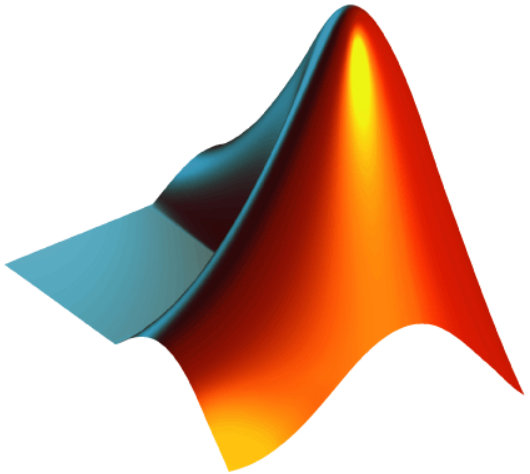
MATLAB



PROJECTS

Engineering Team Project

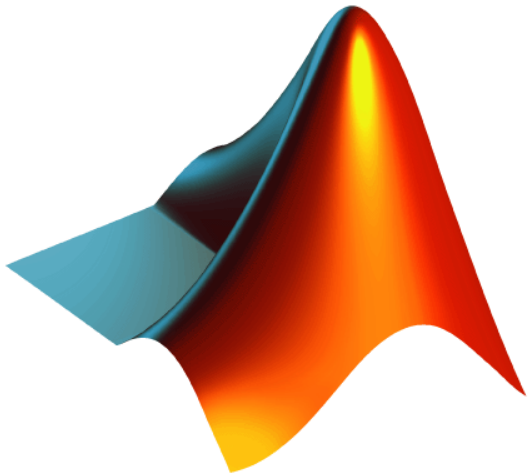
Integrated Project

Final Year Project

~~Fast Prototyping~~

Simulations

HOW?



MATLAB

GOAL FOR TODAY

Learn the basics of MATLAB
(You might use this in your assignments)

OVERVIEW

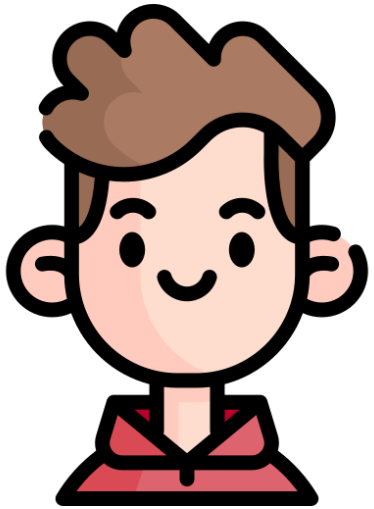
- Introduction to MATLAB
- Applications of MATLAB
- Hands-on MATLAB Activities
- Questions and Answer

WHAT IS MATLAB?

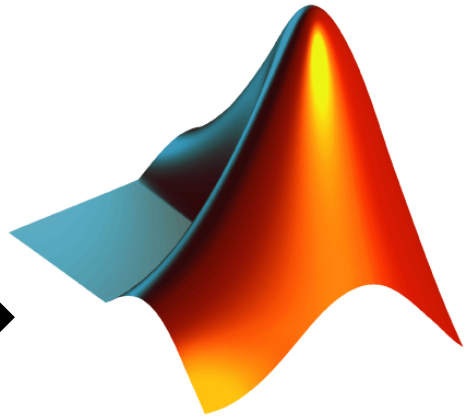
- MATLAB® (**Mat**rix **Lab**oratory) is a **programming platform** designed specifically for engineers and scientists.
- Written in Fortran in the late 1970s by **Cleve Moler**, it was a simple interactive matrix calculator.
- In 1983, Jack Little, who was an engineer, visited Moler for MATLAB. He sees the commercial potential in MATLAB, so Jack Little joined hands with Steve Bangert and Moler to **rewrite MATLAB in C Language.**
- This was also accompanied with the **formation of MathWorks** in the year 1984 to further enhance the development of MATLAB.

HISTORY OF MATLAB

1970s



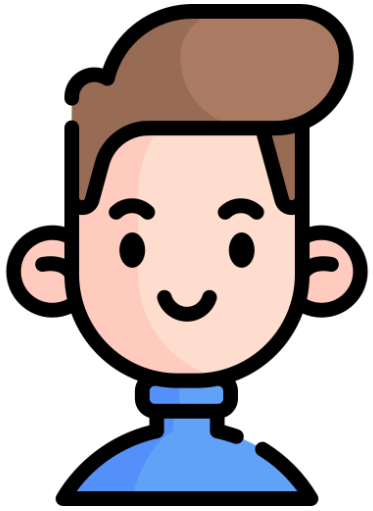
Cleve Moler



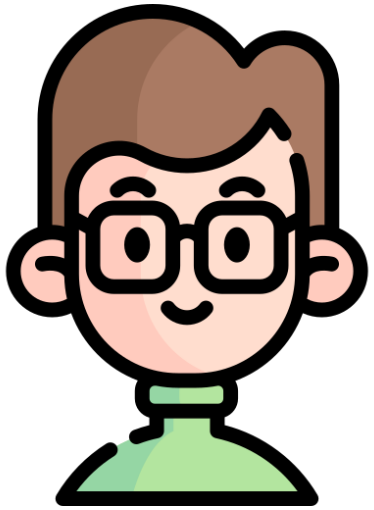
HISTORY OF MATLAB

1983 - 1984

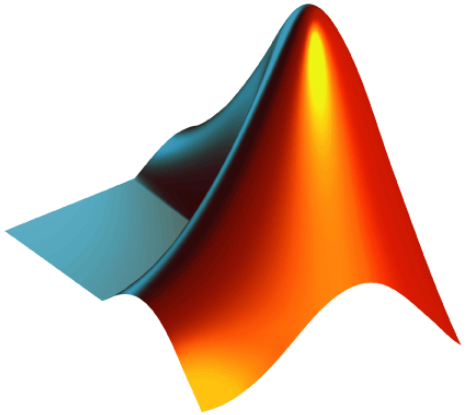
Cleve Moler

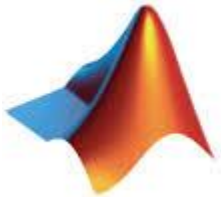


Jack Little



Steve Bangert

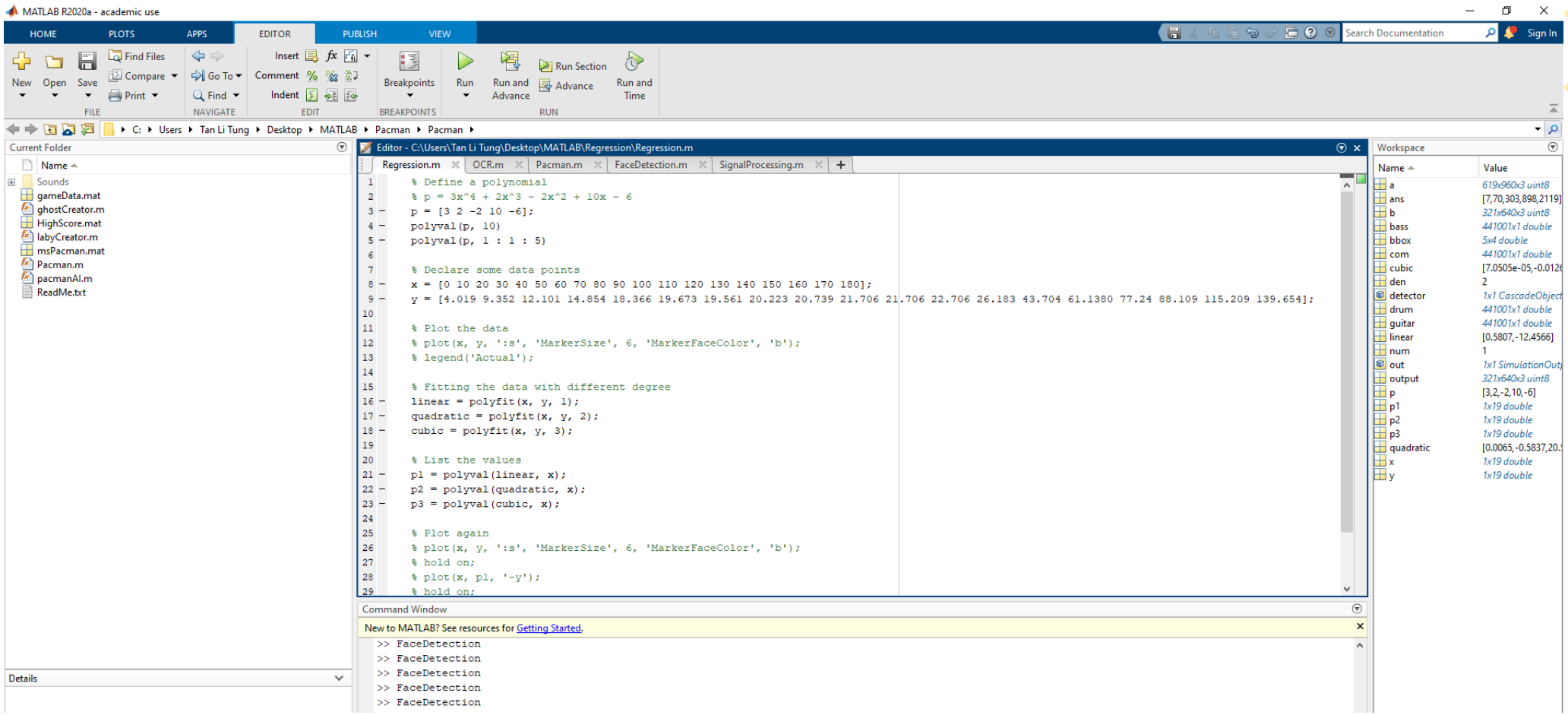




MathWorks®

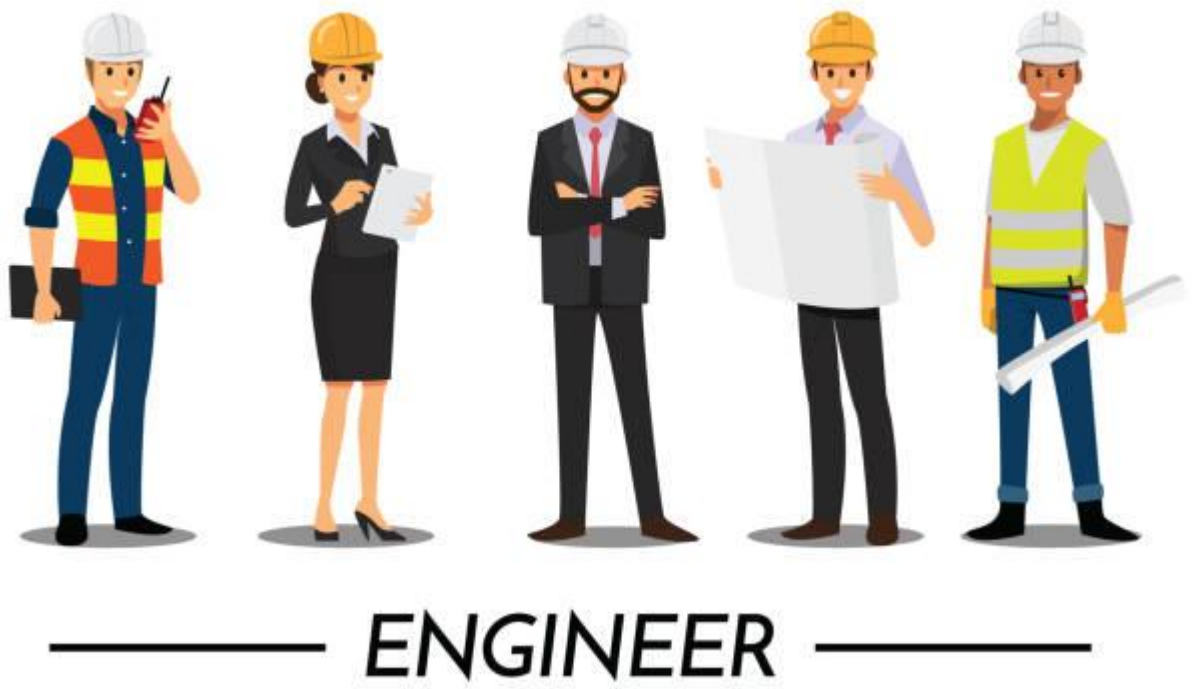
WHY USE MATLAB?

- Easy and intuitive.



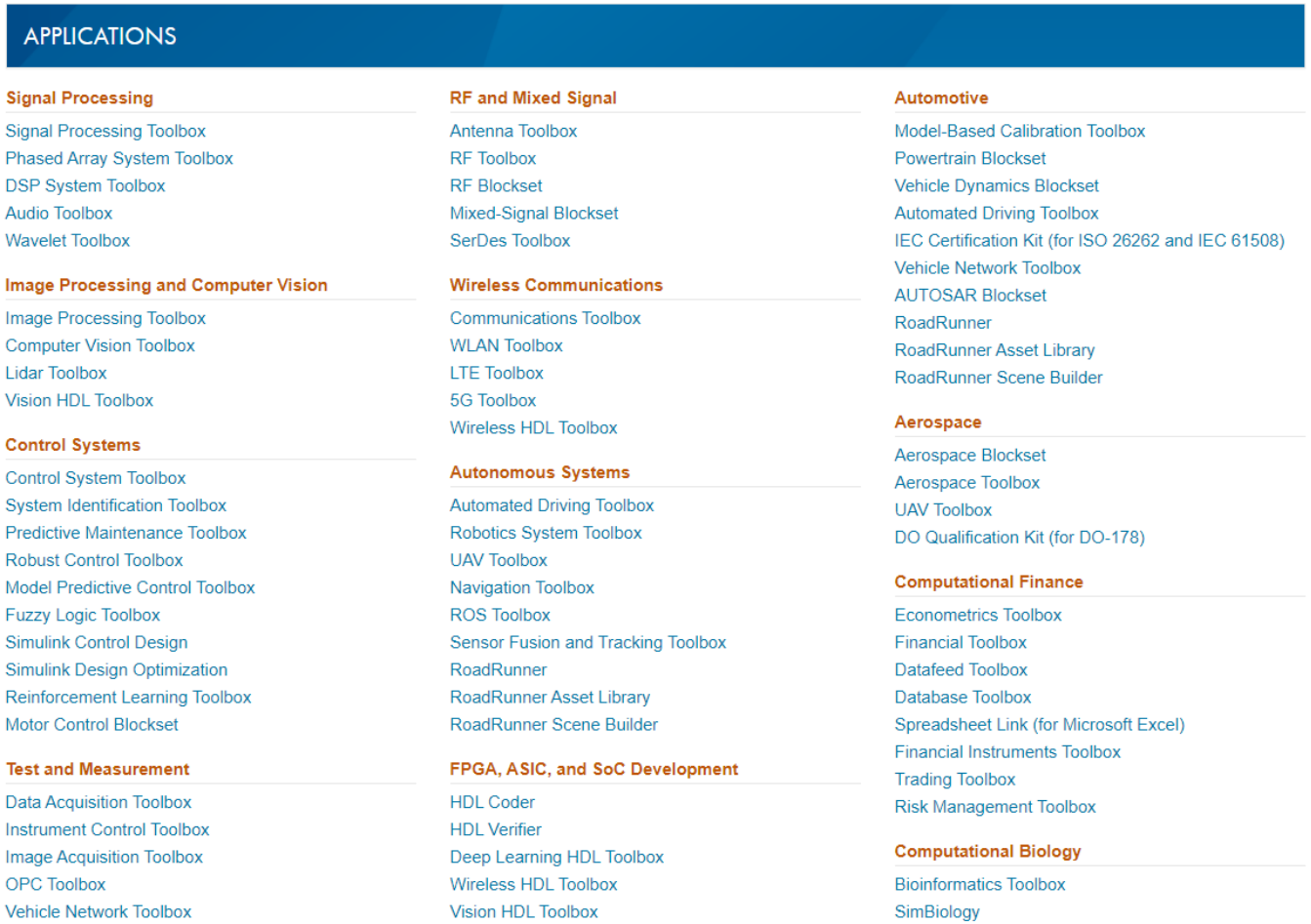
WHY USE MATLAB?

- Designed for Engineers and Scientist.



WHY USE MATLAB?

- Lots of Toolboxes available (Lots of resources).



APPLICATIONS

Signal Processing
- Signal Processing Toolbox
- Phased Array System Toolbox
- DSP System Toolbox
- Audio Toolbox
- Wavelet Toolbox

Image Processing and Computer Vision
- Image Processing Toolbox
- Computer Vision Toolbox
- Lidar Toolbox
- Vision HDL Toolbox

Control Systems
- Control System Toolbox
- System Identification Toolbox
- Predictive Maintenance Toolbox
- Robust Control Toolbox
- Model Predictive Control Toolbox
- Fuzzy Logic Toolbox
- Simulink Control Design
- Simulink Design Optimization
- Reinforcement Learning Toolbox
- Motor Control Blockset

Test and Measurement
- Data Acquisition Toolbox
- Instrument Control Toolbox
- Image Acquisition Toolbox
- OPC Toolbox
- Vehicle Network Toolbox

RF and Mixed Signal
- Antenna Toolbox
- RF Toolbox
- RF Blockset
- Mixed-Signal Blockset
- SerDes Toolbox

Wireless Communications
- Communications Toolbox
- WLAN Toolbox
- LTE Toolbox
- 5G Toolbox
- Wireless HDL Toolbox

Autonomous Systems
- Automated Driving Toolbox
- Robotics System Toolbox
- UAV Toolbox
- Navigation Toolbox
- ROS Toolbox
- Sensor Fusion and Tracking Toolbox
- RoadRunner
- RoadRunner Asset Library
- RoadRunner Scene Builder

FPGA, ASIC, and SoC Development
- HDL Coder
- HDL Verifier
- Deep Learning HDL Toolbox
- Wireless HDL Toolbox
- Vision HDL Toolbox

Automotive
- Model-Based Calibration Toolbox
- Powertrain Blockset
- Vehicle Dynamics Blockset
- Automated Driving Toolbox
- IEC Certification Kit (for ISO 26262 and IEC 61508)
- Vehicle Network Toolbox
- AUTOSAR Blockset
- RoadRunner
- RoadRunner Asset Library
- RoadRunner Scene Builder

Aerospace
- Aerospace Blockset
- Aerospace Toolbox
- UAV Toolbox
- DO Qualification Kit (for DO-178)

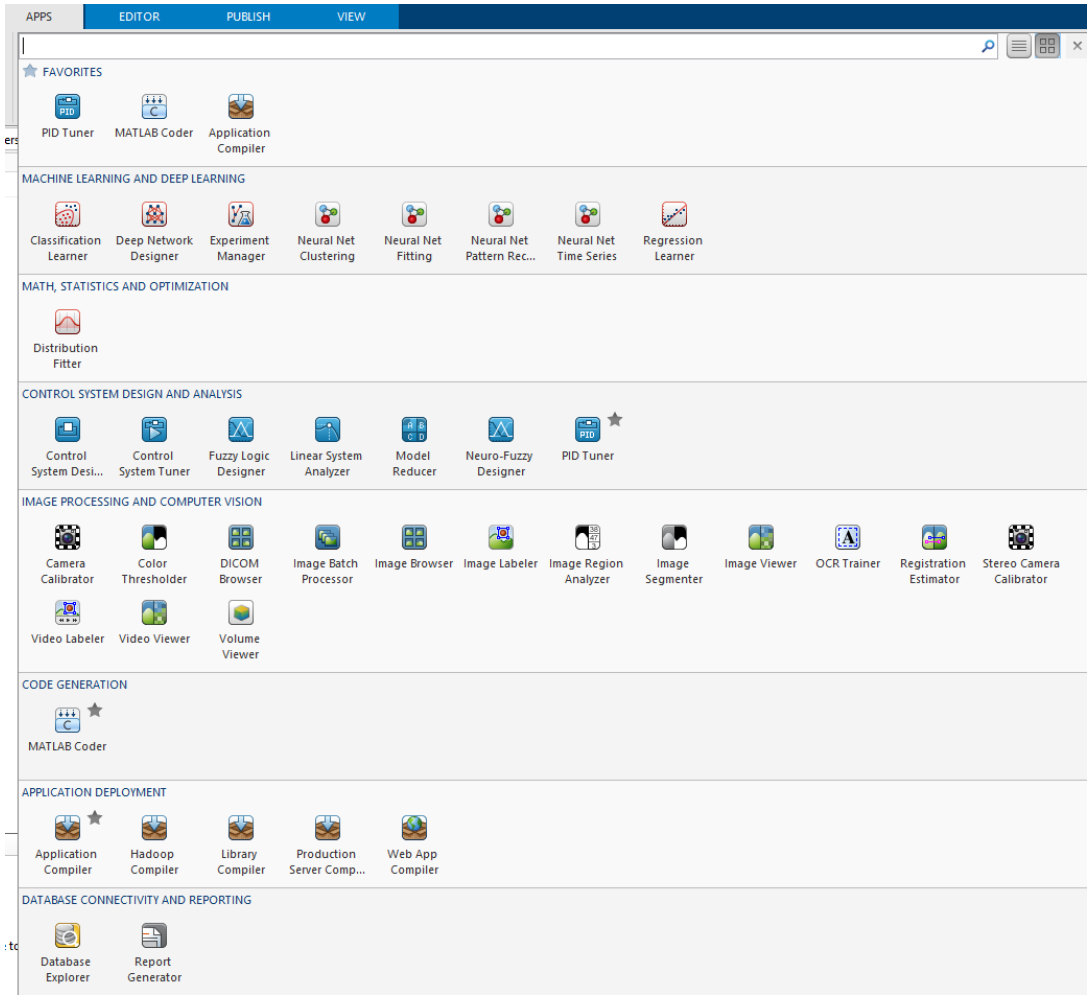
Computational Finance
- Econometrics Toolbox
- Financial Toolbox
- Datafeed Toolbox
- Database Toolbox
- Spreadsheet Link (for Microsoft Excel)
- Financial Instruments Toolbox
- Trading Toolbox
- Risk Management Toolbox

Computational Biology
- Bioinformatics Toolbox
- SimBiology

More at:
https://www.mathworks.com/products/index.html?s_tid=hp_fp_viewall

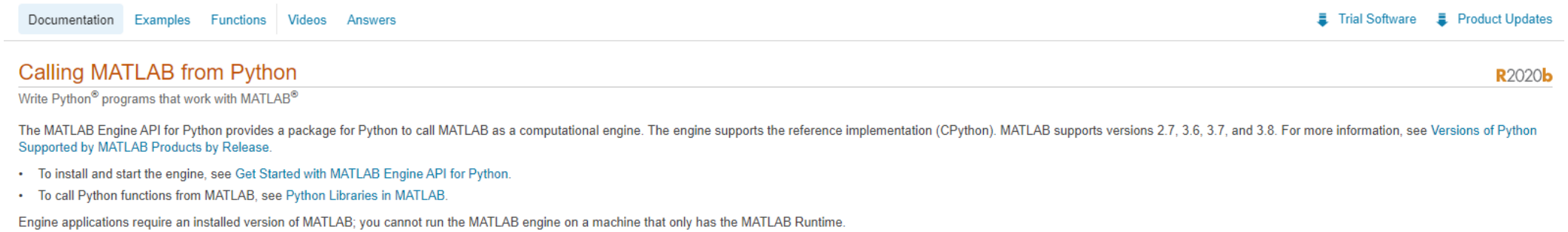
WHY USE MATLAB?

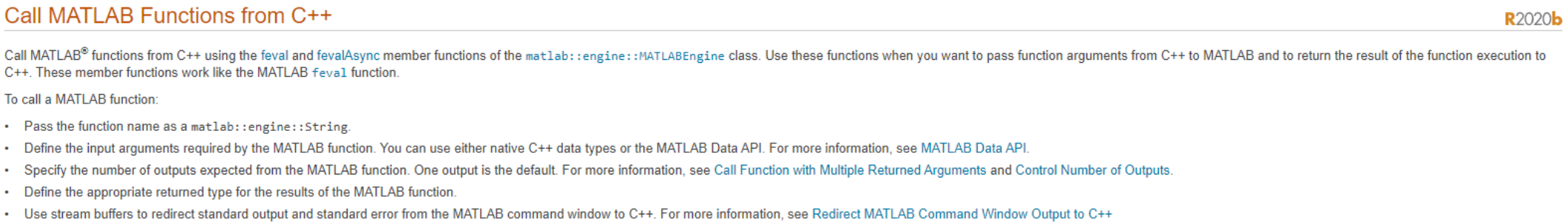
- MATLAB App (No need to code!).



WHY USE MATLAB?

- MATLAB integrates workflow. Fast. Reliable.





APPLICATIONS

- Matrix calculations.
- Plots of graphs.
- Machine learning.
- Signal processing.
- Face recognition.
- Optical Character Recognition (OCR).
- And many more……

APPLICATIONS

- Matrix calculations.
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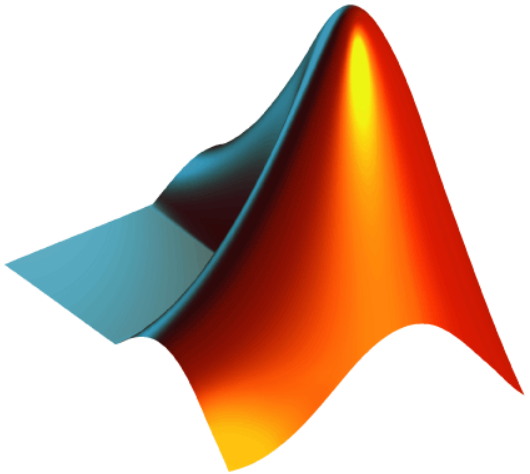
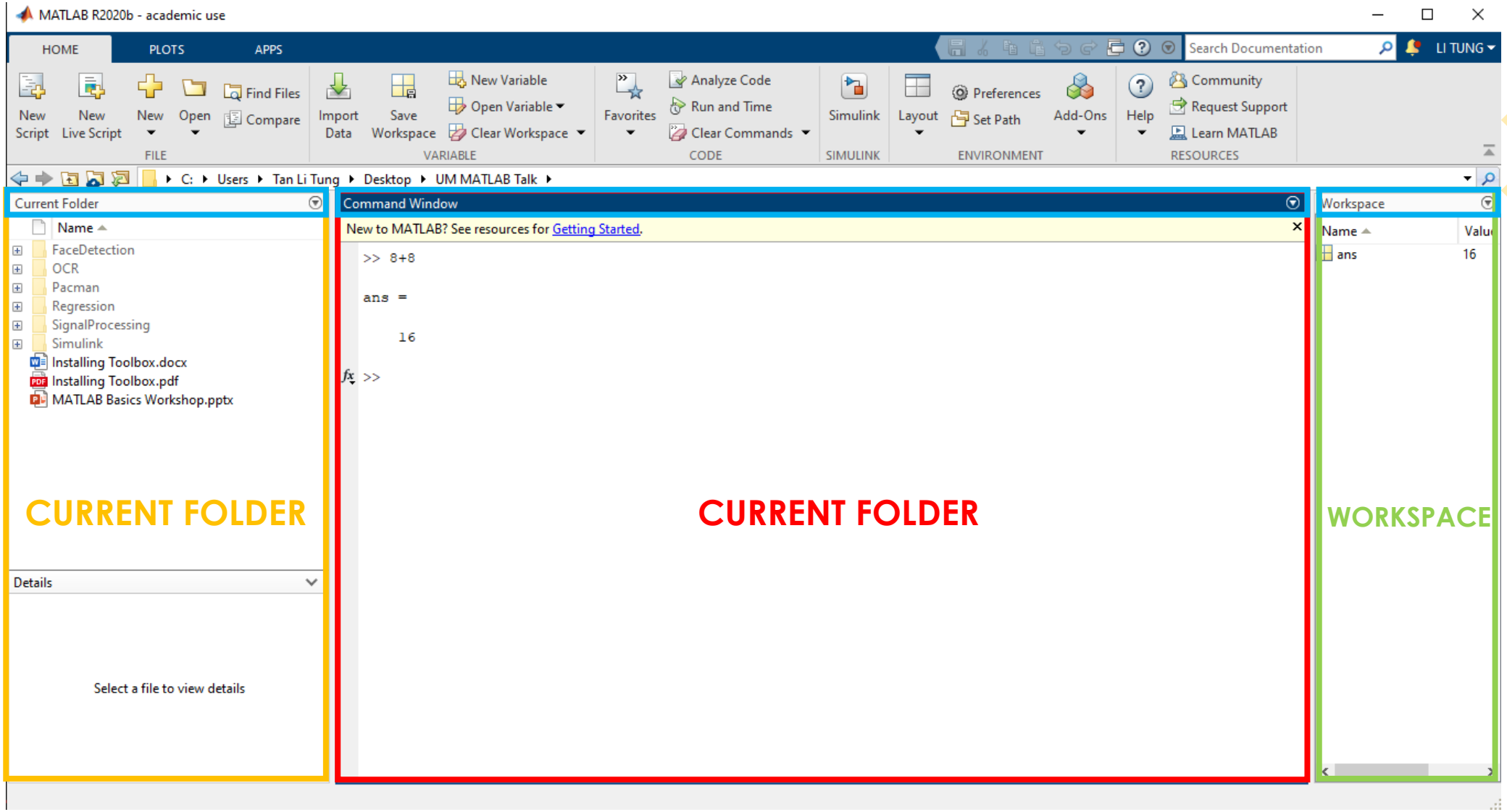
HANDS-ON



MATLAB INTERFACE

MATLAB INTERFACE



**Change the layout by dragging the light blue boxes.

BASIC OPERATIONS

BASIC OPERATIONS

- Assigning Variables (variableName = assignedValue)

```
> a = 3;
```

- Clear the command window

```
> clc
```

- Clear all variables

```
> clear all
```

- Clear all variables (clear variableName)

```
> clear a
```

- See the details of the variables

```
> whos
```

- **Variables are CASE SENSITIVE**
- **All variables are matrix**

VARIABLES

DATA TYPES

- Scalar

```
> variableName = assignedValue;
```

```
> a = 3;
```

- Matrix

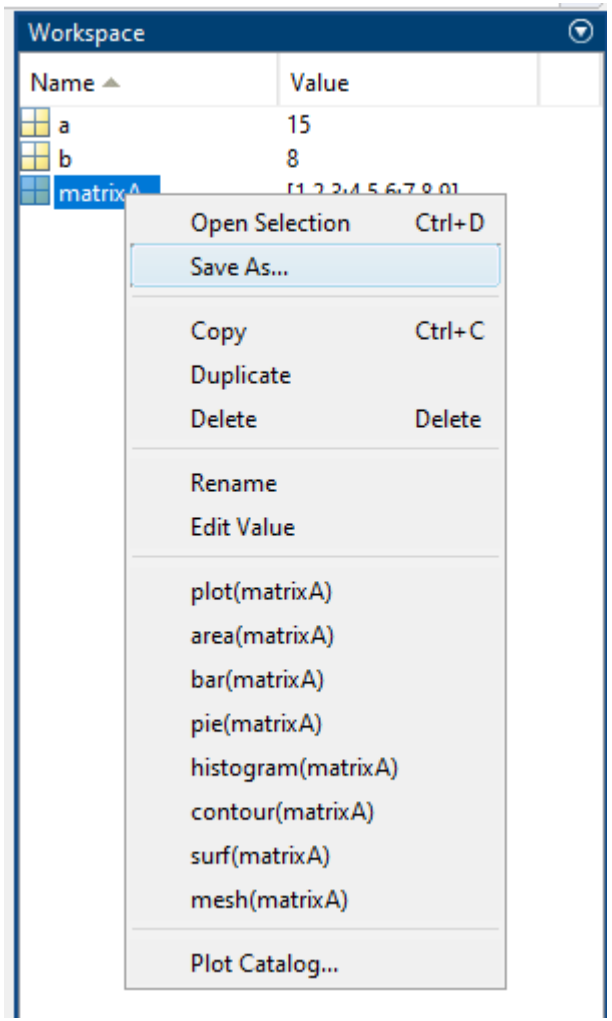
```
> matrixName =[a11 a12 … a1n;a21 a22 … a2n];
```

```
> matrixA = [1 2 3; 4 5 6; 7 8 9];
```

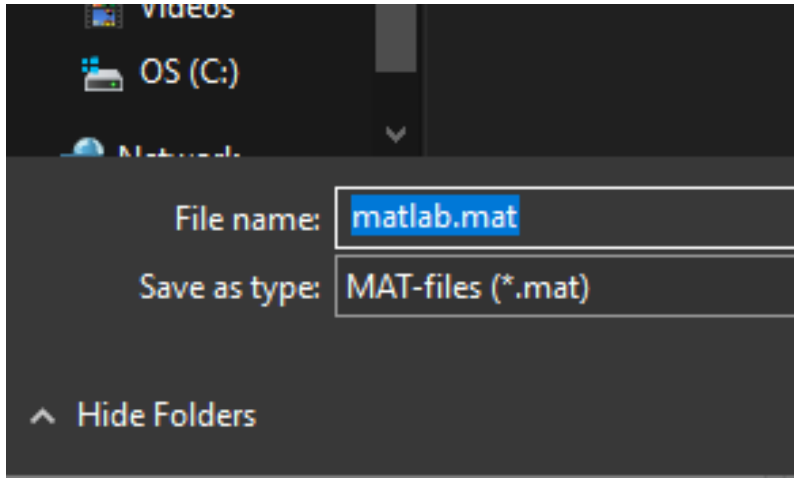
$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

*** Variables are CASE SENSITIVE**

SAVE THE VARIABLES



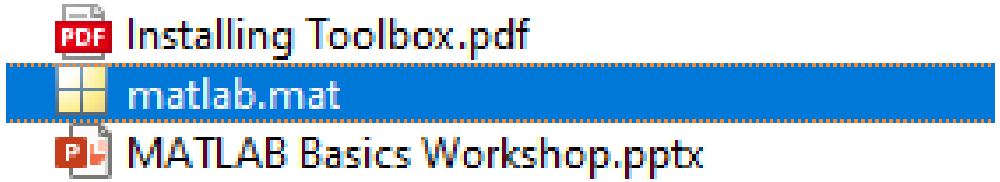
Select the variable(s) that you want to save, right click “Save As…”



Name the file and make sure it have extension of .mat

LOAD THE VARIABLES

Navigate to the folder of the .mat file and select the file



The variable(s) will be loaded into workspace

SCALAR

SCALAR OPERATION

- + - * / ^
- pow, sqrt
- log, exp
- sin, cos, tan
- asin, acos, atan
- round, ceil, floor

Special Variable

Variable Name	Meaning
pi	$\pi = 3.1415926\ldots$
eps	Machine precision
i	Imaginary unit ($\sqrt{-1}$)
inf	Infinity
NaN	Not a number (eg, $\frac{0}{0}$)
ans	Last displayed result
end	Last array element
realmax	Largest real number
intmax	Largest integer

MATRIX

MATRIX OPERATION

- + - * / ^ '
- mpow, sqrtm
- logm, expm
- sum, prod
- cumsum, cumprod
- max, min, std, mean
- length, size, eig

Command	Meaning
ones(m, n)	Create m x n matrix of 1's
zeros(m, n)	Create m x n matrix of 0's
eye(n)	Create n x n identity matrix
diag(vec)	Create diagonal matrix
diag(A)	Diagonal elements of A
rand(m, n)	Uniform random number matrix
randn(m, n)	Gaussian random number matrix
magix(m)	Magic square matrix
hilb	Hilbert matrix

ELEMENT WISE OPERATION

+ - .* ./ .^

$$Consider\ A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}\ B = \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$$

$$A^{*}B = \begin{bmatrix} 19 & 22 \\ 43 & 50 \end{bmatrix}$$

Matrix multiplication

$$A.^{*}\ B = \begin{bmatrix} 5 & 12 \\ 21 & 32 \end{bmatrix}$$

Element Wise multiplication

SUBSET A MATRIX

$$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

- Subset an element

```
Recall matrixA = [1 2 3; 4 5 6; 7 8 9];

> variableName(row, column);

> matrixA(1, 2); % Ans = 2
```

- Subset a matrix

```
> variableName(row1:row2, column1:column2);

> matrixA(1:2, 2:3); % Ans = [2 3; 5 6]
```

GRAPH PLOTTING

GRAPH PLOTTING

- Using the PLOT function

```
> plot(x, y, 'lineStyle lineColor markerStyle');
> plot(x, y, '--ks');
```

- Example

```
> x = 0:0.5:10;
> y = x .^ 2;
> z = x .^ 3;
> plot(x, y, ':ks');
> hold on
> plot(x, z, '-.r^');
> grid on
```

LINE STYLE

Line Style	Description
-	Solid line
--	Dashed line
:	Dotted line
-.	Dash-dot line

Color	Description
y	yellow
m	magenta
c	cyan
r	red
g	green
b	blue
w	white
k	black

Marker	Description
'o'	Circle
'+'	Plus sign
'*'	Asterisk
'.'	Point
'x'	Cross
'_'	Horizontal line
'|'	Vertical line
's'	Square
'd'	Diamond
'^'	Upward-pointing triangle
'v'	Downward-pointing triangle
'>'	Right-pointing triangle
'<'	Left-pointing triangle
'p'	Pentagram
'h'	Hexagram

GRAPH PLOTTING

- 3D Plot

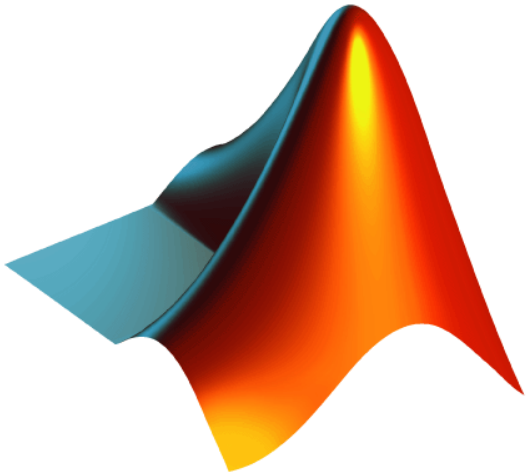
```
> z = peaks(25);

> mesh(z)



> surf(z)

> surfl(z)

> colormap(jet) % change color map
```

GRAPH PLOTTING

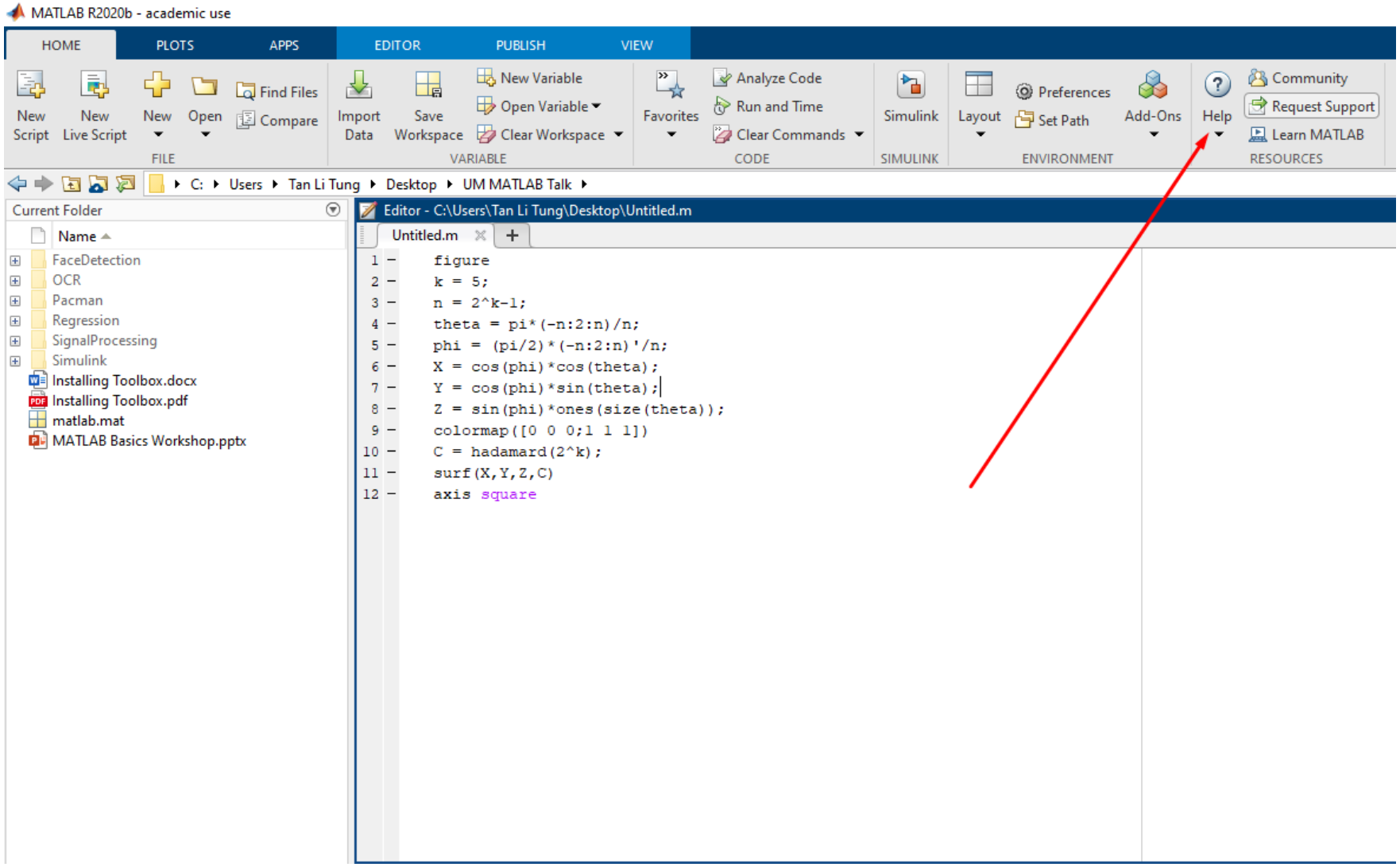
- Another Example

```
figure
k = 5;
n = 2^k-1;
theta = pi*(-n:2:n)/n;
phi = (pi/2)*(-n:2:n)'/n;
X = cos(phi)*cos(theta);
Y = cos(phi)*sin(theta);
Z = sin(phi)*ones(size(theta));
colormap([0 0 0;1 1 1])
C = hadamard(2^k);
surf(X,Y,Z,C)
axis square
```

RESOURCES



MATLAB DOCUMENTATION



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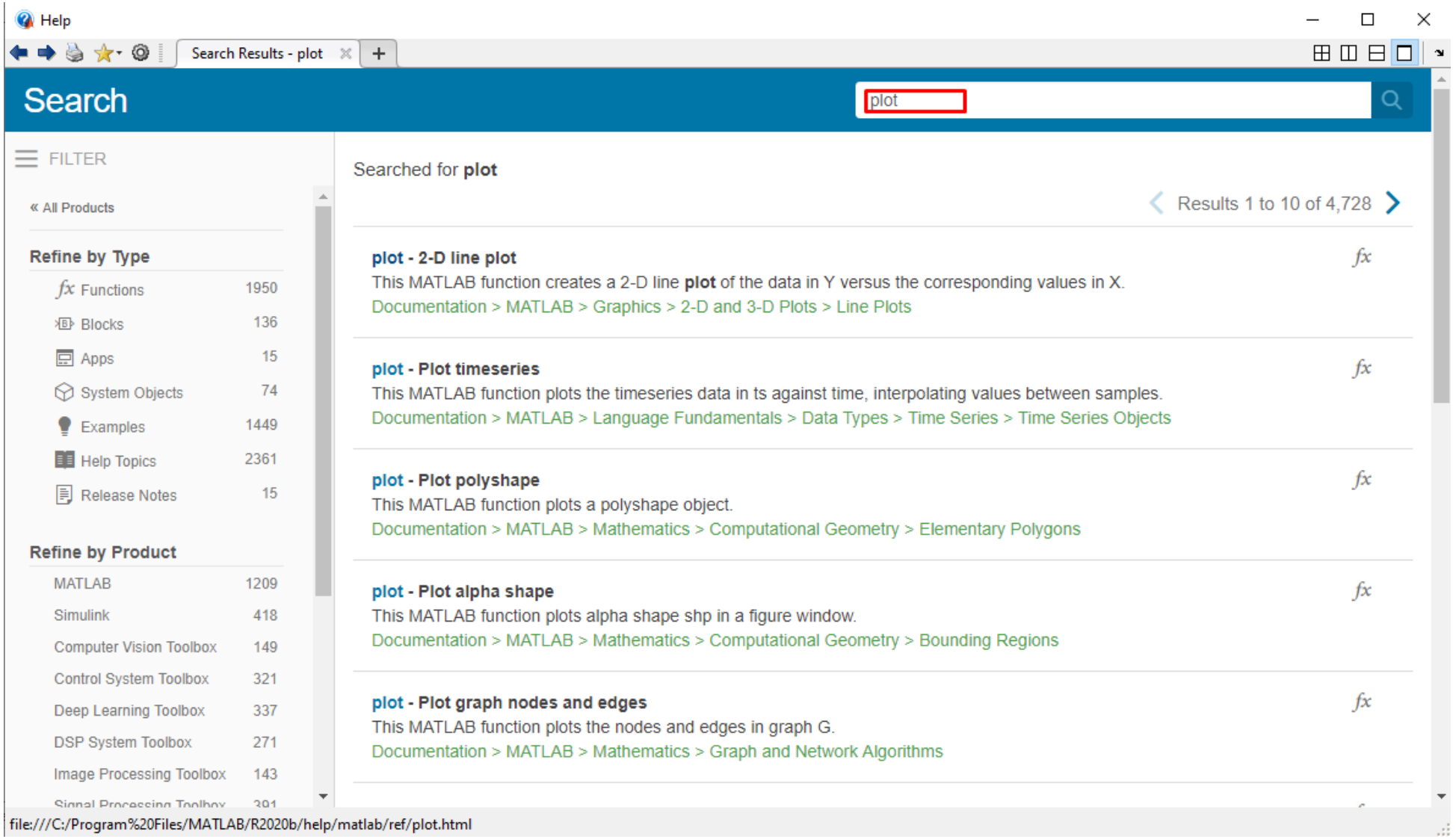
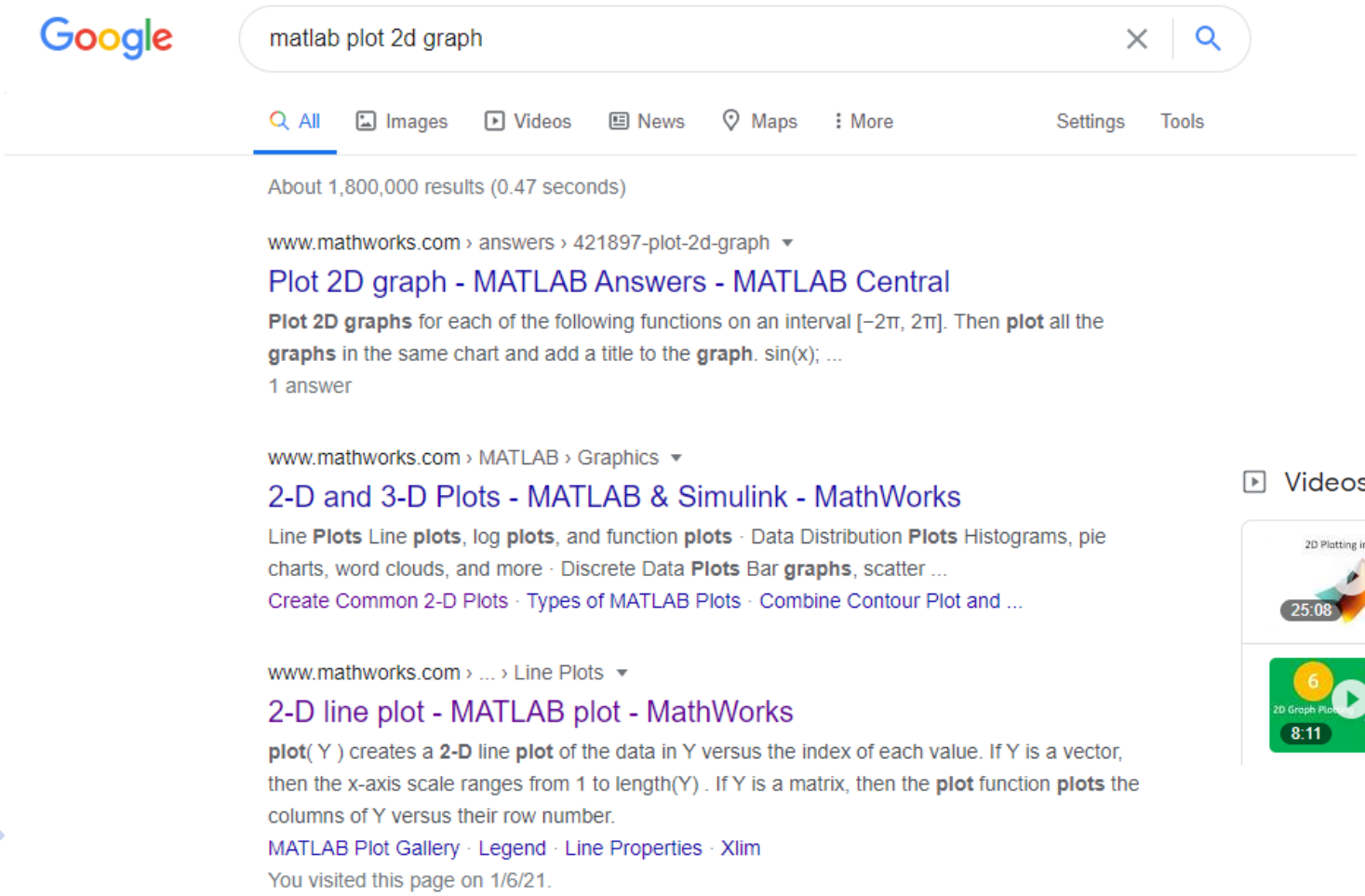
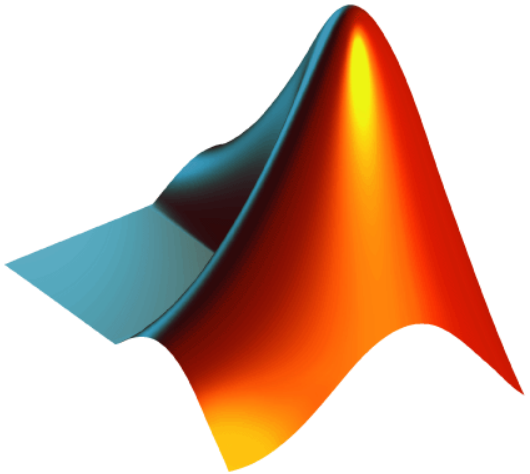


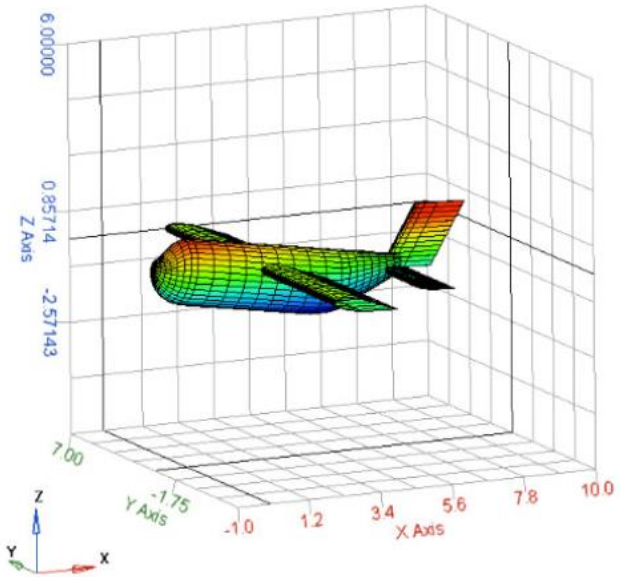
MATLAB DOCUMENTATION



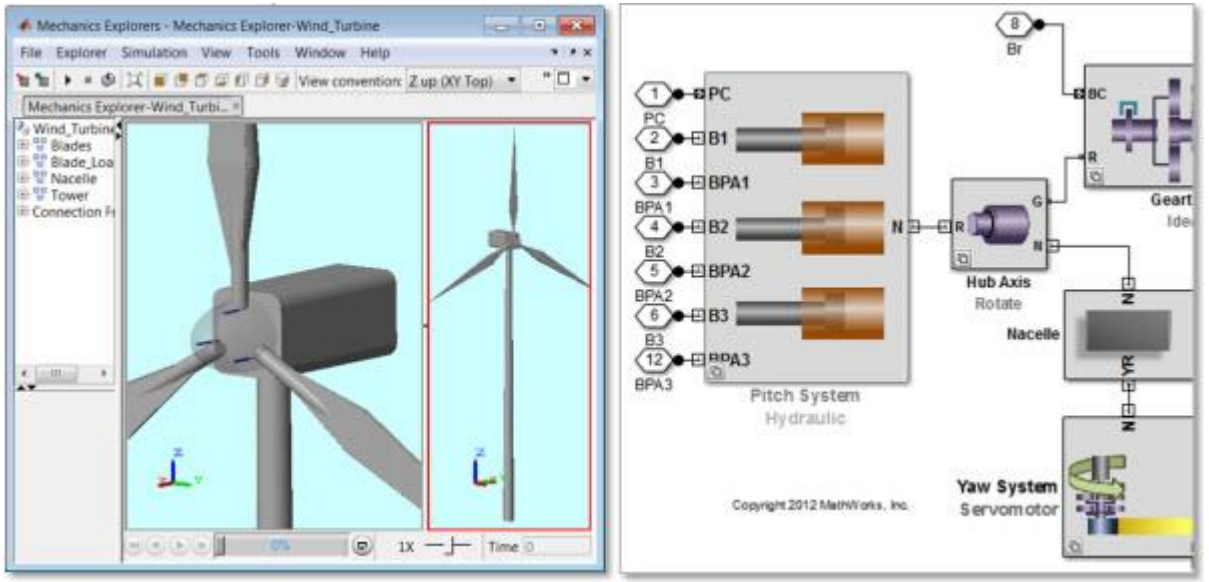
INDUSTRY USE



MATLAB USAGE IN THE INDUSTRIES

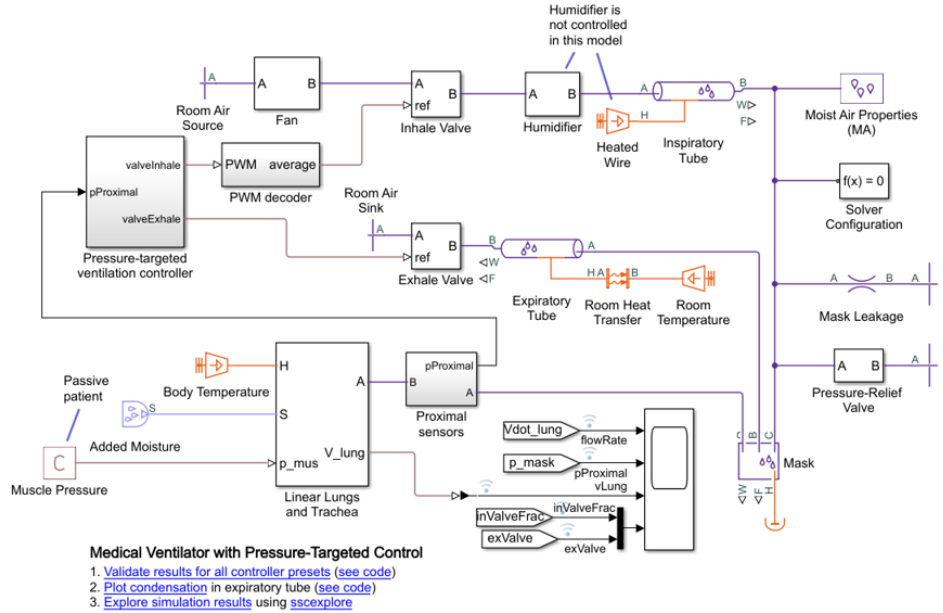


Aircraft System Modelling

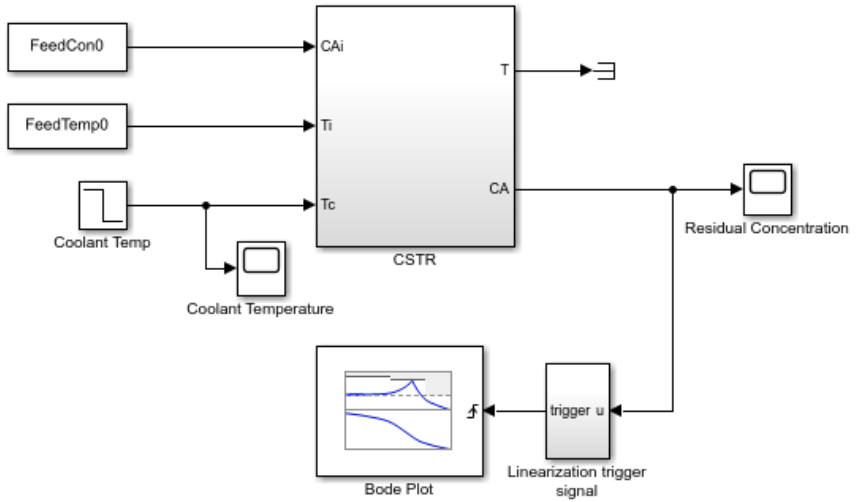


Wind Turbine Modelling

MATLAB USAGE IN THE INDUSTRIES



Medical Ventilation Modelling



Chemical Reactor Modelling

USEFUL LINKS

MATLAB Academy (Certification)

https://matlabacademy.mathworks.com

MATLAB for Beginners

https://www.youtube.com/watch?v=T_ekAD7U-wU

Solving ODEs in MATLAB

https://www.mathworks.com/help/symbolic/solve-a-single-differential-equation.html

THANK YOU