

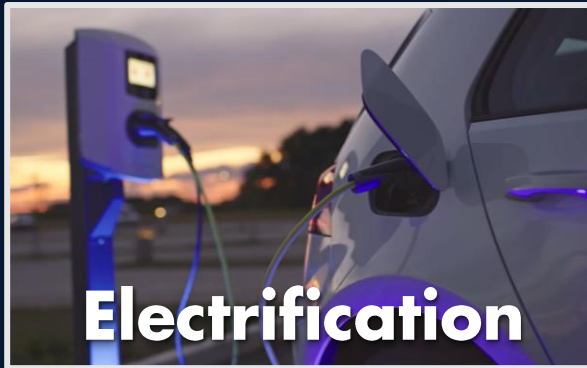
# MATLAB EXPO

## What's New in MATLAB and Simulink R2023a

*Vijayalayan R, MathWorks*







## Software-Defined Systems

**7,39,080**

```
>> datestr(739080)
```

```
ans =
```

```
    '13-Jul-2023'
```

```
>> todays_date = datetime('today')
```

```
todays_date =
```

```
datetime
```

```
    '13-Jul-2023'
```

```
>> todays_date -1
```

```
todays_date =
```

```
datetime
```

```
    '12-Jul-2023'
```



categorical



table



datetime



duration



calendarDuration



timetable



string



Bus



Connection Bus



Value Type



Alias Type



Numeric Type

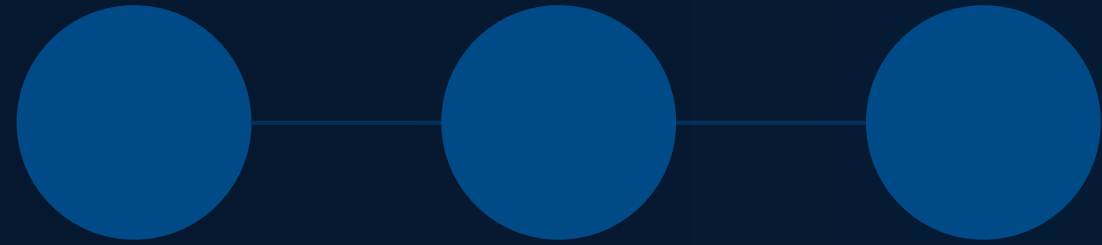


Enum Type

## Types

**3,662**





**Ease of Use**

**Software  
Development**

**Integration**

# Low code capabilities



## ★ FAVORITES



Curve Fitter



Optimization



PID Tuner

System  
IdentificationWireless  
Waveform G...Signal  
AnalyzerInstrument  
ControlSimBiology  
Model BuilderSimBiology  
Model Analy...

MATLAB Coder

Application  
CompilerAnalog Input  
RecorderAnalog  
Output Gen...Modbus  
ExplorerWeb App  
Compiler

## MATLAB

Class Diagram  
Viewer

Code Analyzer

Code  
Compatibilit...

Data Cleaner

Dependency  
Analyzer

Profiler

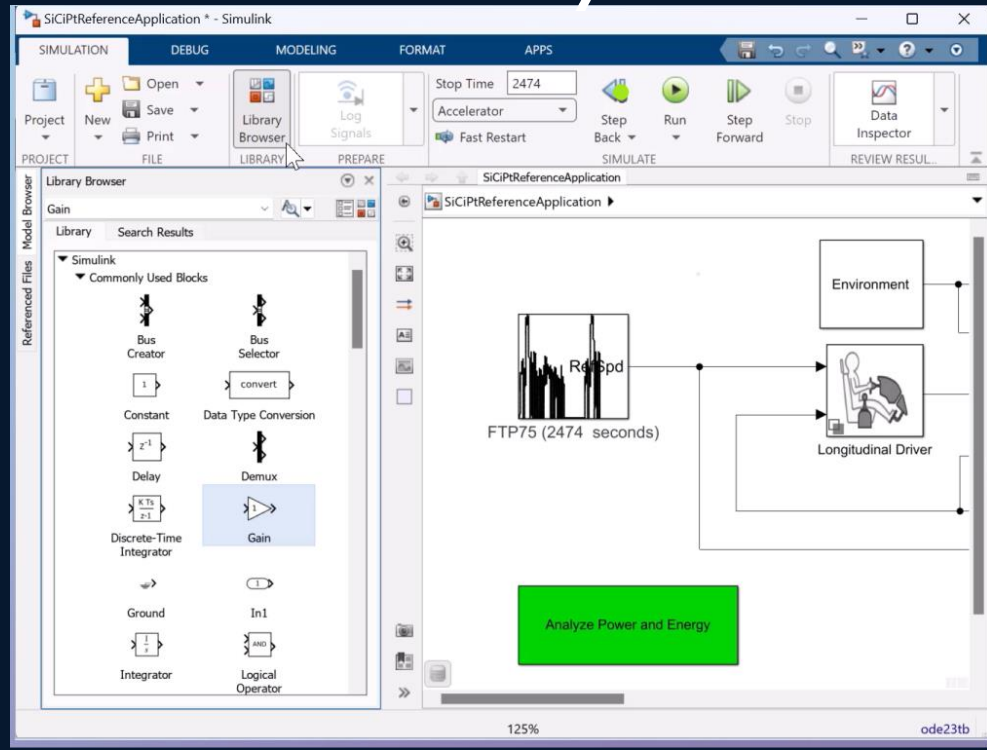


Test Browser

## MACHINE LEARNING AND DEEP LEARNING

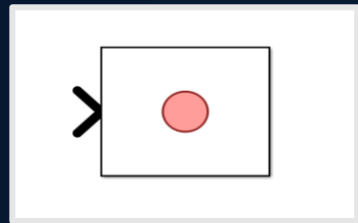
Classification  
LearnerDeep Network  
DesignerDeep Network  
QuantizerExperiment  
ManagerNeural Net  
ClusteringNeural Net  
FittingNeural Net  
Pattern Rec...Neural Net  
Time SeriesRegression  
LearnerReinforcement  
Learning De...

# Embedded Library Browser

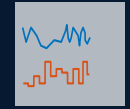
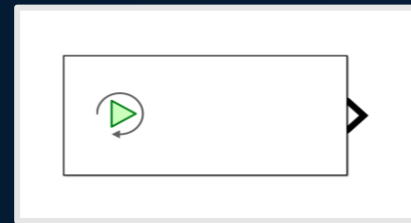


# Fast and repeatable tests

Record Block



Playback Block



# Step through a Simulation



Step Over



Step In



Step Out

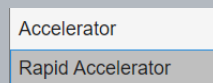
# Improve Performance of Simulations



Model Referencing



Fast Restart



Accelerator Modes



Simulink Cache



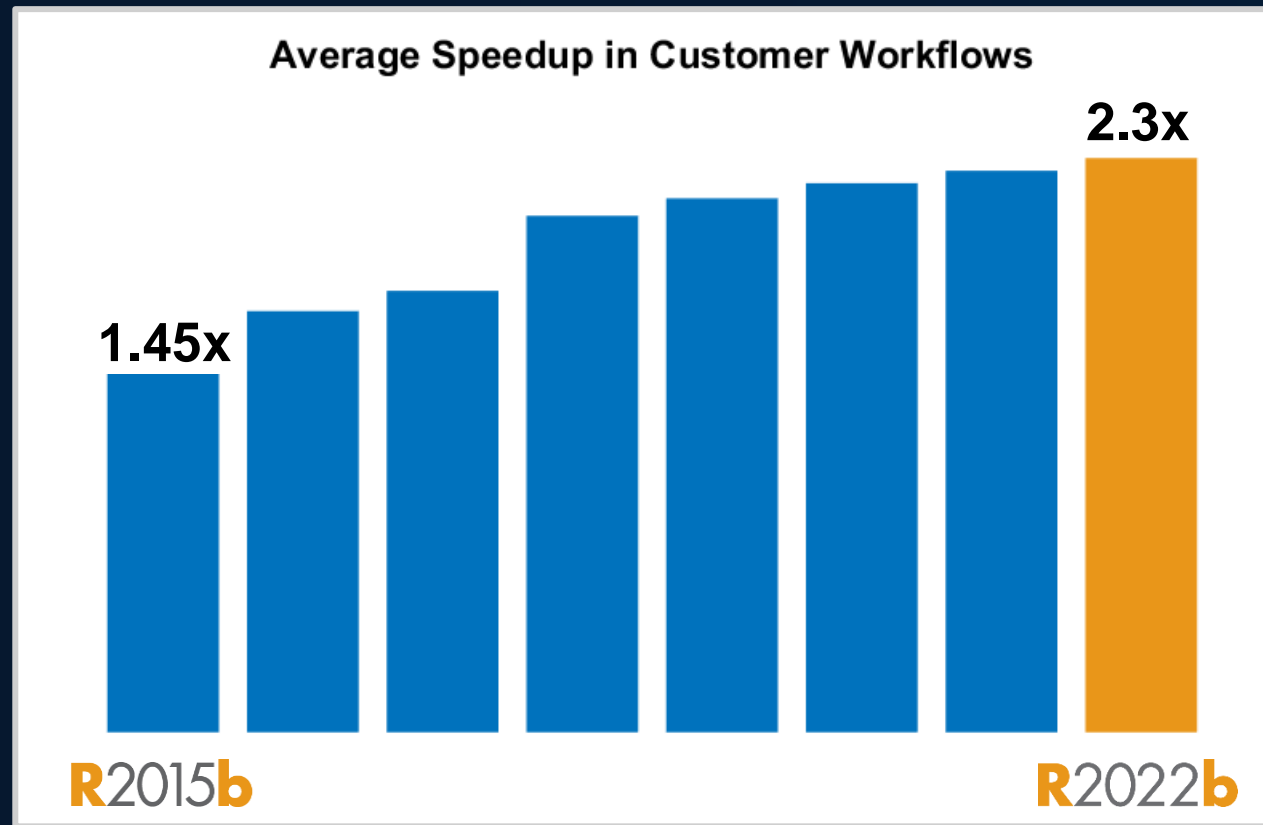
Performance Advisor



Multi-Core Co-Simulation

**SIMD**

Hardware Acceleration



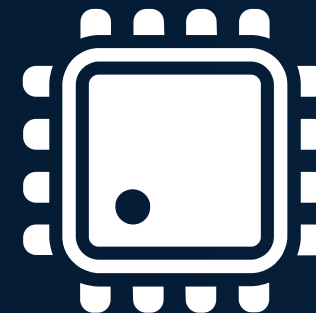
**Functions**      **1.6x**

**Function handles**      **40x**









## Code Analyzer

The Code Analyzer identifies and addresses code issues, including problems and areas for improvement.

### Overall Summary

11

total files



0

Error



8

Warning



4

Info

Select Folder

/Users/mhirsch/Library/CloudStorage/OneDrive-MathWorks/mfiles/Demos/TwitterAnalysis

Rerun Analysis

Group by Severity

Filter by Severity

Filter by Issue Type

### Code Health Details

Analysis Date: 3/31/2023, 5:28:42 PM

#### Warning (8)

- ▶ Input argument might be unused. Consider replacing the argument with ~ instead. (3)
- ▶ To avoid conflicts with functions on the path, specify variables to load from file. (3)
- ▶ Variable might be used before it is defined. (1)
- ▶ Value assigned to variable might be unused. (1)

#### Info (4)

- ▼ Add a semicolon after the statement to hide the output (in a script). (3)

Fix All

[Line 3](#)

Script1\_ImportTwitterData.m twitter(c.ConsumerKey,c.ConsumerSecret,c.AccessToken,c.AccessToker

Fix

[Line 14](#)

Script1\_ImportTwitterData.m statuses [statuses;sRefresh.Body.Data.statuses]

Fix

[Line 47](#)

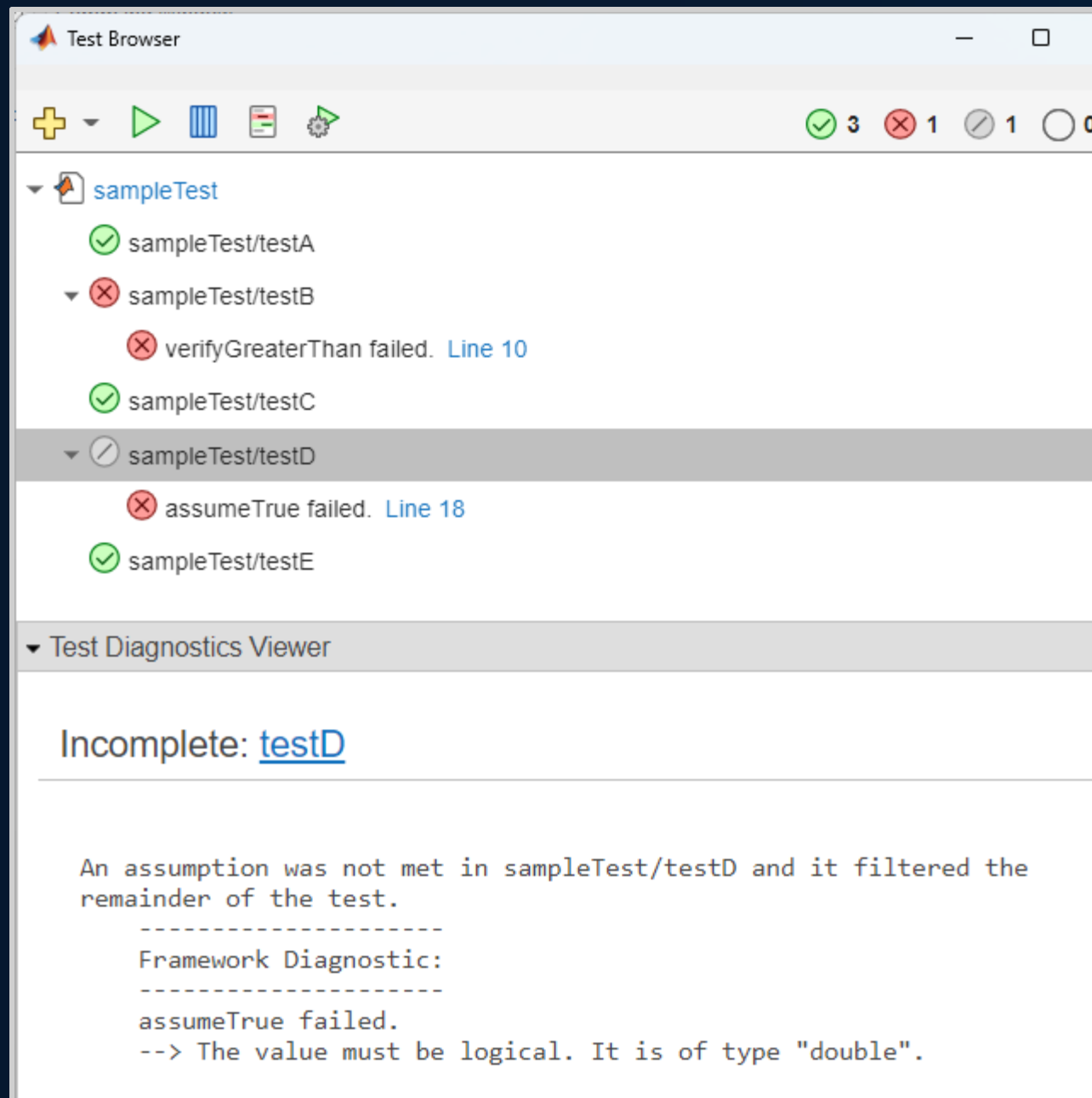
Script1\_ImportTwitterData.m tweets timetable(tweetTexts,'RowTimes', datetime(tweetTimes,'Format'

Fix

	Fix All
<code>ccessToken, c.AccessToker</code>	Fix
<code>es]</code>	Fix
<code>time(tweetTimes, 'Format'</code>	Fix

```
2  
3 evalin("base", "newvar = " + x)  
4
```

 Flight Analysis Team standards prohibit use of evalin.



Test Browser

+ ▶ ▢ 📄 ⚙️

✔️ 3 ❌ 1 ⏸️ 1 ○ 0

- sampleTest
  - ✔️ sampleTest/testA
  - ❌ sampleTest/testB
    - ❌ verifyGreaterThan failed. [Line 10](#)
  - ✔️ sampleTest/testC
  - ⏸️ sampleTest/testD
    - ❌ assumeTrue failed. [Line 18](#)
    - ✔️ sampleTest/testE

Test Diagnostics Viewer

Incomplete: [testD](#)

An assumption was not met in sampleTest/testD and it filtered the remainder of the test.

```

-----
Framework Diagnostic:
-----
assumeTrue failed.
--> The value must be logical. It is of type "double".
  
```

### MATLAB Test Manager: All Tests in Current Project

15 Total Tests

14 Passed

1 Failed

Test Details [Expand All](#)

Test	Diagnostic
<ul style="list-style-type: none"> <li>tests/graph_unit_tests.m           <ul style="list-style-type: none"> <li>graph_unit_tests/check_unity_path</li> <li>graph_unit_tests/check_longest_path</li> <li>graph_unit_tests/check_edgeless_start</li> <li>graph_unit_tests/check_edgeless_graph</li> <li>graph_unit_tests/check_non_unique</li> <li>graph_unit_tests/check_invalid_idx_empty_adj</li> <li>graph_unit_tests/check_no_path</li> <li>graph_unit_tests/check_start_end_same</li> </ul> </li> </ul>	

1 Error


0 Warning

2 Info

Coverage

Function	100%
Statement	53.7%
Decision	80.6%
Condition	76.7%
MC/DC	53.3%

Tests



Passed	85.7%
Failed	14.3%
Incomplete	0%
Not Run	0%

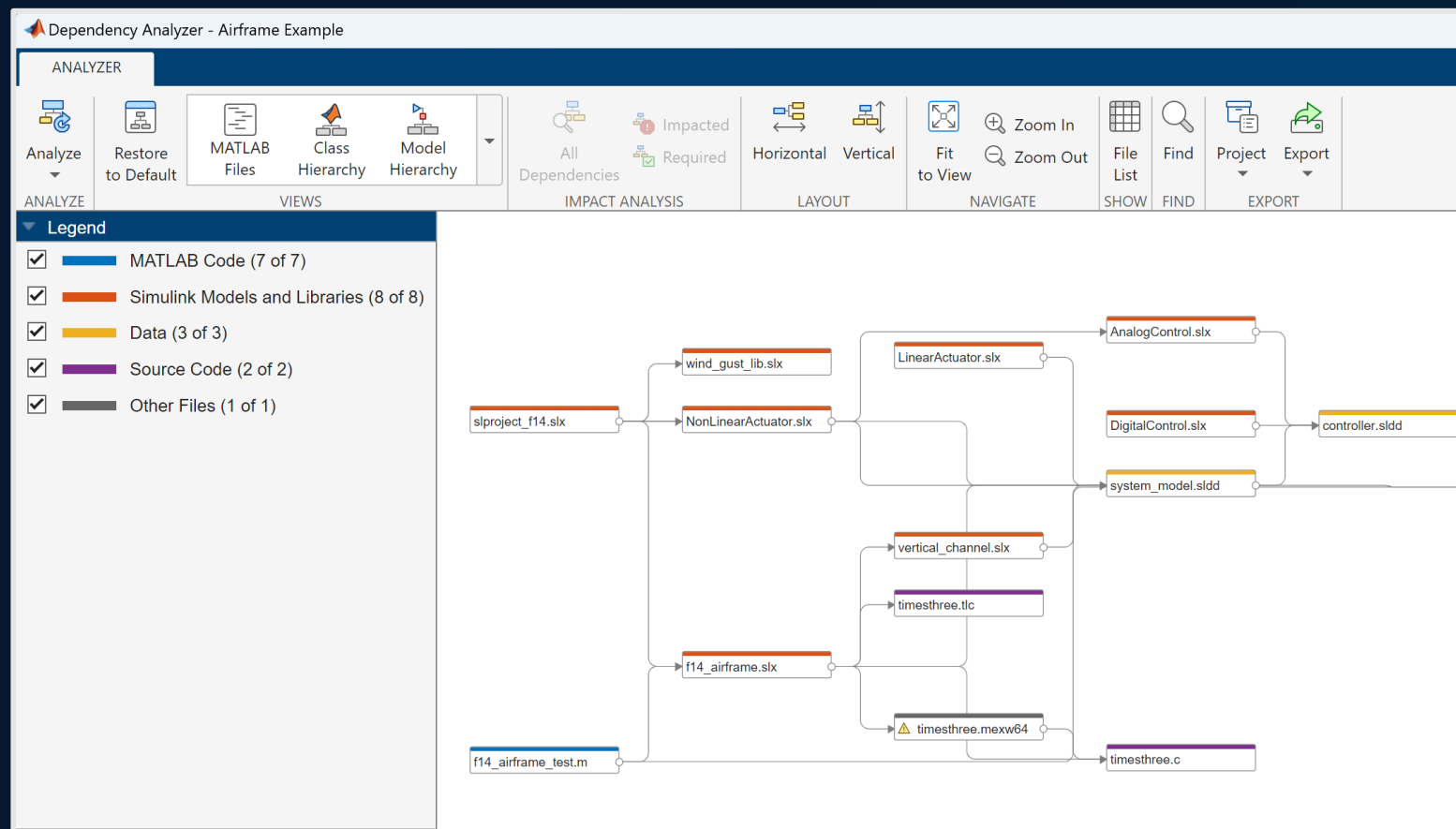
# MATLAB Test

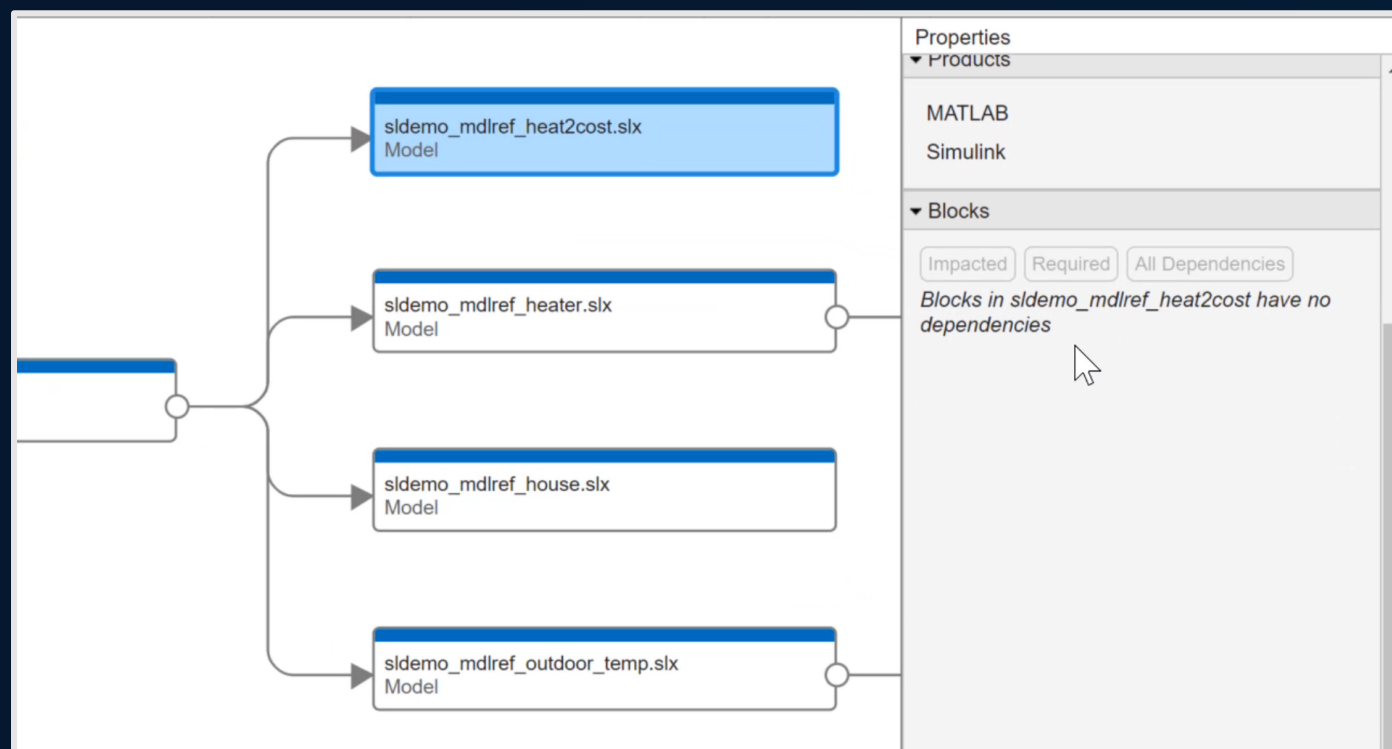


```
>> buildtool -tasks  
check    - Identify code issues  
test     - Run unit tests  
Toolbox  - Package Toolbox
```

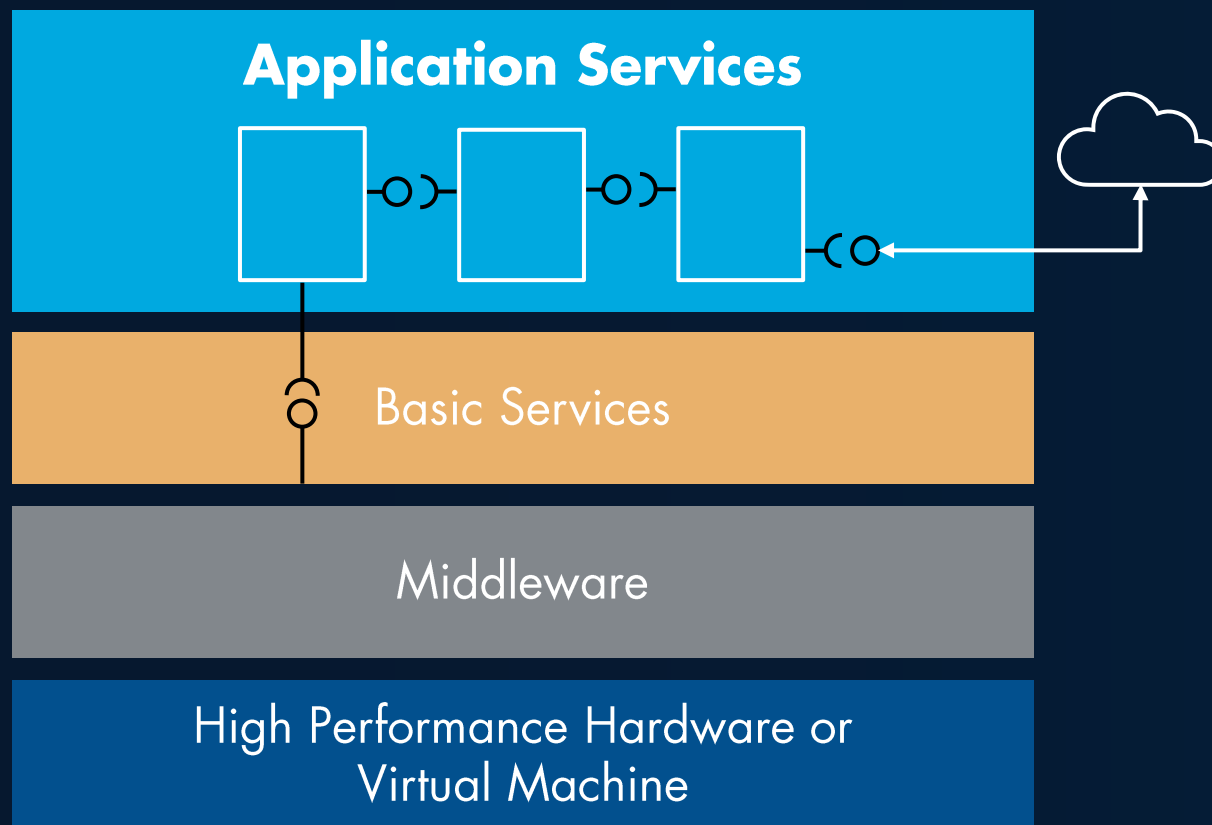
```
>> buildtool  
** Starting check  
** Finished check  
  
** Starting test  
** Finished test  
  
** Starting toolbox  
** Finished toolbox  
>>
```

# Projects

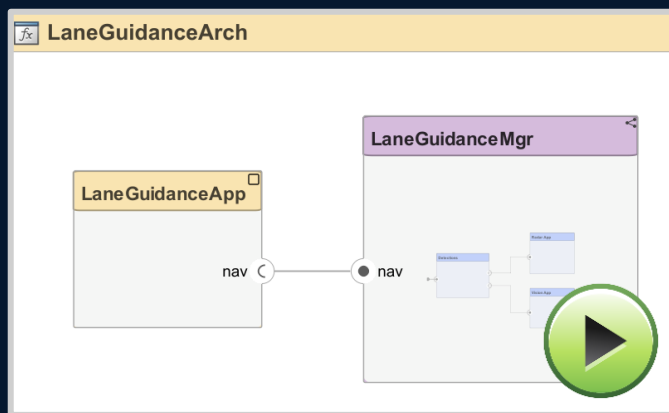




# Service-Oriented Architecture (SOA)

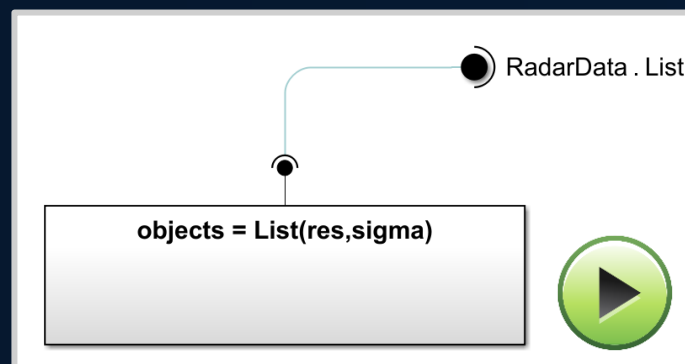


## From **architecture** to **design**



Describe Architecture

## From **design** to **code**

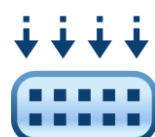


Implement Design

```

36 class scServiceInterfaceExample final
37 {
38     // public data and function members
39     public:
40     // Block signals (default storage)
41     struct B_scServiceInterfaceExample_T {
42         real_T fetchData_b;
43         real_T reset_d;
44         real_T fetchData_m;
45         real_T reset_p;
46     };
47

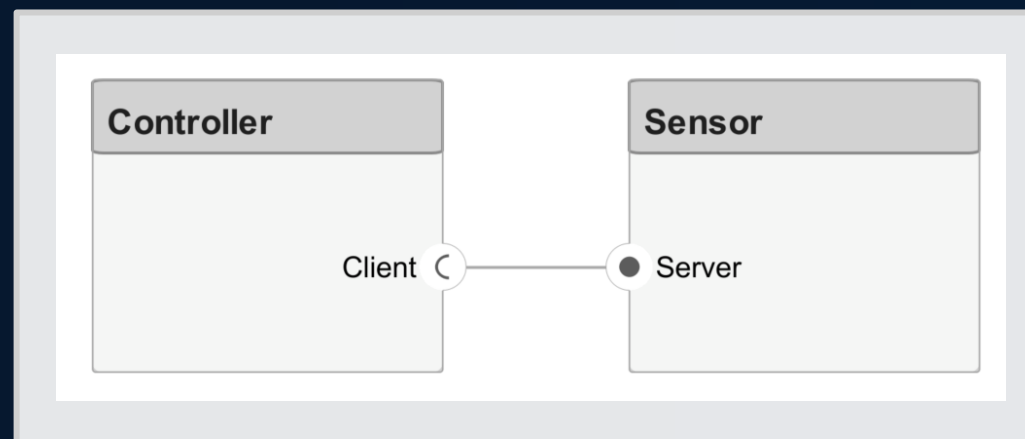
```



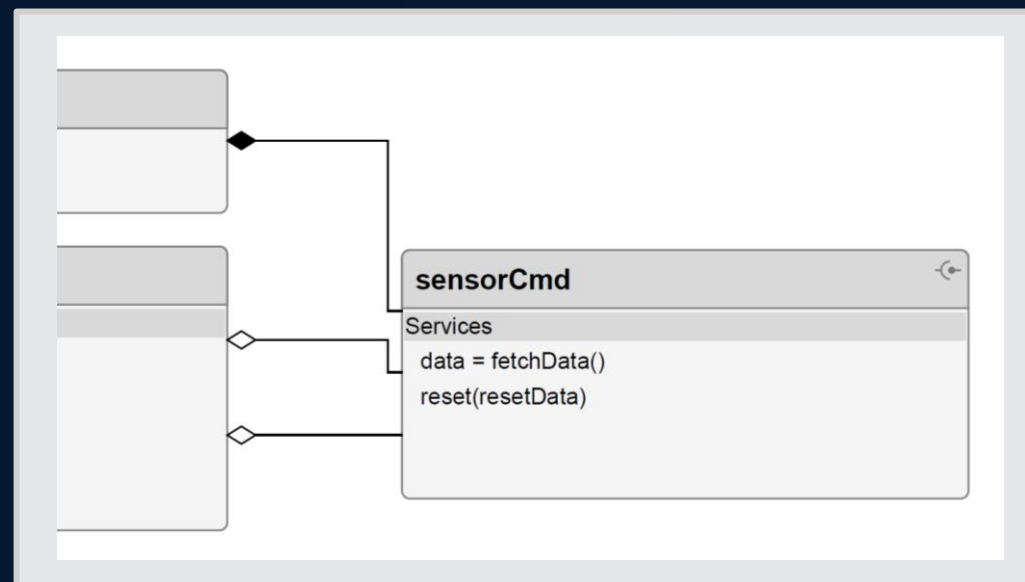
Generate C++ Code

# Describe Architecture

Define

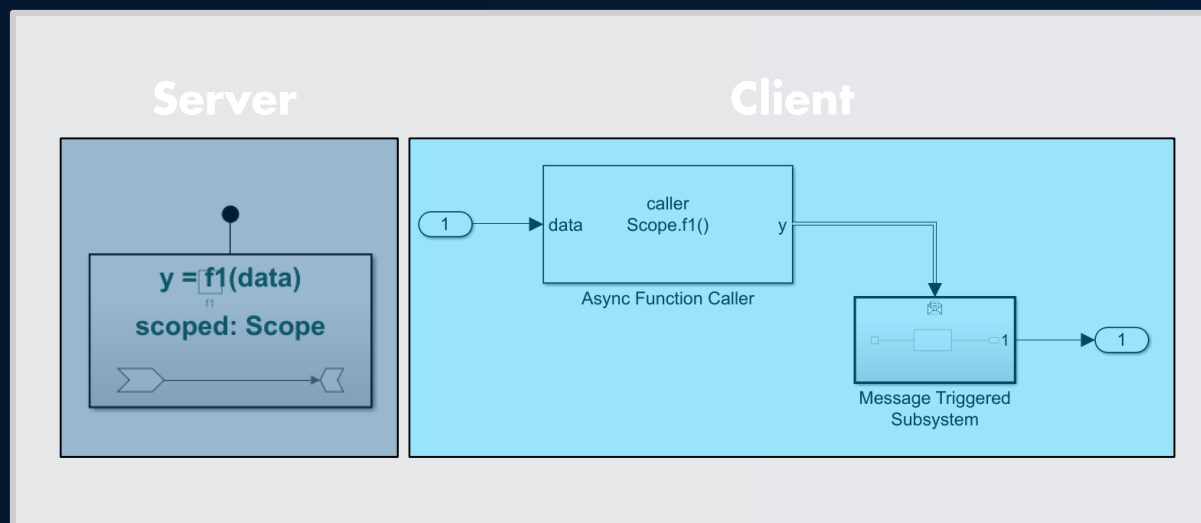


Visualize

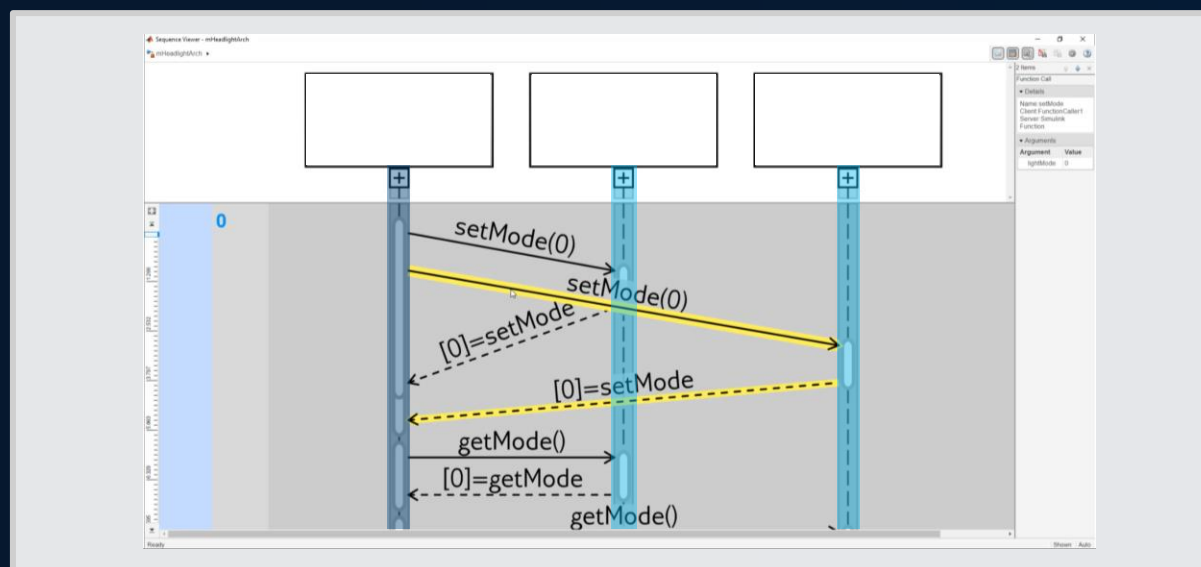


# Implement Design

Model



Simulate






# Generate Code

```

36 class scServiceInterfaceExample final
37 {
38     // public data and function members
39     public:
40     // Block signals (default storage)
41     struct B_scServiceInterfaceExample_T {
42         real_T fetchData_b;           // '<Root>/Sensor1'
43         real_T reset_d;              // '<Root>/Sensor1'
44         real_T fetchData_m;         // '<Root>/Sensor2'
45         real_T reset_p;              // '<Root>/Sensor2'
46     };

```



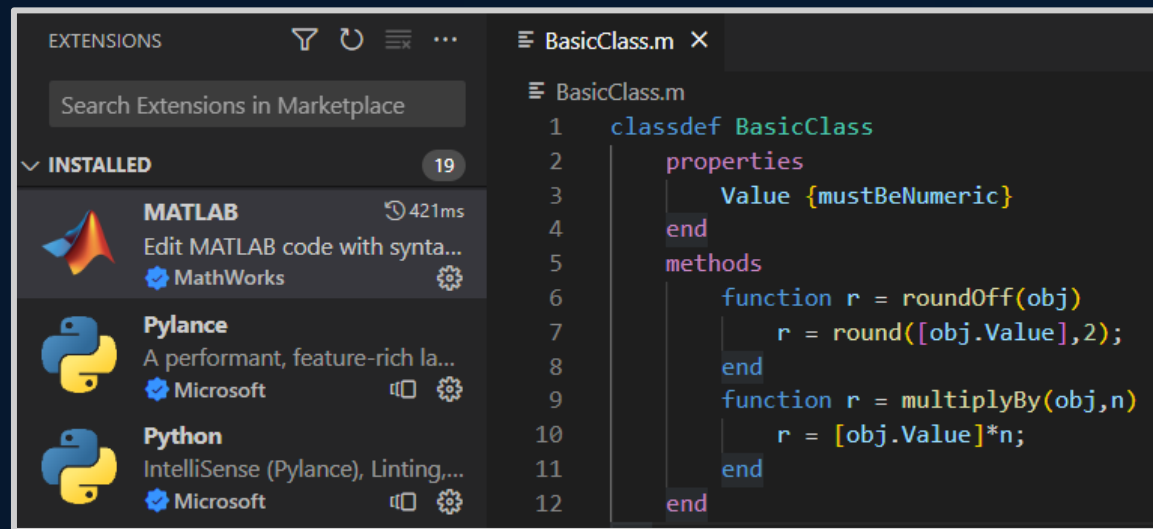
**AUTOSAR**



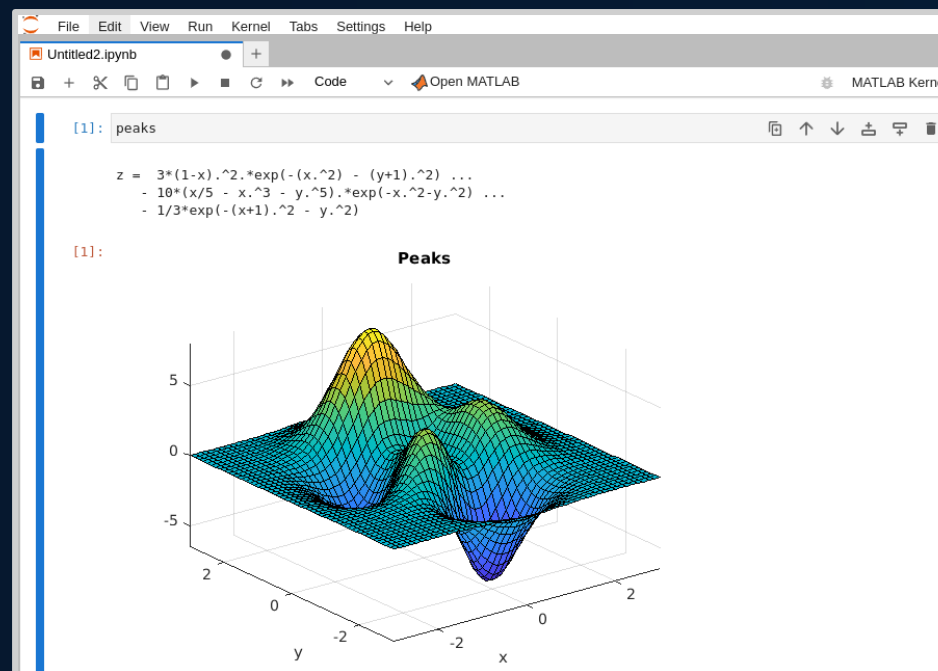
ROS



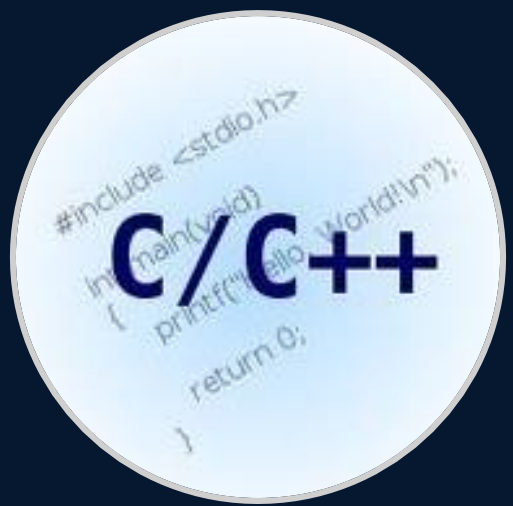




Visual Studio Code



Jupyter





R2017b

FMU  
Import

FMU Import

R2018b

<FunctionName>

C Caller

R2020a

C

C Function

R2021a



Code Importer

R2022a

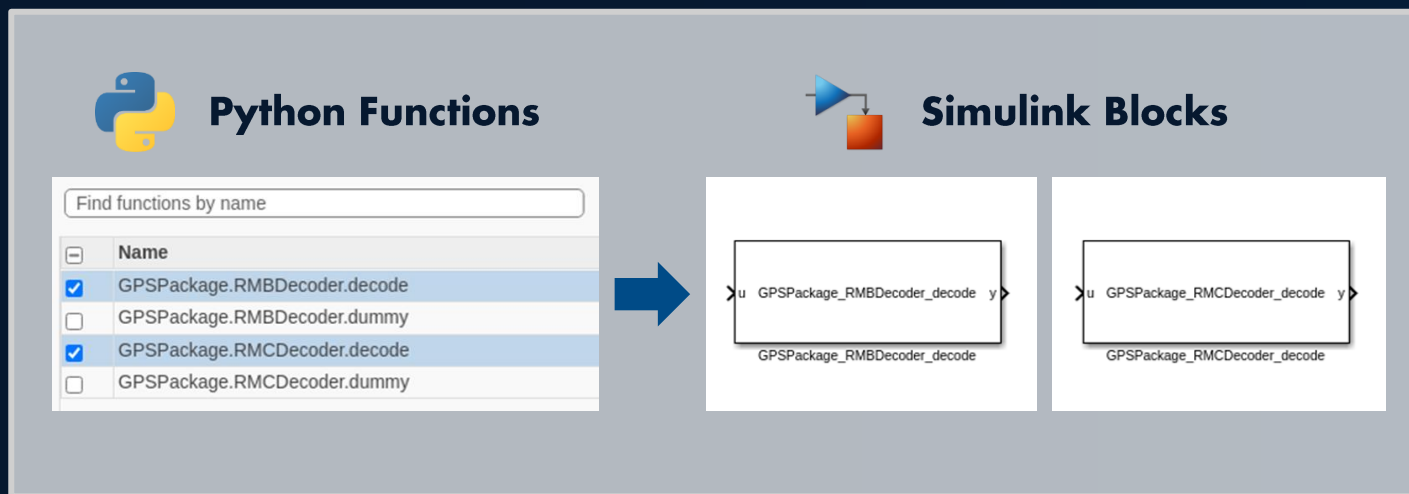
C

C Function  
Supports C++

R2023a

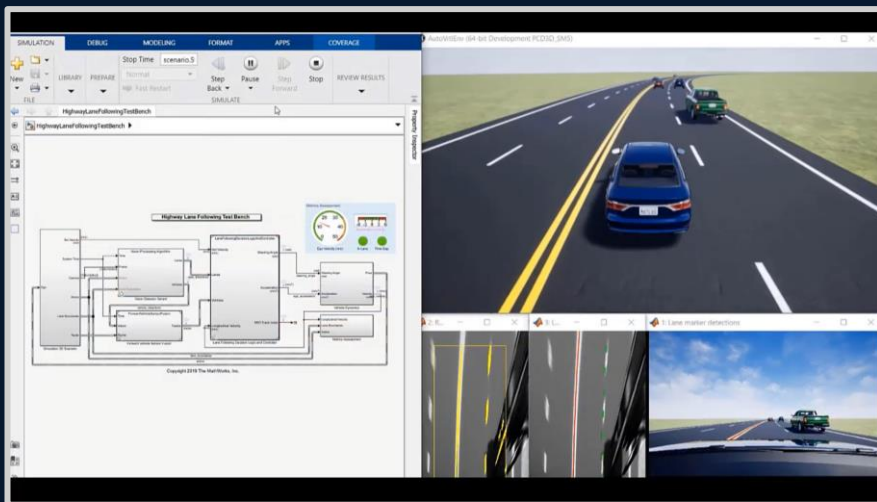
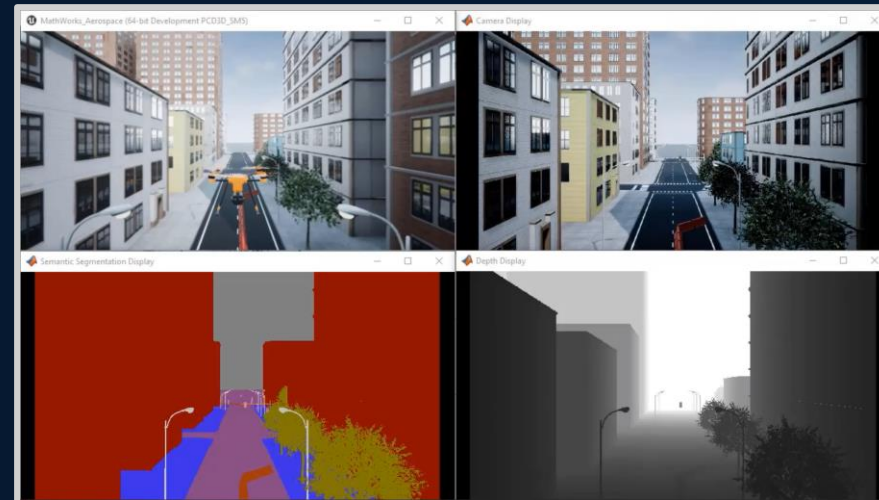


Python Importer

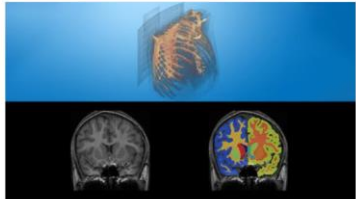




# 3D Visualizations

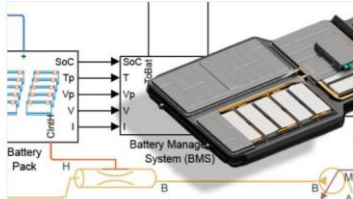


## New Products



### Medical Imaging Toolbox

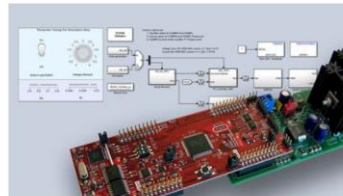
Visualize, register, segment, and label 2D and 3D medical images



### Simscape Battery

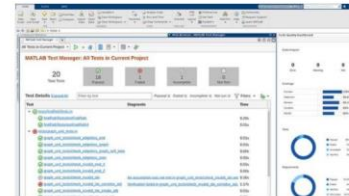
Design and simulate battery and energy storage systems

## New Products



### C2000 Microcontroller Blockset

Design, simulate, and implement applications for Texas Instruments C2000 microcontrollers



### MATLAB Test

Develop, manage, analyze, and test MATLAB applications



<https://www.mathworks.com/videos/whats-new-in-matlab-and-simulink-r2023a-1683545073311.html>

# MATLAB EXPO

Thank you



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# MATLAB EXPO

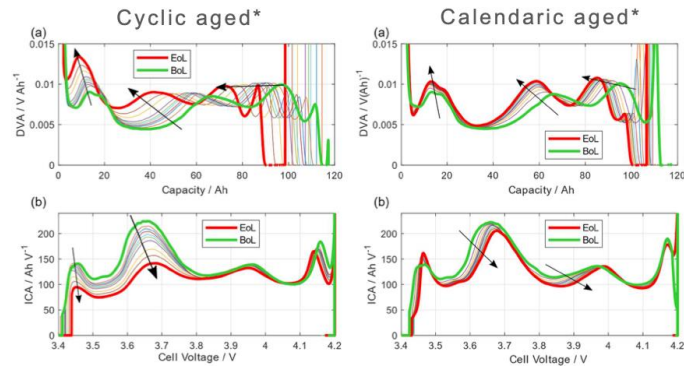
## ChatGPT and Large Language Models with MATLAB

*Prashant Rao, MathWorks*



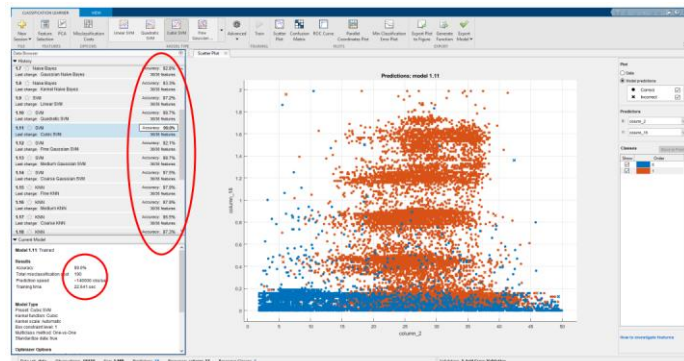
# AI is making its way into all stages of developing products

## R&D



## Gotion

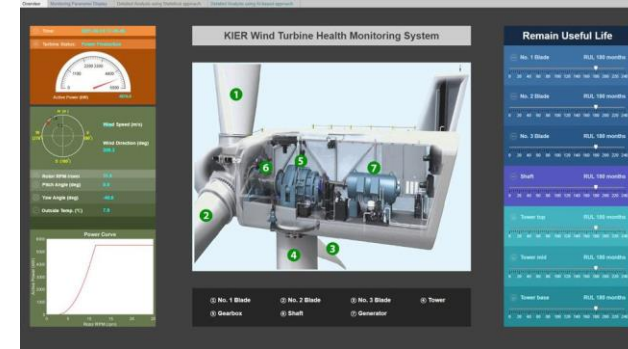
Battery SOH Estimation



## PathPartner

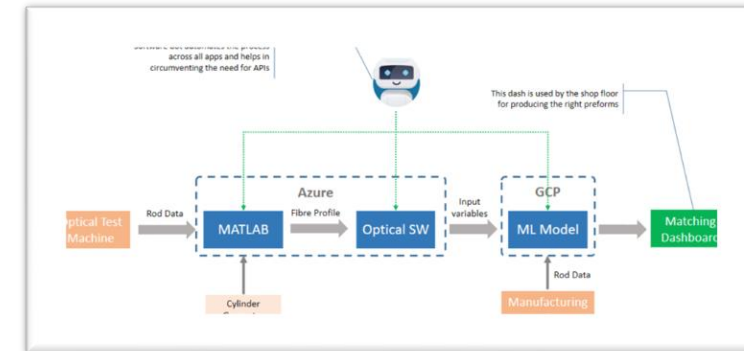
Radar-based automotive packages

## Manufacturing & Maintenance



## Korea Institute of Energy Research

AI-Based Predictive Maintenance Models



## Sterlite

Minimizes Optical Fiber Manufacturing Cost

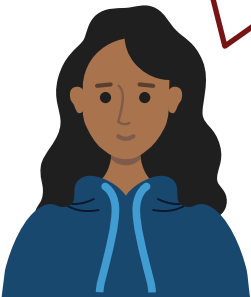
# Disruptive AI technology: ChatGPT

## How is it going to change R&D?

### Example:

ChatGPT Integration in automotive

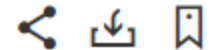
What activities can I do at the beach ... or in Bangalore traffic?



## Mercedes-Benz tests ChatGPT in intelligent vehicle production

Stuttgart, July 06, 2023

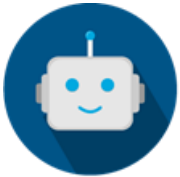
3 Pictures | 2 Documents



*"... ChatGPT can additionally support Mercedes-Benz quality engineers in identifying faults by clustering data. For example, with the help of ChatGPT, complex evaluation and presentations of production-relevant data and quality management are significantly simplified for employees.... "*

<https://media.mercedes-benz.com/article/dd57aac5-7911-48bb-b61a-7c3d54cdfdf>

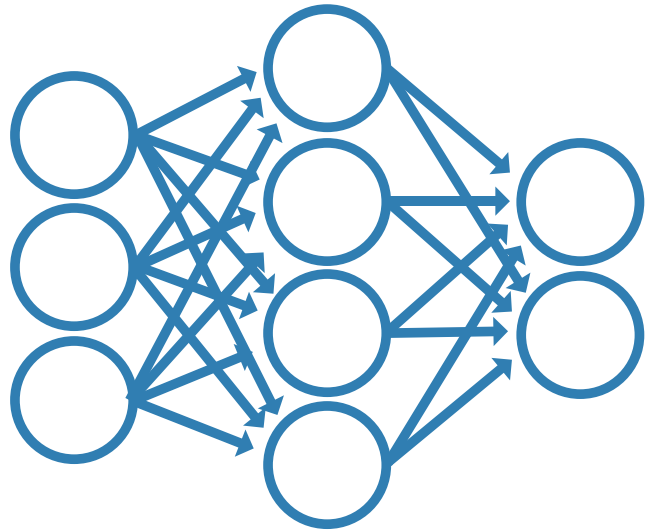
## But wait, what is it?



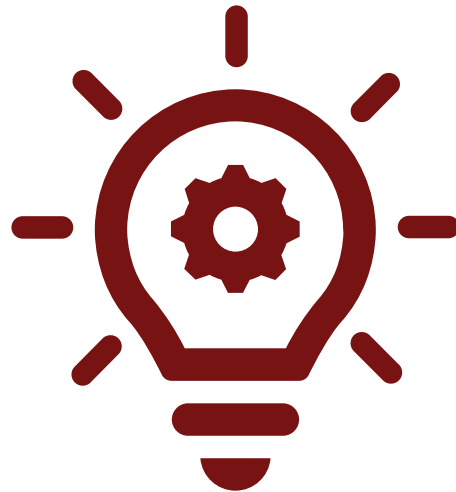
- It's an AI chatbot, developed by OpenAI
- Built on GPT-3.5 and GPT-4, focused on human alignment
- GPTs are generative pre-trained transformers, a type of *large language models*



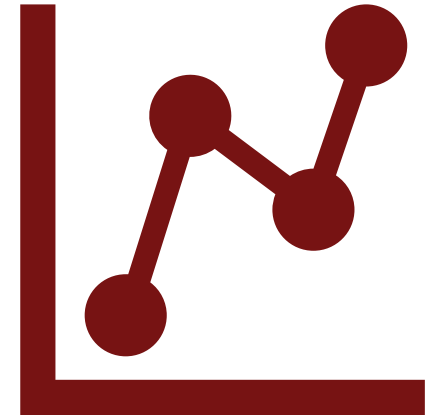
# What are Large Language Models?



Large language models (or LLMs) are a type of artificial intelligence model



Trained on huge amounts of data



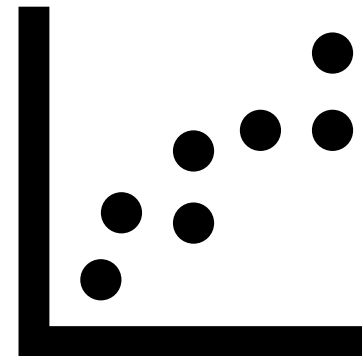
Networks with millions to trillions of parameters

# LLMs generate output word by word

## What is the next word?

Accelerating the pace of engineering and science  
with tech plus research  
of innovation and knowledge  
then engineering or science

They do not understand text  
in the way humans do.



They recognize patterns in the data  
they were trained on.

# Being trained on next word prediction results in impressive functionality

- **Grammar**

When I get home, I like to do some {reading, *banana*}

- **World Knowledge**

The capital of Brazil is {Brasília, *Buenos Aires*}

- **Sentiment Analysis**

That movie was very boring, it was quite {bad, *good*}

- **Math**

First grade arithmetic exam:  $3 + 8 + 4 = \{15, 11\}$

- **Programming**

```
while (x<100)
    x = x * 3;
{end, for}
```

## But some things cannot be learned in that way

- **Current world knowledge**

MathWorks is hosting MATLAB EXPO 2023, the event will happen at ???

- **Long arithmetic**

$12698681629350158454873 + 632359246225445775100 = ???$

- **Predict the future**

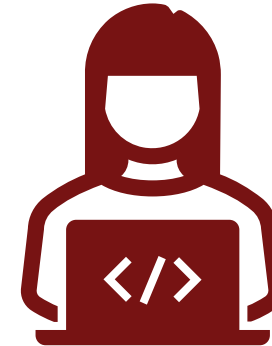
The hockey team that will win the 2024 Olympic gold medal is ???

# What Large Language Models are great at...

Natural Language Understanding



Generating text and code



# There are still many limitations with Large Language Models

## Models can hallucinate



How can I tokenize text in MATLAB?

If you need help with your software, talk to us!

Function does not exist!



In MATLAB, you can tokenize text by using the `tokenize` function, which is available starting from MATLAB R2017a. The `tokenize` function splits a string into individual tokens based on a specified delimiter. Here's an example of how you can use it:

```
matlab Copy code
str = 'Hello, how are you today?';
delimiter = ' ,.?'; % Specify the characters to be treated as delimiters
tokens = tokenize(str, delimiter);
```

## Output is not always reliable



Translate the following code from MATLAB to C:

```
A = [1, 2; 3, 4];
[eigVec, eigVal] = eig(A);
```

You will not have this problem with MATLAB Coder!

Code does not compile!



Here's the equivalent code in C:

```
c Copy code
#include <stdio.h>
#include <stdlib.h>
#include <math.h>

void matrix_eig(double *A, int n, double *eigVec, double *eigVal);

int main() {
```

# LLMs can help you solve specific problems

## Generate Text

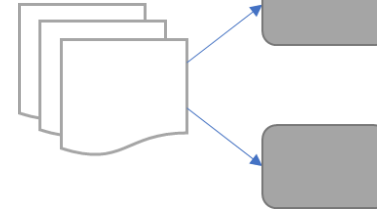


Write Code

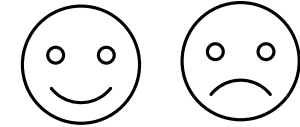


Document

## Classify Text

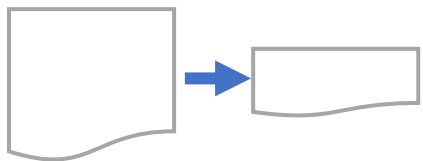


Classify Maintenance Documents

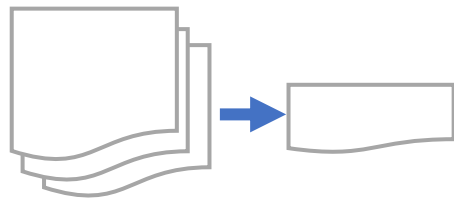


Analyze Sentiment

## Summarize



One document

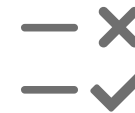


Multiple documents

## Retrieve Information



Scientific Discovery

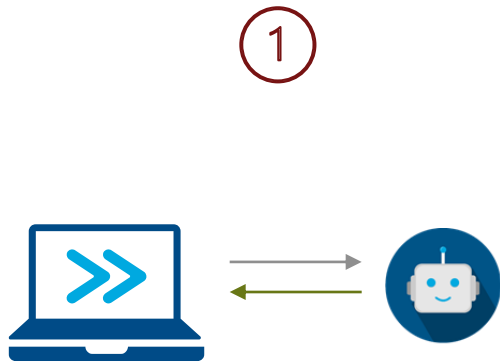


Requirements for design & engineering

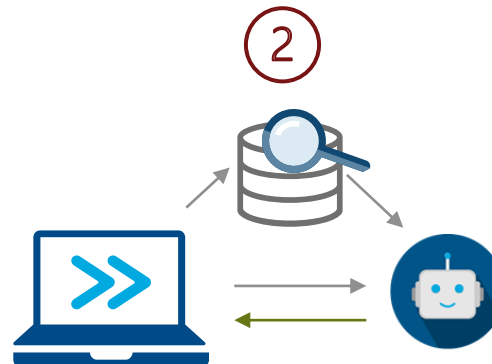


Knowledge from internal documents

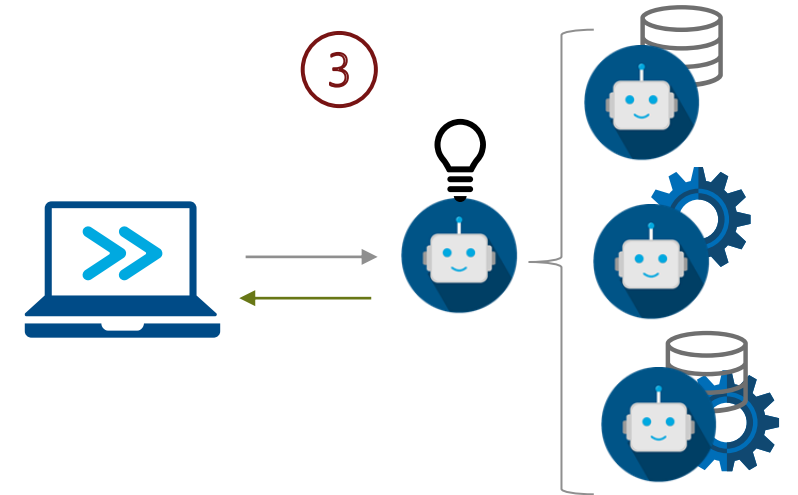
# Approaches for leveraging LLMs



Prompt Engineering



Retrieval-Augmented Generation



Fine-tuning



# For some things it's just easier to use the chat interface...



Generate MATLAB code to compute the sine of values between 1 and 30. The code should be optimized and use vectorization. Let's think step-by-step.

Prompt engineering is the process of crafting and refining inputs to an AI model to guide its output.



Sure! Here's the MATLAB code that computes the sine of values between 1 and 30 using vectorization:

matlab

Copy code

```
% Define the range of values
startValue = 1;
endValue = 30;

% Generate the values within the range
x = startValue:endValue;

% Compute the sine of the values using vectorization
y = sin(x);

% Display the results
disp(y);
```

# For other things, you might want to use ChatGPT programmatically



① Copy and paste each document individually into the chat interface.

② Ask ChatGPT for a summary

③ Copy and paste the result into another file



Summarize...

...



① Read each file inside MATLAB in a loop

② Request the ChatGPT API for a summary for each document

③ Automatically save each summary to a file

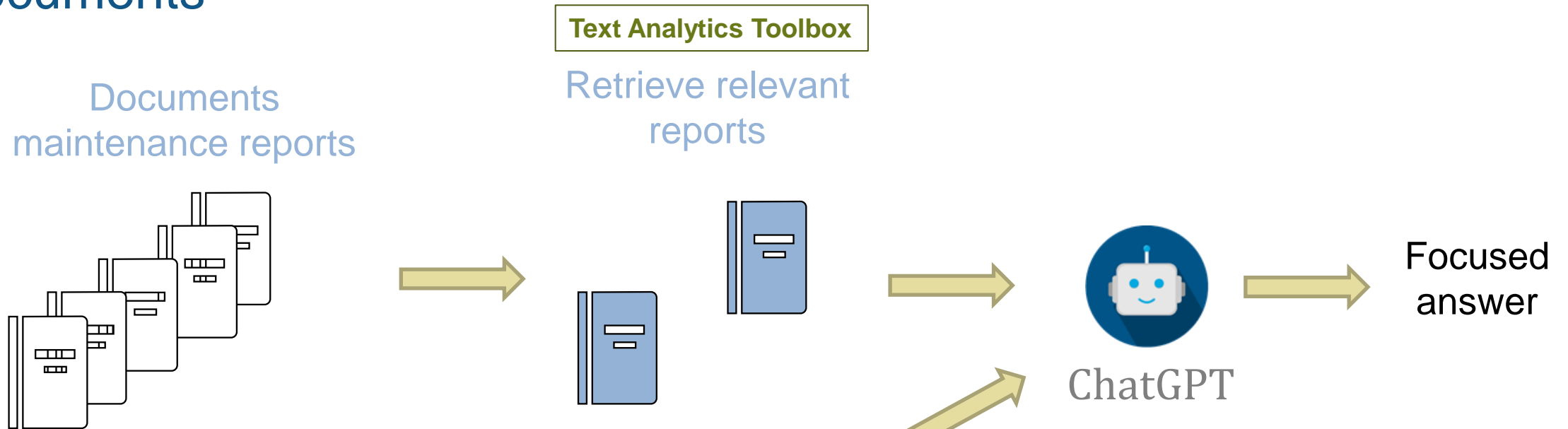


Design notes



If there is repetition, there is potential for automation via MATLAB

# Retrieval-Augmented Generation (RAG) to ask questions about your documents



Query: Model XYZ had a faulty spark plug,  
what should I do?

Use RAG when you  
want to tailor the  
model's output to  
your own data!

# Fine-tuning Large Language Models

For domain-specific text, you might want to fine-tune (adapt) a model to your own data.



## R2020a

Fine-tuning a large model requires parameter efficient fine-tuning techniques.

# AI Chat Playground

# Playground

Hello! Whether you're checking out MATLAB for the first time or years, I'm here to answer your questions and provide coding tips

✓ Ran in R2023a

DF Deborah Ferreira

How can I compute the eigenvalues for a matrix?

AI



To compute eigenvalues for a matrix in MATLAB, you can use the `eig()` function. Here's an example code.

```
A = [1 2; 3 4];
eigenvalues = eig(A);
disp(eigenvalues);
```

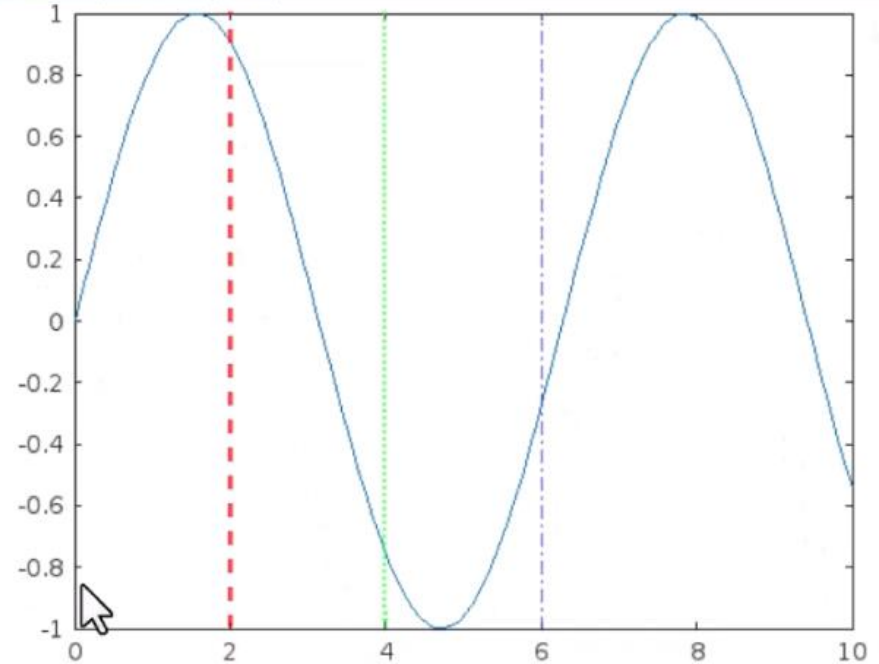
This will output the eigenvalues for matrix A. What happens when you try to compute eigenvalues for a non-square matrix?

How can you verify the correctness of your code?

Send a message...



Generated code and text might be inaccurate. Validate before use.



```
A = [1 2; 3 4];
eigenvalues = eig(A);
disp(eigenvalues);
```

```
-0.3723
 5.3723
```

# MATLAB EXPO

AI Chat Playground

Early Access



Thank you



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