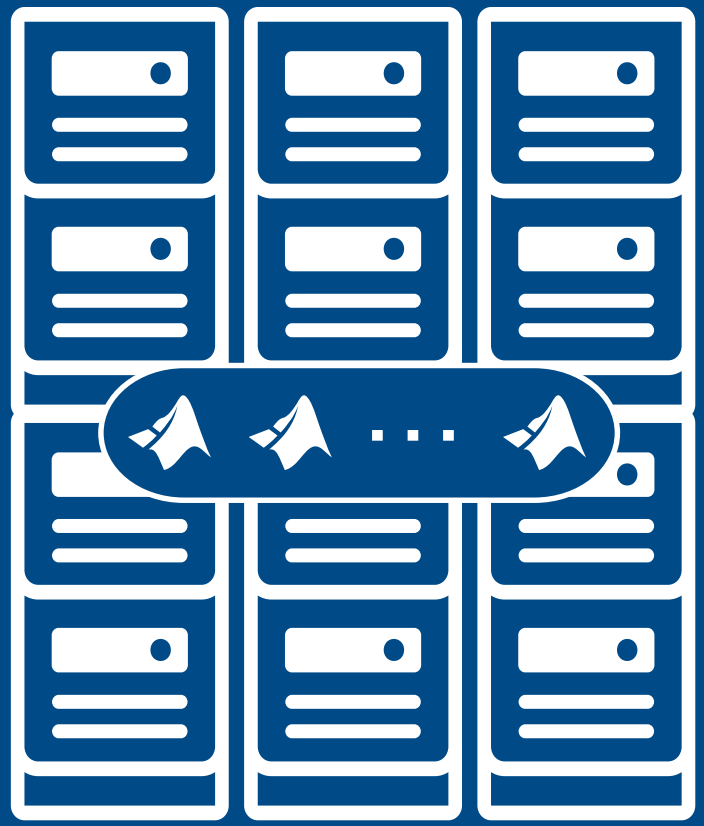



**Simulink**
**Parallel Computing Toolbox**

# Scaling Computations on Clusters and Clouds



MATLAB

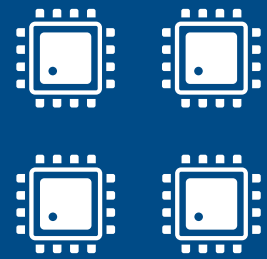


Parallel Computing Toolbox

MATLAB Parallel Server

Cloud

GPU

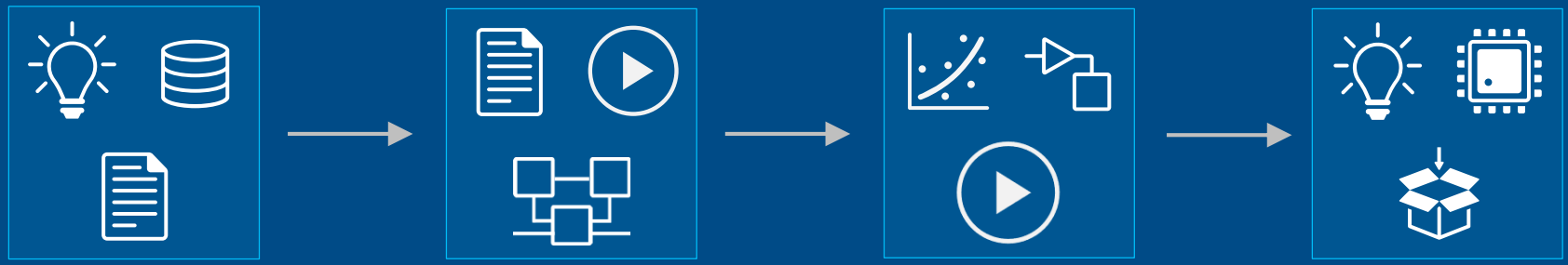


Multi-core CPU



# Using MATLAB & Simulink to Build Algorithms in Everything



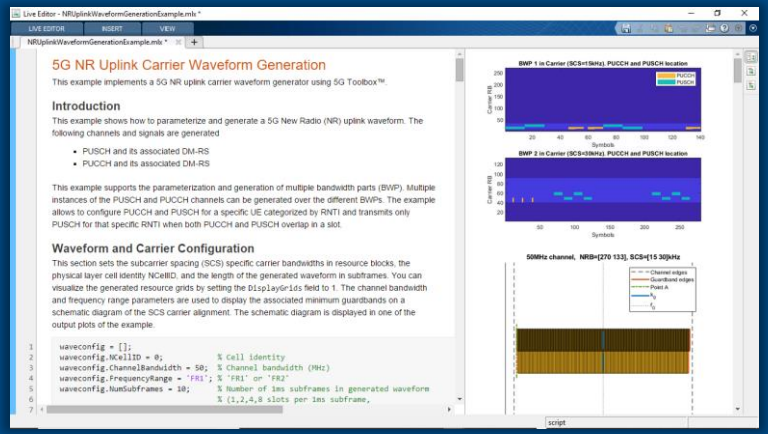


MATLAB&SIMULINK®

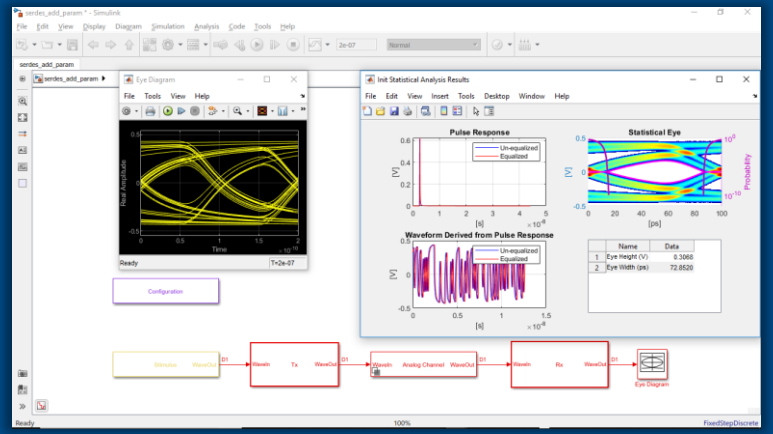
# Specialized Tools for Building Algorithms in Everything

## Communications



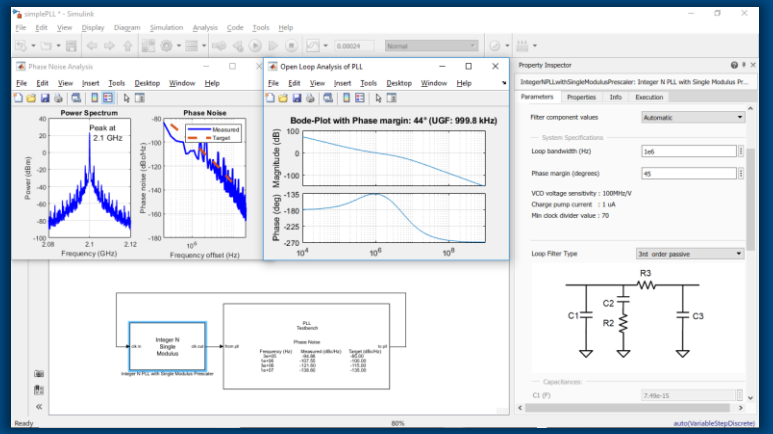

**5G Toolbox**

## Physical interconnects



**SerDes Toolbox**

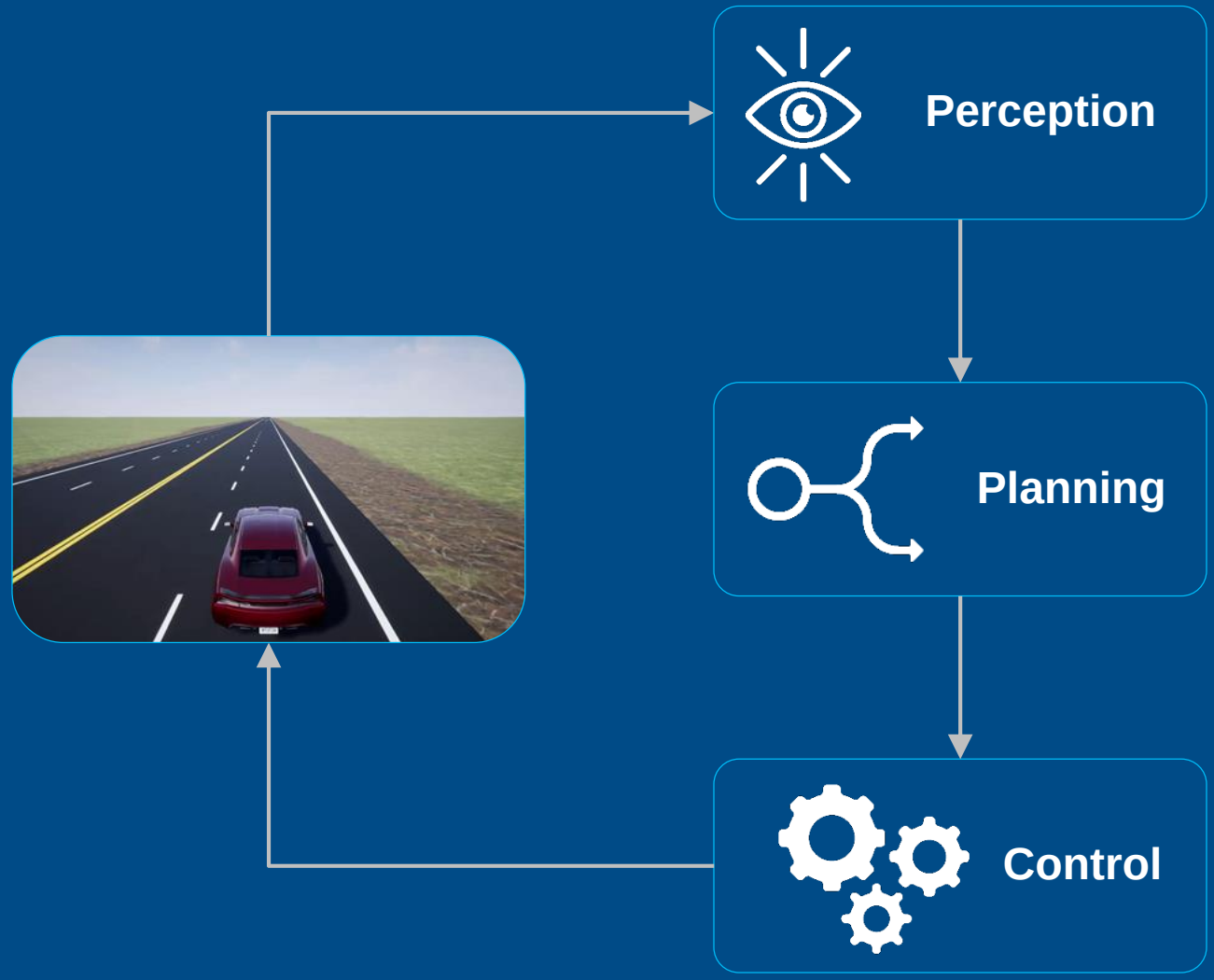
## Analog Mixed-Signal



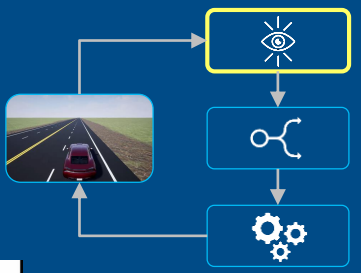

**Mixed-Signal Blockset**

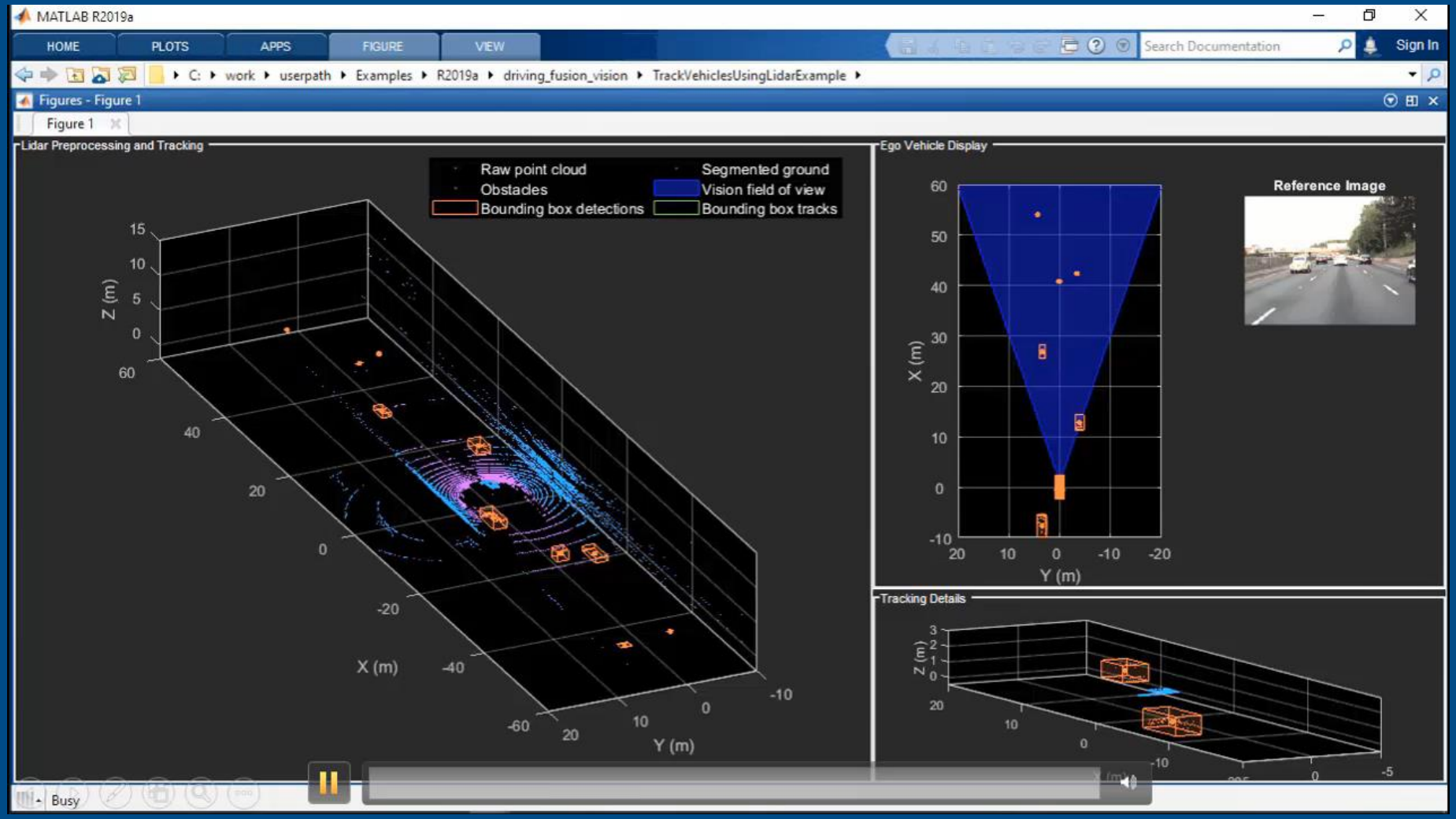
 

# Developing Autonomous Systems



# Evaluate Sensor Fusion Architectures

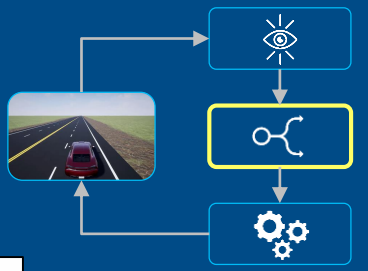


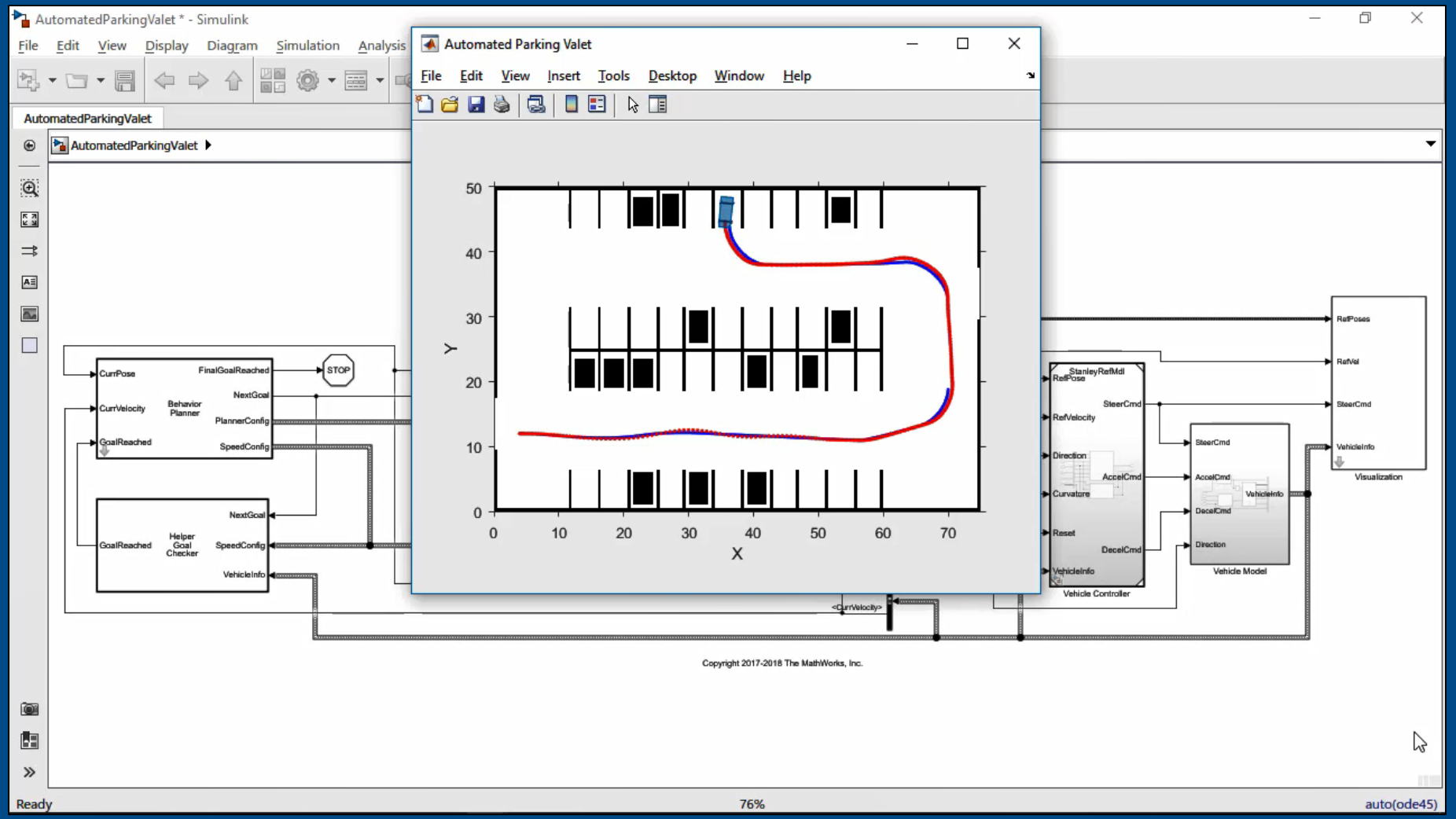



**Sensor Fusion and Tracking Toolbox**

# Simulate Path Planning Algorithms

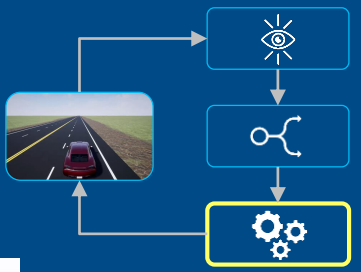


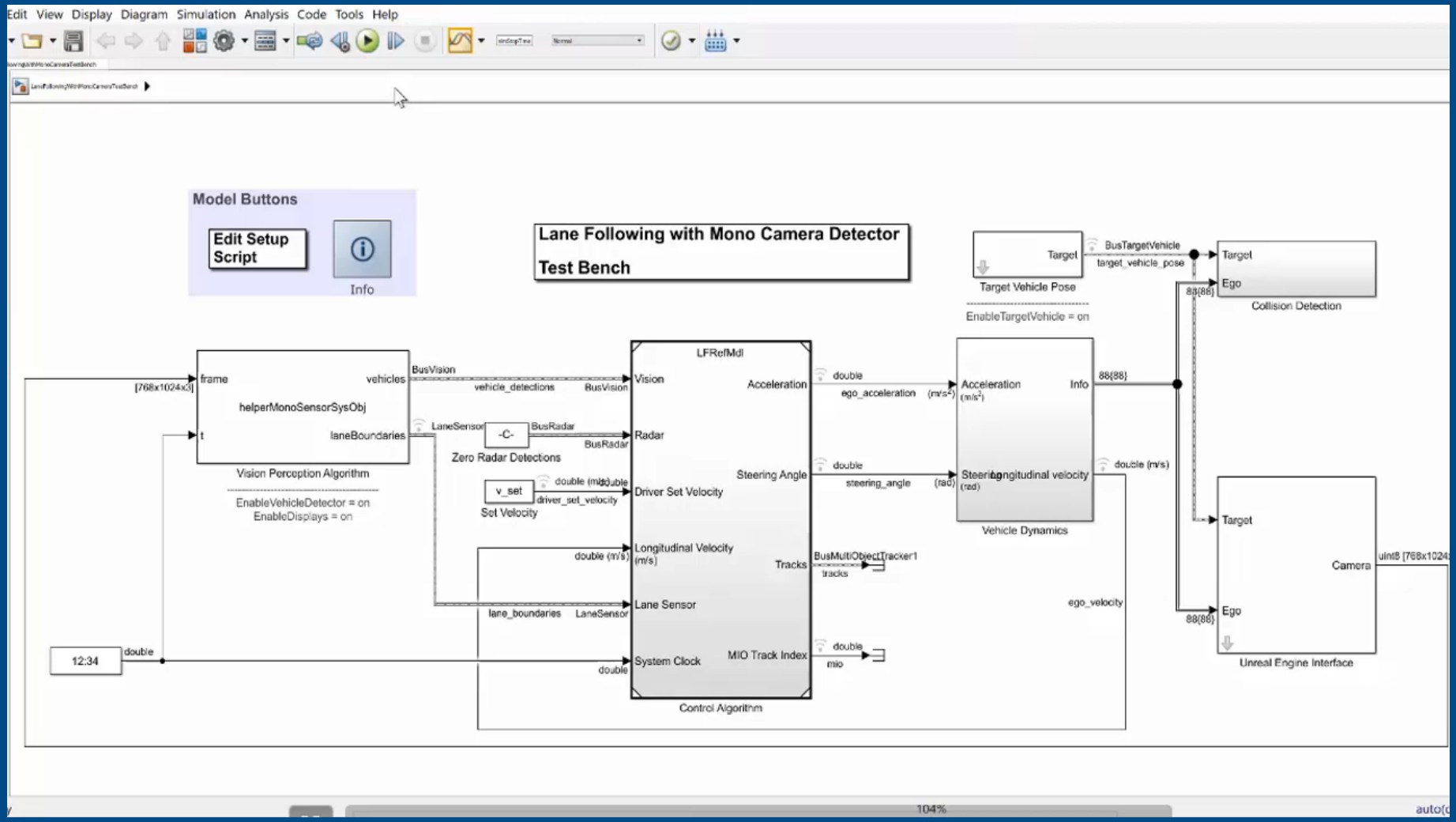



**Automated Driving Toolbox**

# Design Lane-following and Spacing Control Algorithms

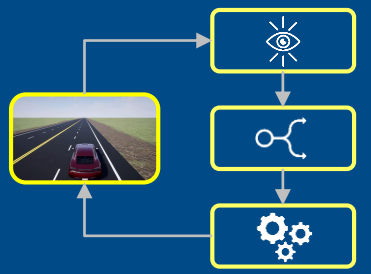




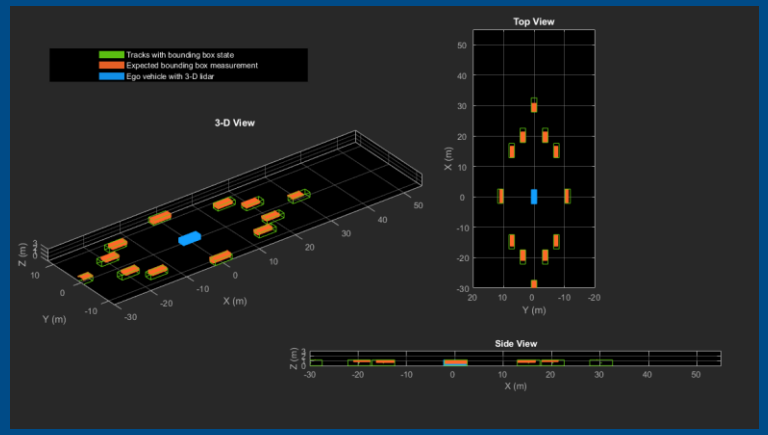

**Model Predictive Control Toolbox**

# Developing Autonomous Systems

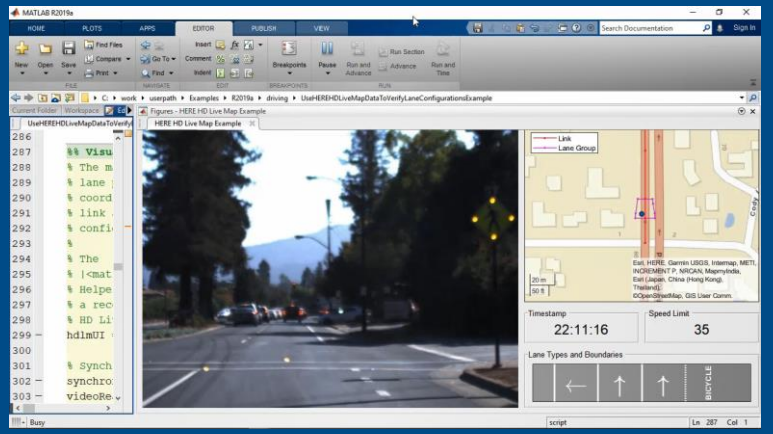


## Lidar Processing & Tracking



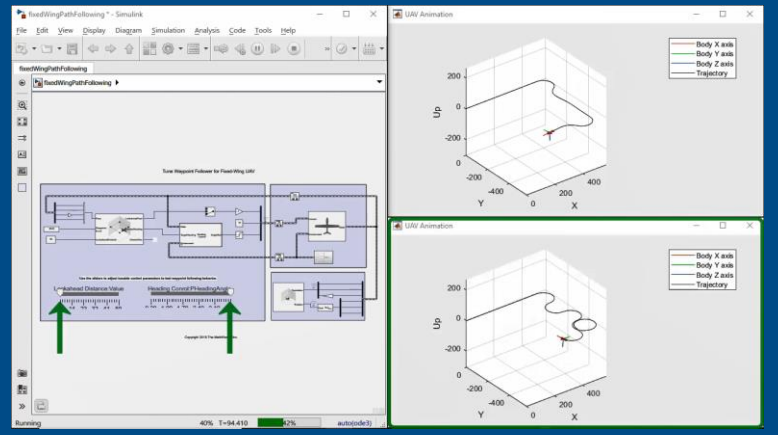

**Computer Vision Toolbox**

## HERE HD Maps & OpenDRIVE Roads




**Automated Driving Toolbox**

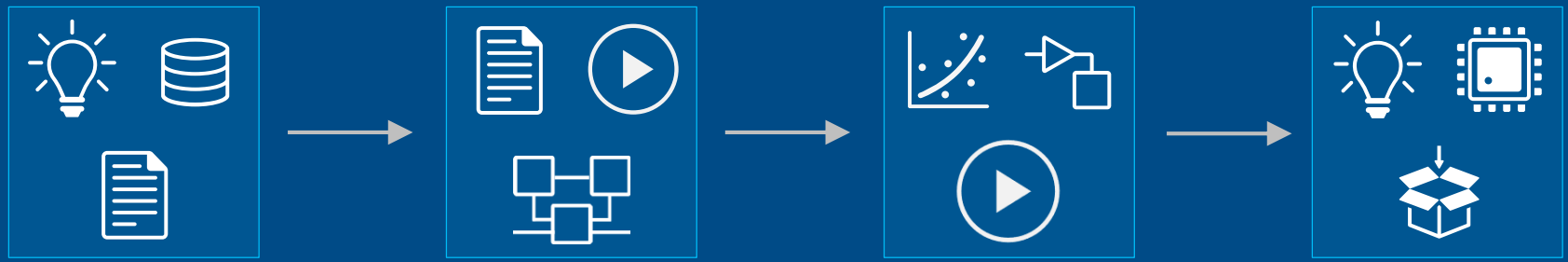
## UAV Algorithms



**Robotics System Toolbox**

# Using MATLAB & Simulink to Build Algorithms in Everything




Test & Verification

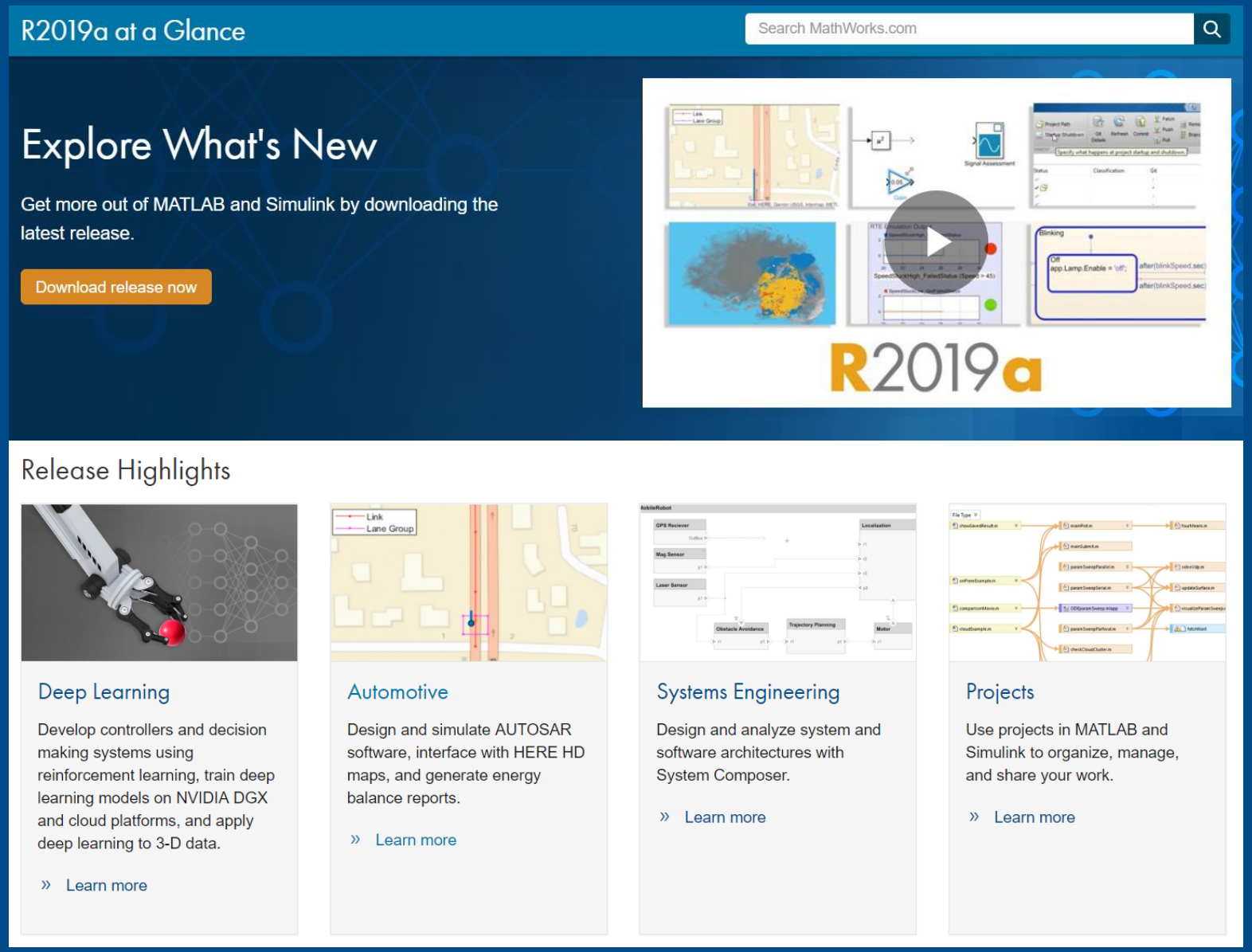
Collaboration

Scaling

MATLAB&SIMULINK

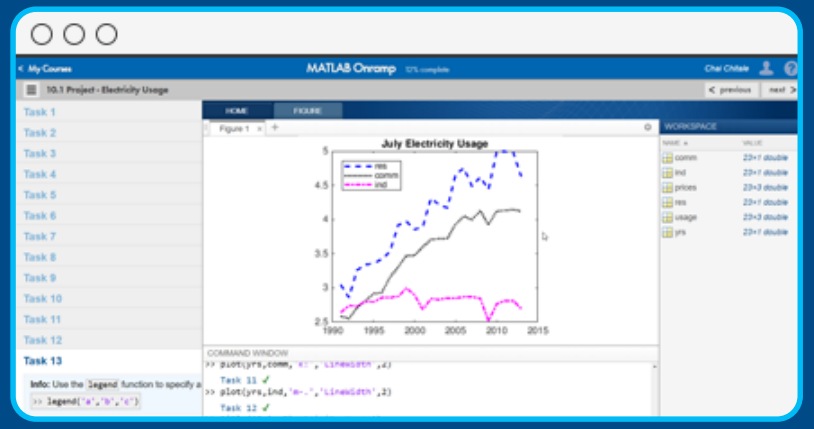
 

# Read the Release Notes



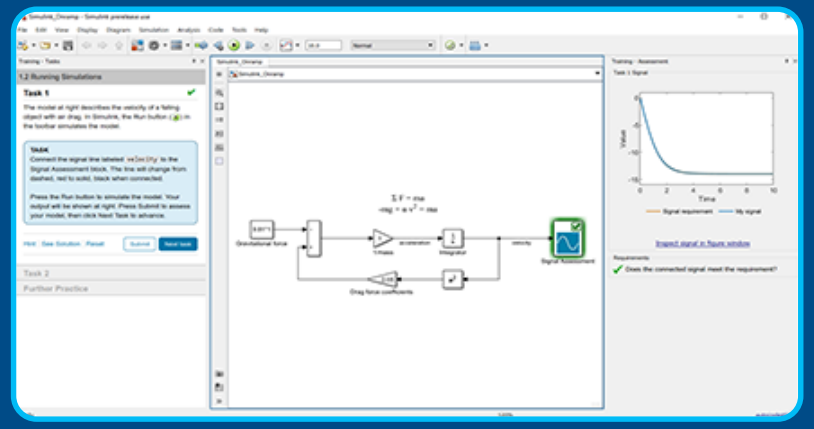

 

# Get Started



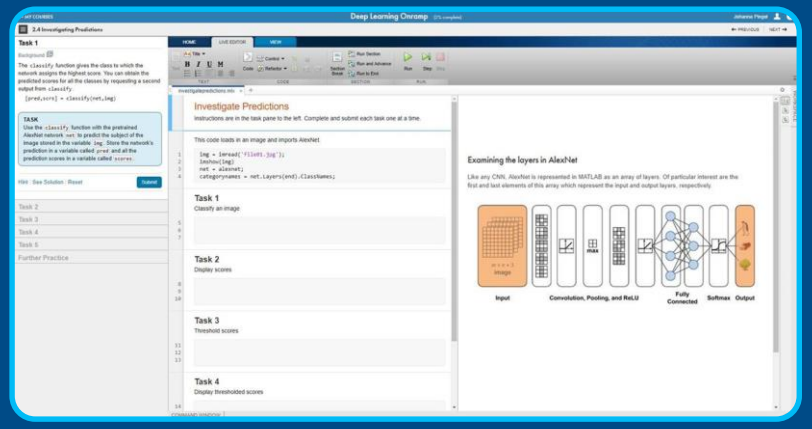

## MATLAB Onramp

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.