Wireless Communications

Introduction to MATLAB & Simulink

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MATLAB Introduction

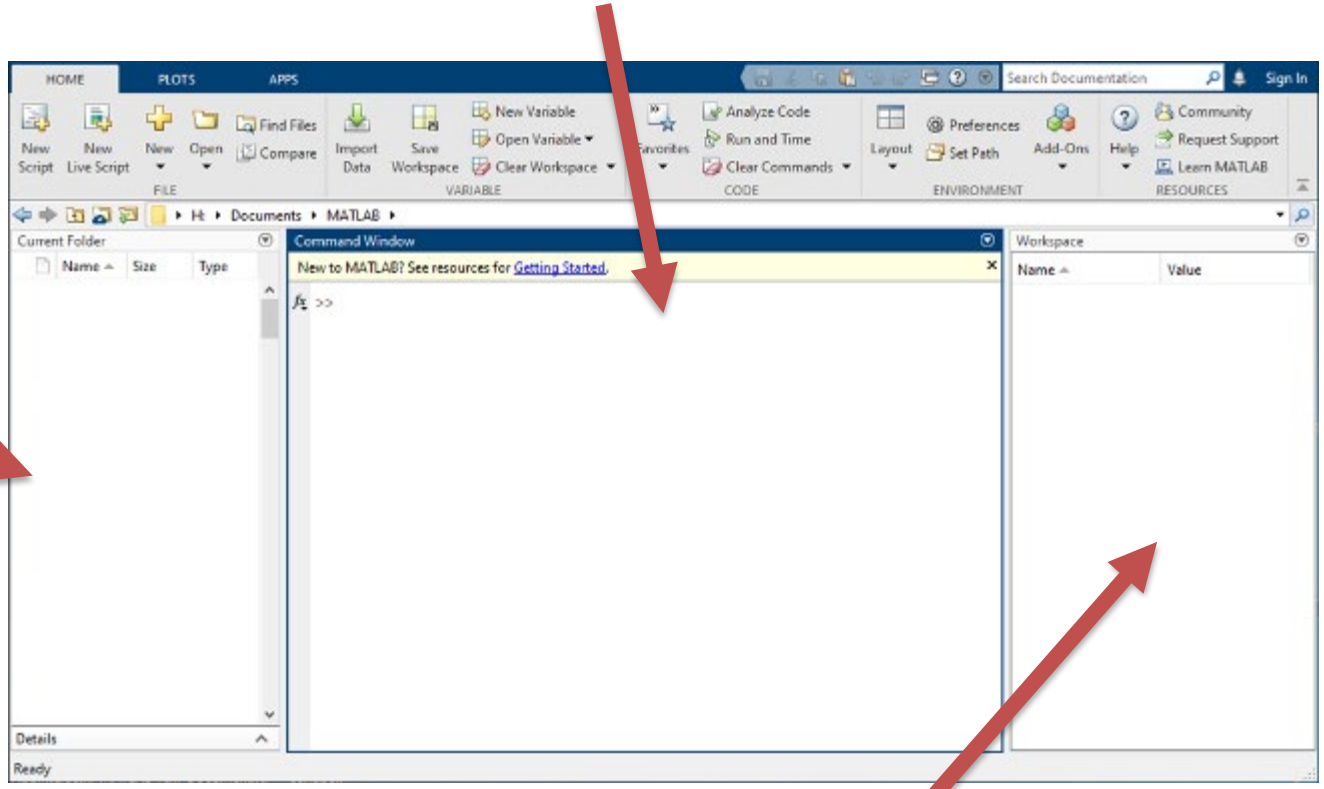
Console: executes code line by line

File browser:

browse files

such as scripts

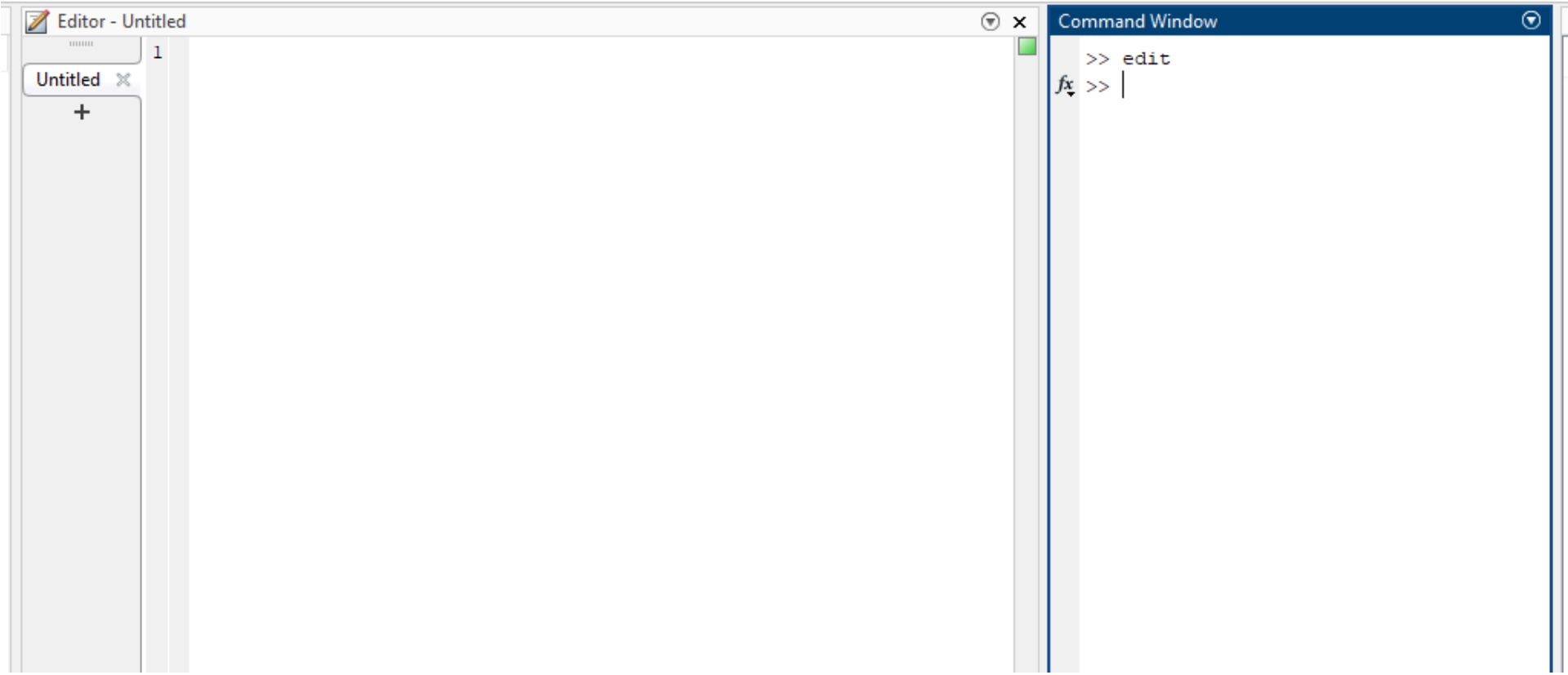
and functions



Workspace: browse variables and their value

MATLAB Introduction

Editor: for creating scripts and functions, opens when you open a file or by typing **`edit`** in the console



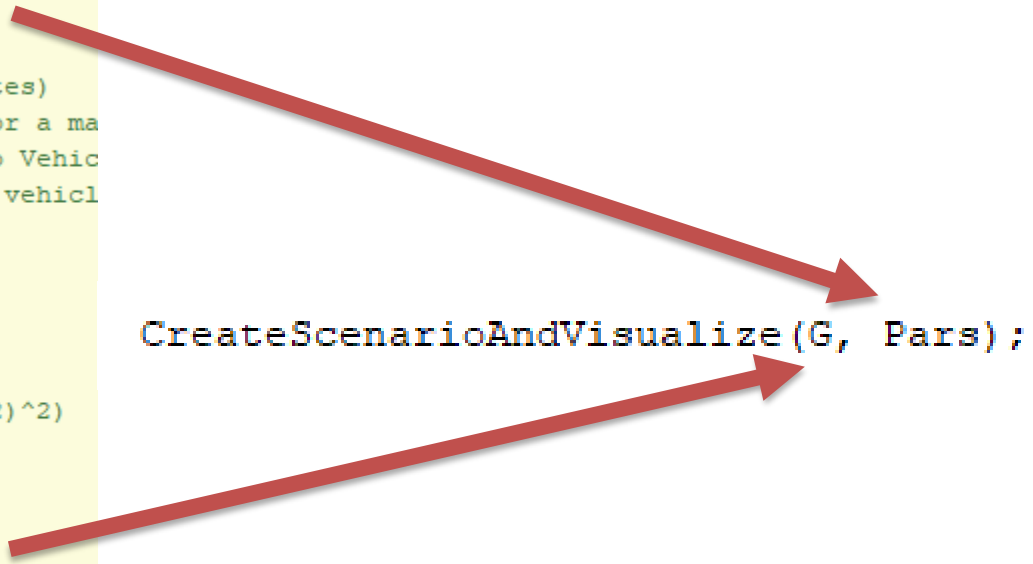
MATLAB Introduction

1. After running a script or command all the variables are left in the workspace. These leftover variables may interfere with your next simulations. If you want to clear them type clear all.
2. If your console is full of messages and you want to clear it you can type clc.
3. If there are many windows open you can close them all by typing close all.

MATLAB Introduction

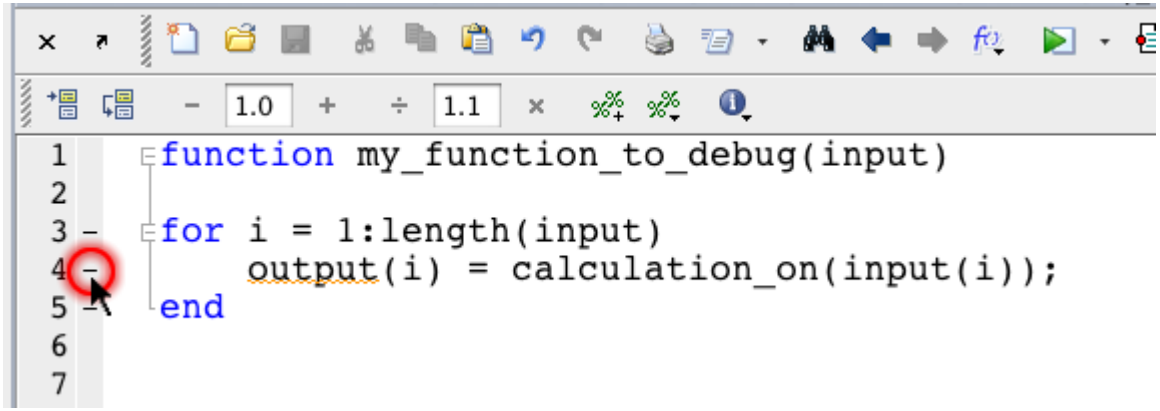
You can declare structures of variables to very quickly pass data to a function

```
%% Define constants and geometry
Pars.fc=1e9; %Carrier frequency
Pars.c = physconst('LightSpeed');
Pars.lambda = Pars.c/Pars.fc;

%Define geometry of the problem (xyz coordinates)
G.BSPos=[0,0,25]; % 25m is a typical height for a ma
G.V1PosStart=[70,-100,1.5]; %Start position fo Vehic
G.V1PosEnd=[70,100,1.5];    %End position for vehicl
G.V2PosStart=[200,-50,1.5];
G.V2PosEnd=[10,-50,1.5];
G.I1Pos=[10,-210,1.5];
G.I2Pos=[-150,100,1.5];

% Calculate distances as sqrt((x1-x2)^2+(y1-y2)^2)
G.T1=sqrt(sum((G.V1PosEnd(1,1:2) -...
    G.V1PosStart(1,1:2)).^2));
G.T2=sqrt(sum((G.V2PosEnd(1,1:2) -...
    G.V2PosStart(1,1:2)).^2));
G.DistV1Start=sqrt(sum((G.V1PosStart(1,1:2) - ...
    G.BSPos(1,1:2)).^2));
G.DistV2Start=sqrt(sum((G.V2PosStart(1,1:2) - ...
    G.BSPos(1,1:2)).^2));
```



MATLAB Introduction

You can set up breakpoints in the editor to examine the state of the variables at any point in your code



MATLAB Introduction

The help function returns a short description for a function. If nothing is returned then the function is part of a package that is not installed!

```
>> help atan2
 atan2  Four quadrant inverse tangent.
    atan2(Y,X) is the four quadrant arctangent of the elements of X and Y
    such that -pi <= atan2(Y,X) <= pi. X and Y must have compatible sizes.
    In the simplest cases, they can be the same size or one can be a
    scalar. Two inputs have compatible sizes if, for every dimension, the
    dimension sizes of the inputs are either the same or one of them is 1.

    See also atan, atan2d.

    Documentation for atan2
    Other functions named atan2

>>
```

SIMULINK Introduction

Simulink® is a software package for modeling, simulating, and analyzing dynamic systems.

It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two.

Systems can be multirate, i.e., have different parts that are sampled or updated at different rates.

Simulink® is integrated with MATLAB®, providing immediate access to an extensive range of tools that let's you to develop algorithms, analyze and visualize simulations, create batch processing scripts, customize the modeling environment, and define signal, parameter, and test data.

SIMULINK Introduction

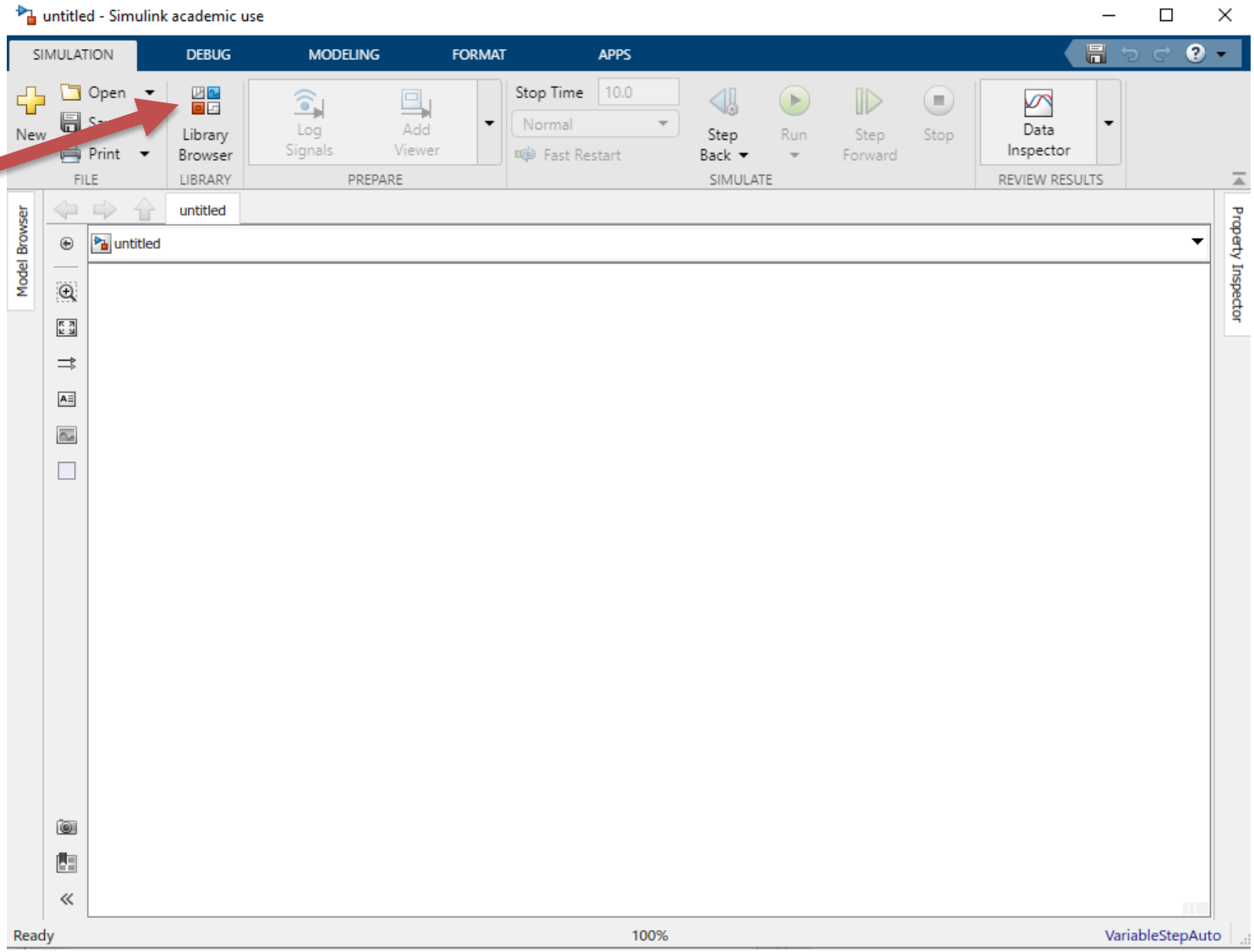
Simulink provides a Graphical User Interface for building models as block diagrams, using click-and-drag mouse operations.

Basic elements:

1. **BLOCKS:** used to generate, modify, combine, output and display signals.
2. **LINES:** used to transfer signals from one block to another.

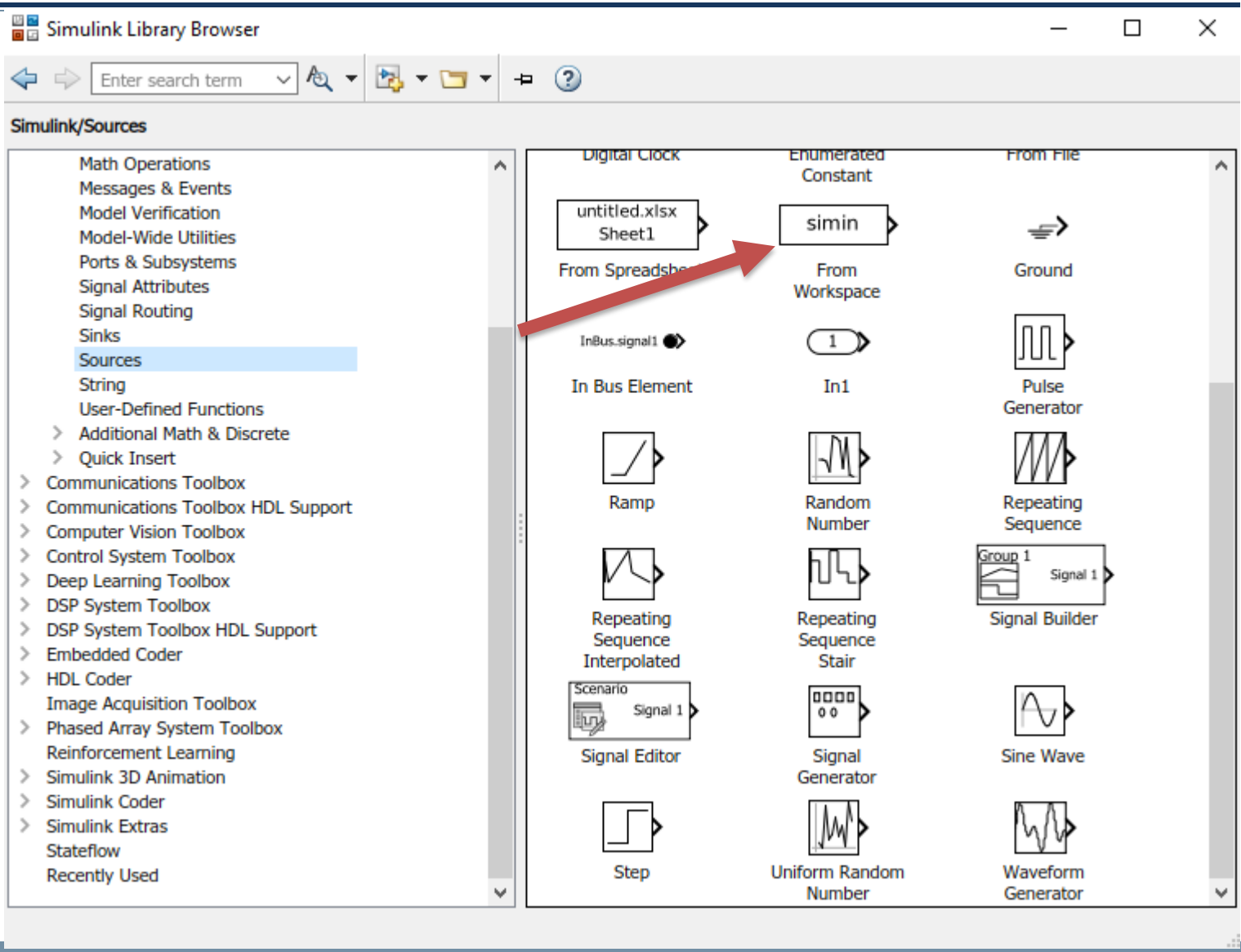
SIMULINK Introduction

Open the Library Browser to drag and drop blocks in your model window



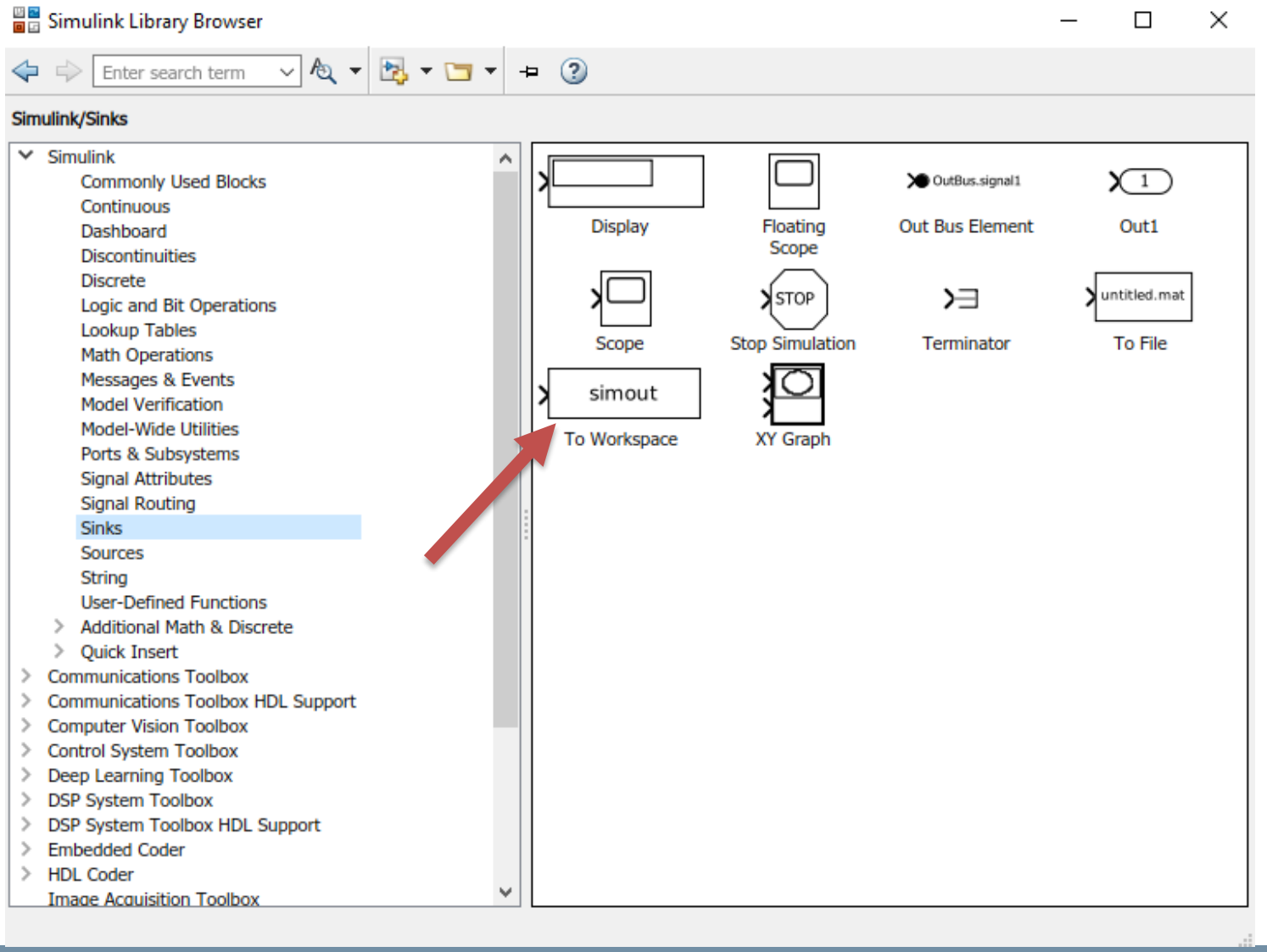
SIMULINK Introduction

Sources create signals such as sinusoids, random bits or take from matlab workspace variables



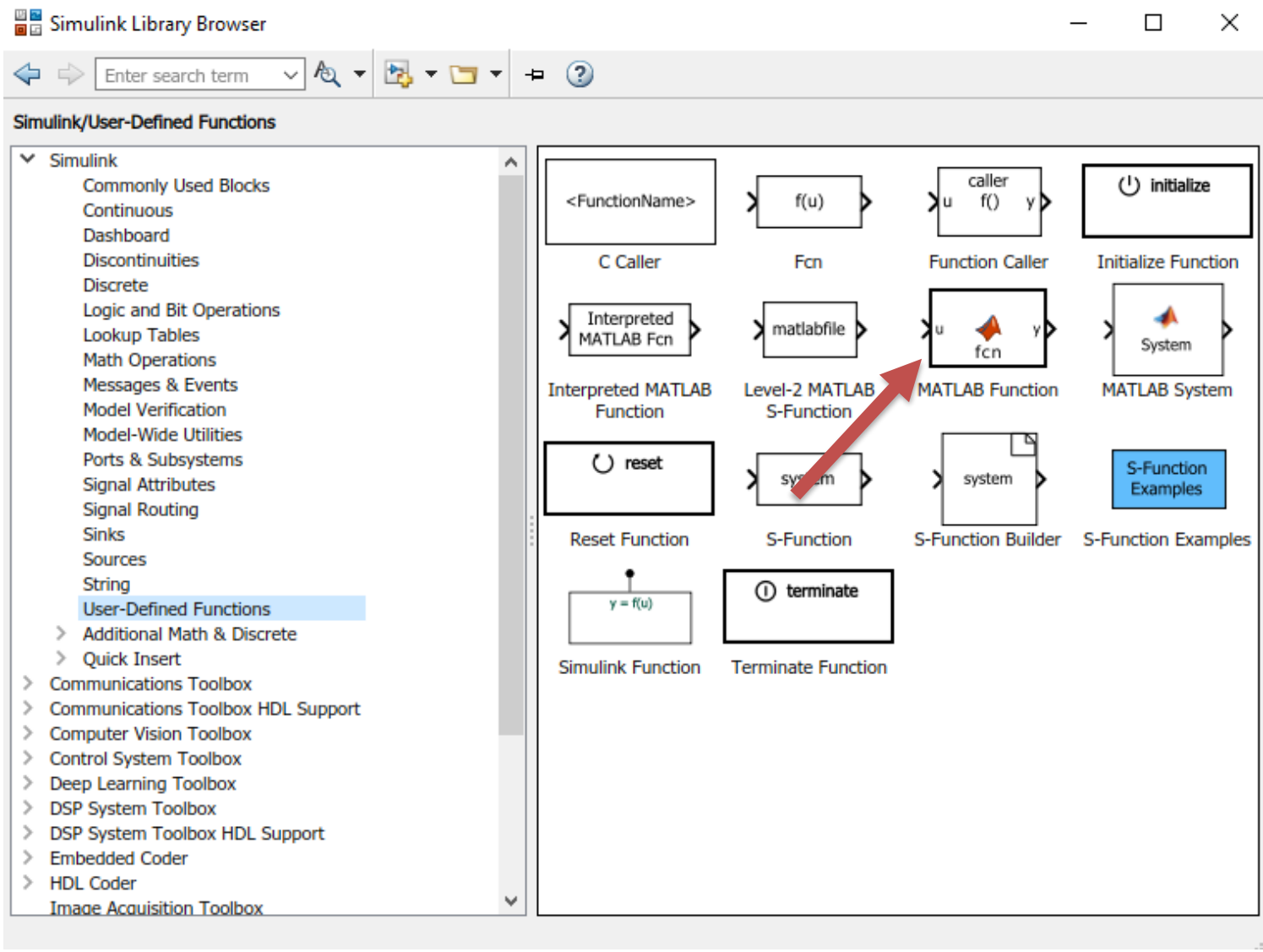
SIMULINK Introduction

Sinks do the opposite, taking signals as input for various types of visualization or return them to the matlab workspace as variables



SIMULINK Introduction

It is possible to use MATLAB defined functions in Simulink using the appropriate block



SIMULINK Introduction

- Every Simulink® block is considered to have a sample time.
- Discrete-time blocks: allows to specify their sample time via a Sample Time parameter.
- Continuous-time blocks: have an infinitesimal sample time called continuous sample time.

SIMULINK Introduction

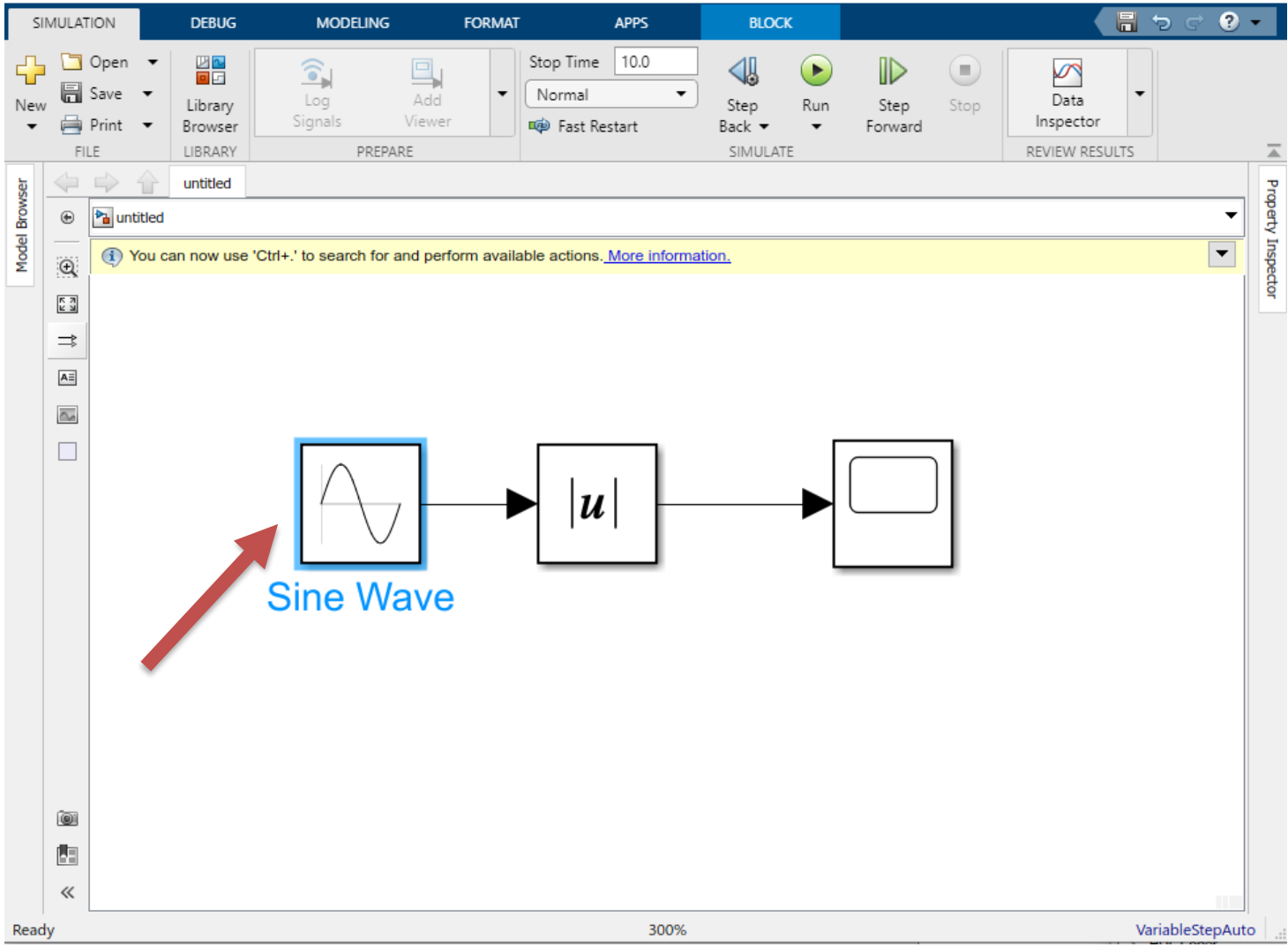
The most frequently used libraries for analyzing communication systems are

- Simulink: math operations, sinks, sources, portes & subsystems, etc.
- Communication System Toolbox: channels, modulation, error detection and correction, equalizers, interleaving, synchronization, etc.
- DSP System Toolbox: filtering, math functions, quantizers, signal management, estimation, transforms, statistics, etc.

Custom blocks can be also created graphically by drawing a block diagram representing the blocks' behavior.

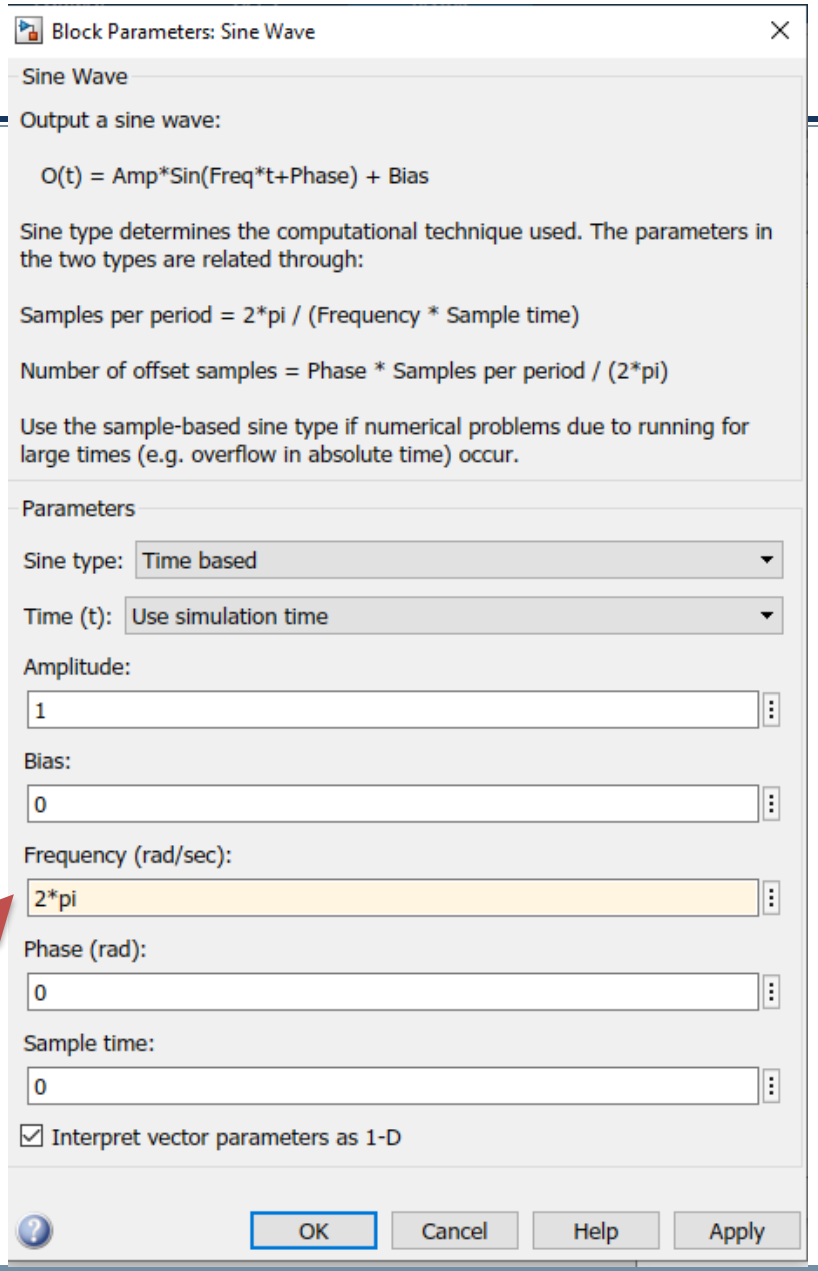
SIMULINK Introduction

Let's make a simple example: one sinusoid of 1hz frequency, calculate the abs and visualize



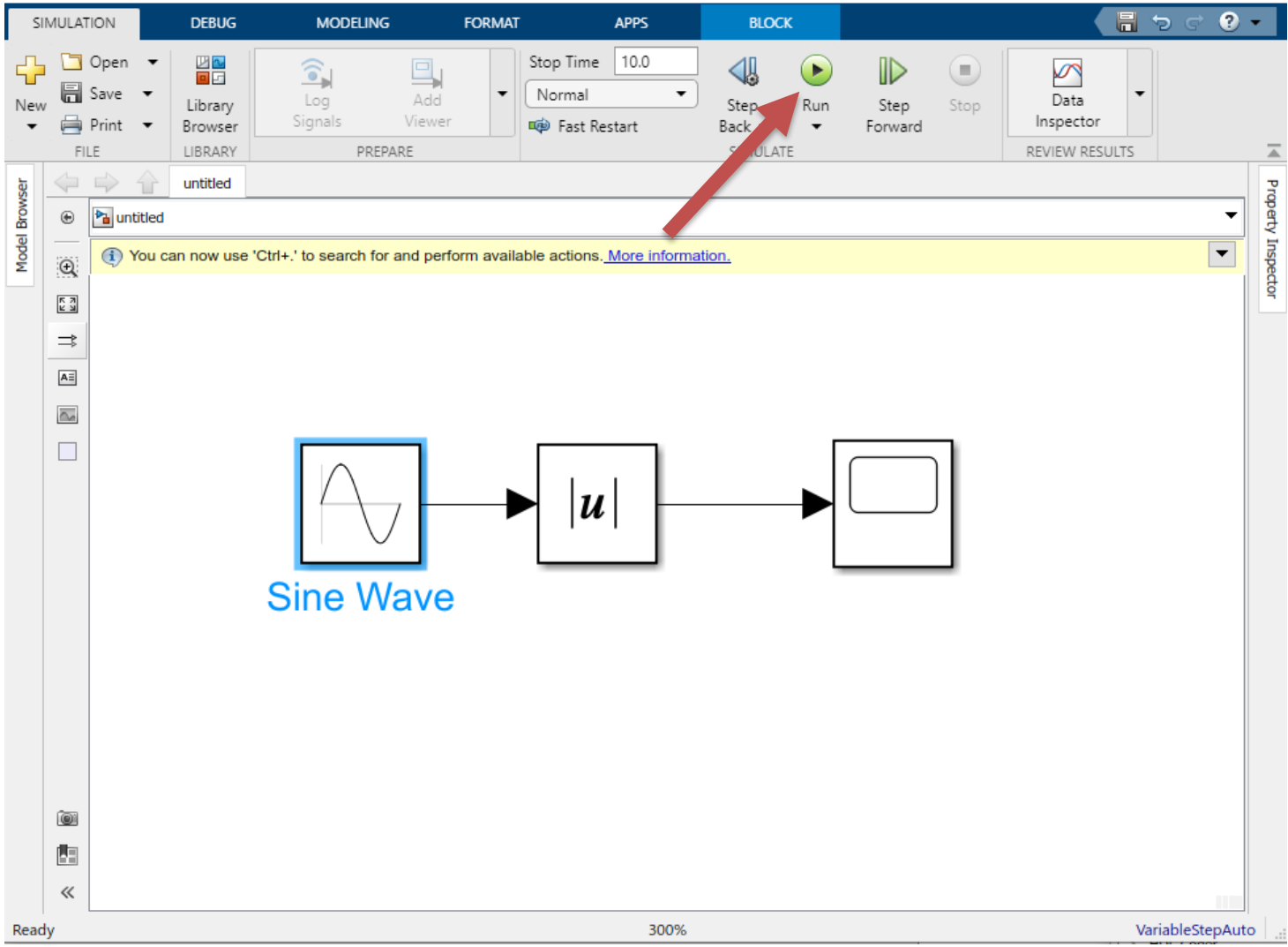
SIMULINK Introduction

To edit block parameter double click a block. For the sine wave block the following pop-up will display:



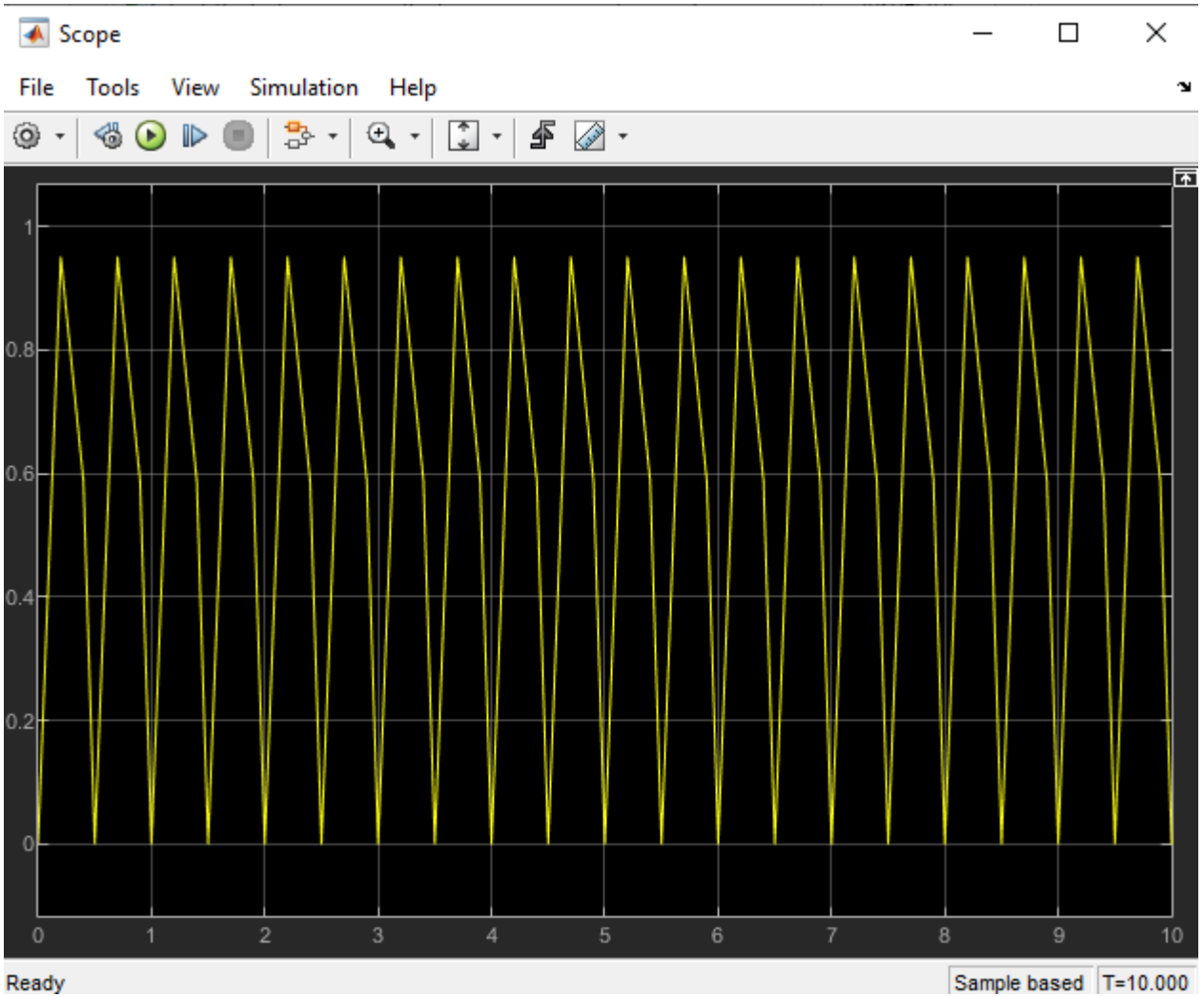
SIMULINK Introduction

Let's run it



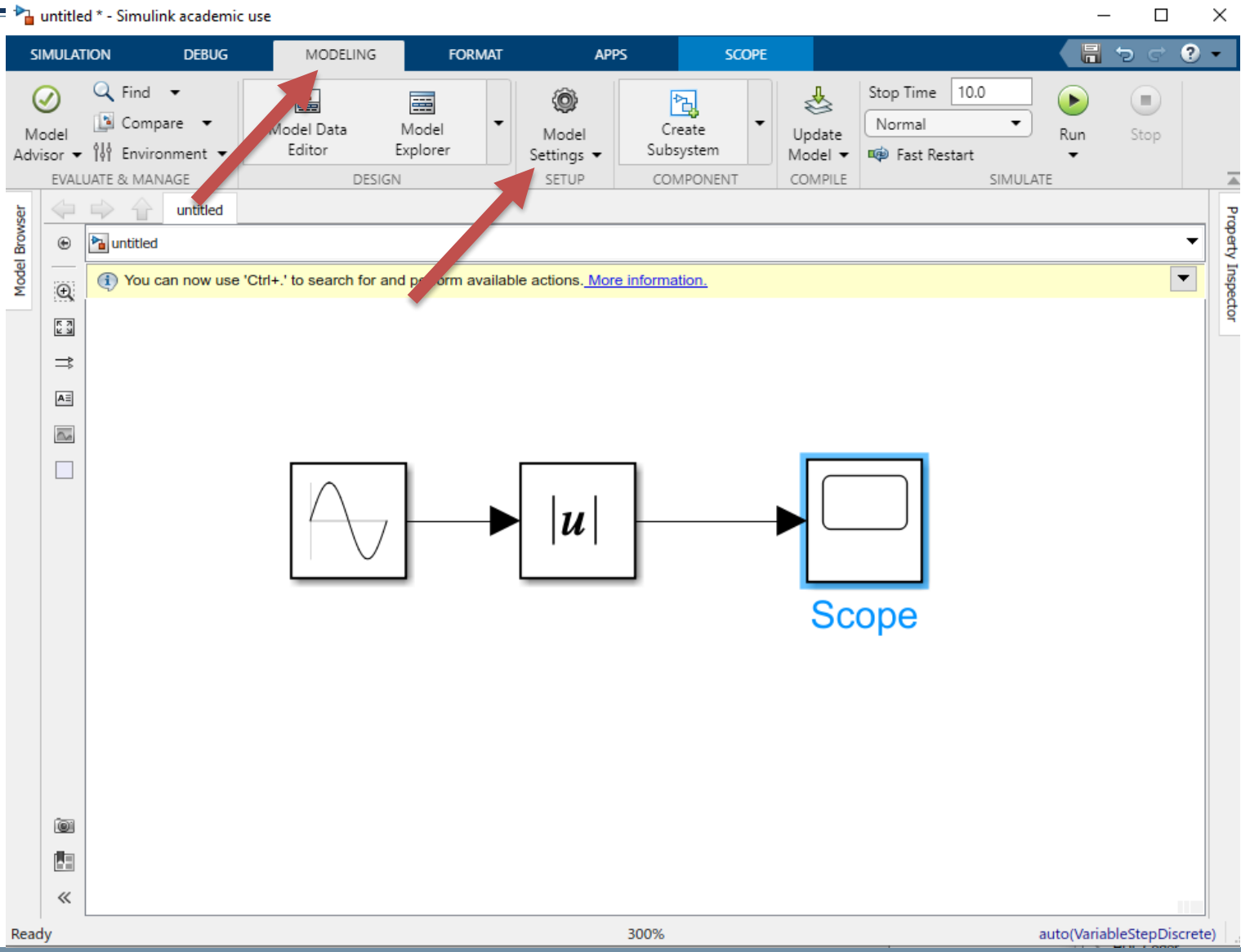
SIMULINK Introduction

Opening the scope via double click we get a very bad looking sinusoid



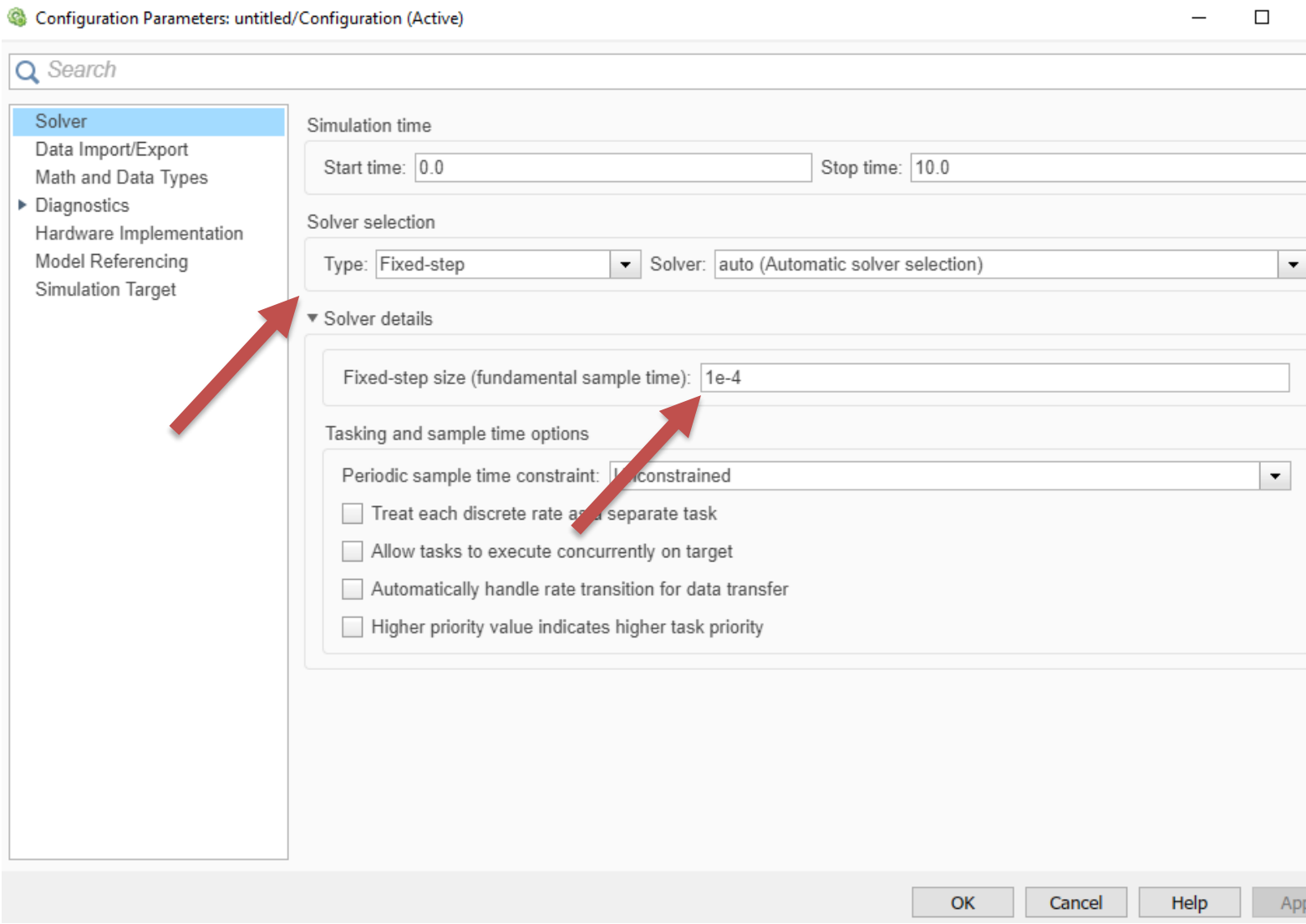
SIMULINK Introduction

We can modify simulation parameters to enhance the quality of the sinusoid

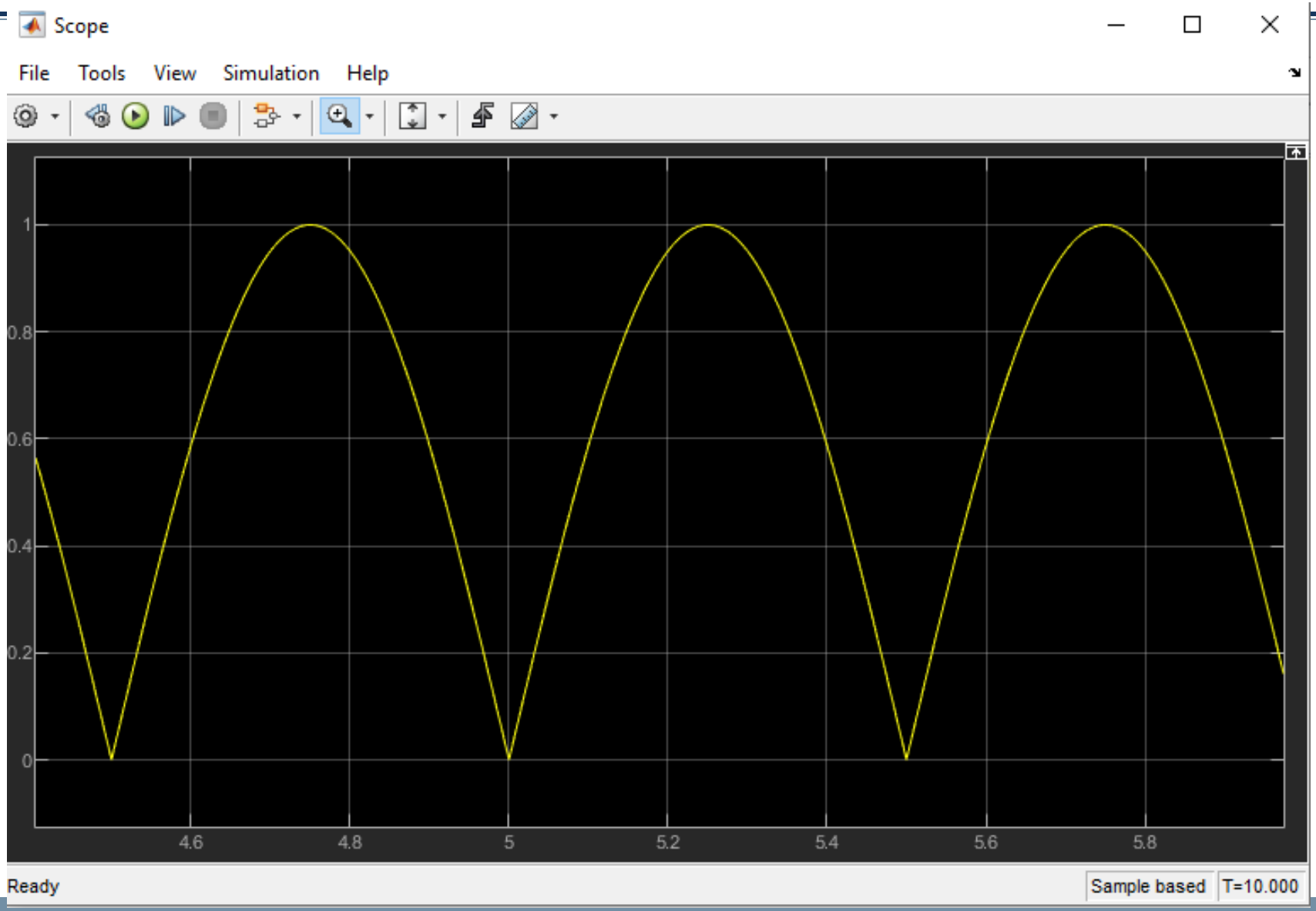


SIMULINK Introduction

Force an appropriate step size for the fixed step size solver



SIMULINK Introduction



Thank you!
Questions?