Simulink® for System and Algorithm Modeling

Modeling Algebraic Systems

The MathWorks
Training Services

Outline

- Defining the system and identifying its components
- Modeling the system with equations
- Starting Simulink
- Building a block diagram for the model
- Defining the model parameters
- Defining the model I/O
- Simulating the system
- Creating signal viewers
- Modifying solver settings
- Validating the simulation results

Defining the System and Identifying Its Components

One of the outputs of the throttle subsystem is its angle. This is computed in radians and needs to be translated to degrees for analysis, and then translated to voltage for use in the controller by a potentiometer.

Before modeling the system with equations, answer the following questions:

- How many inputs?
- How many outputs?
- How many states?
- What are the parameters?
- Are there any intermediate signals?

Modeling the System with Equations

- The following equation describes the relationship between the angle in radians, u, and the position in volts, y.

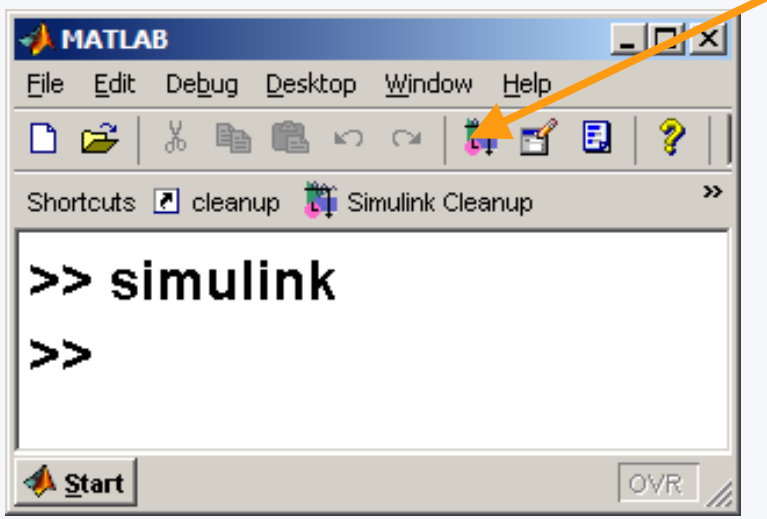
$$\angle^\circ = 180/\Pi * u$$

$$y = \begin{cases} 0.5V & if \quad \angle^\circ = 0^\circ \ (closed\ throttle) \\ 4.5V & if \ \angle^\circ = 90^\circ \ (open\ throttle) \end{cases}$$

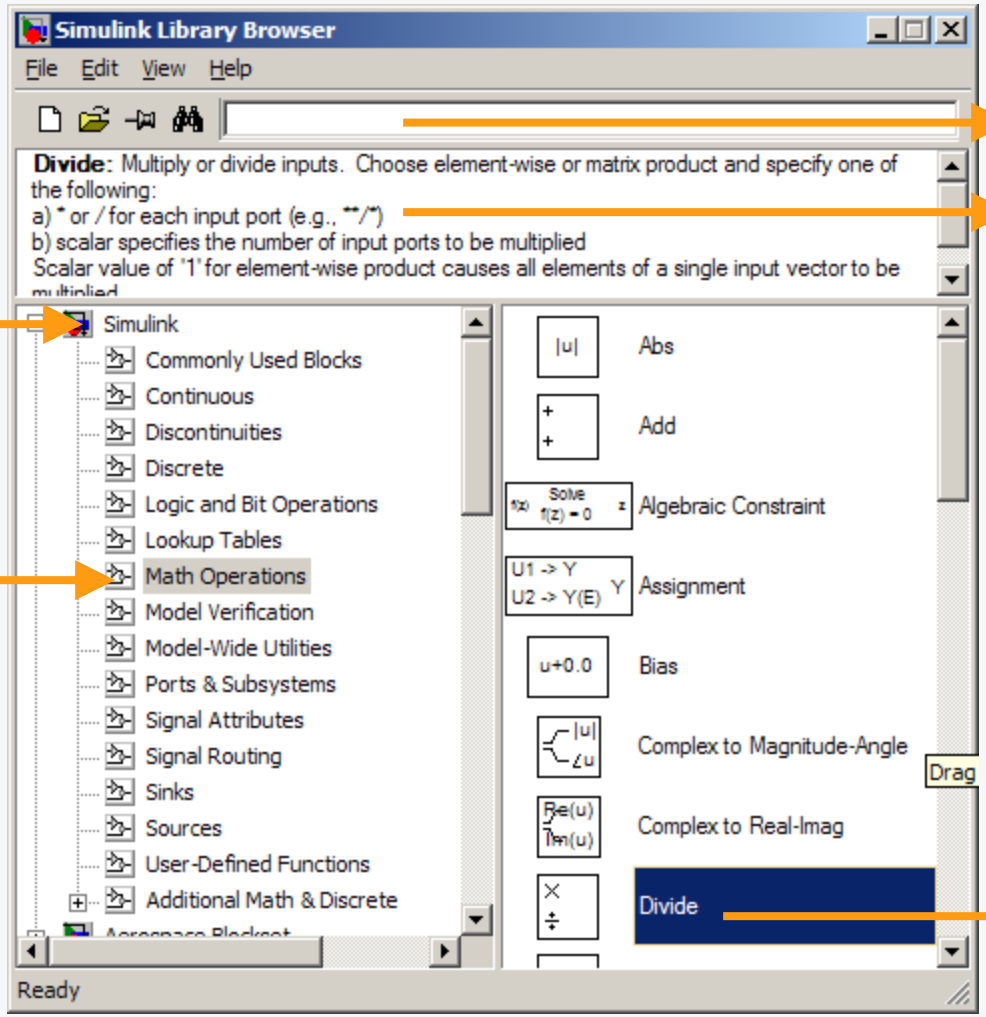
- Compute y using a lookup table that linearly interpolates between points to determine voltages for angles that fall between 0 and 90 degrees.

Starting Simulink

- Open the Simulink Library Browser by typing **`simulink`** at the MATLAB command line or by selecting the  icon.



Using the Simulink Library Browser



Block Search

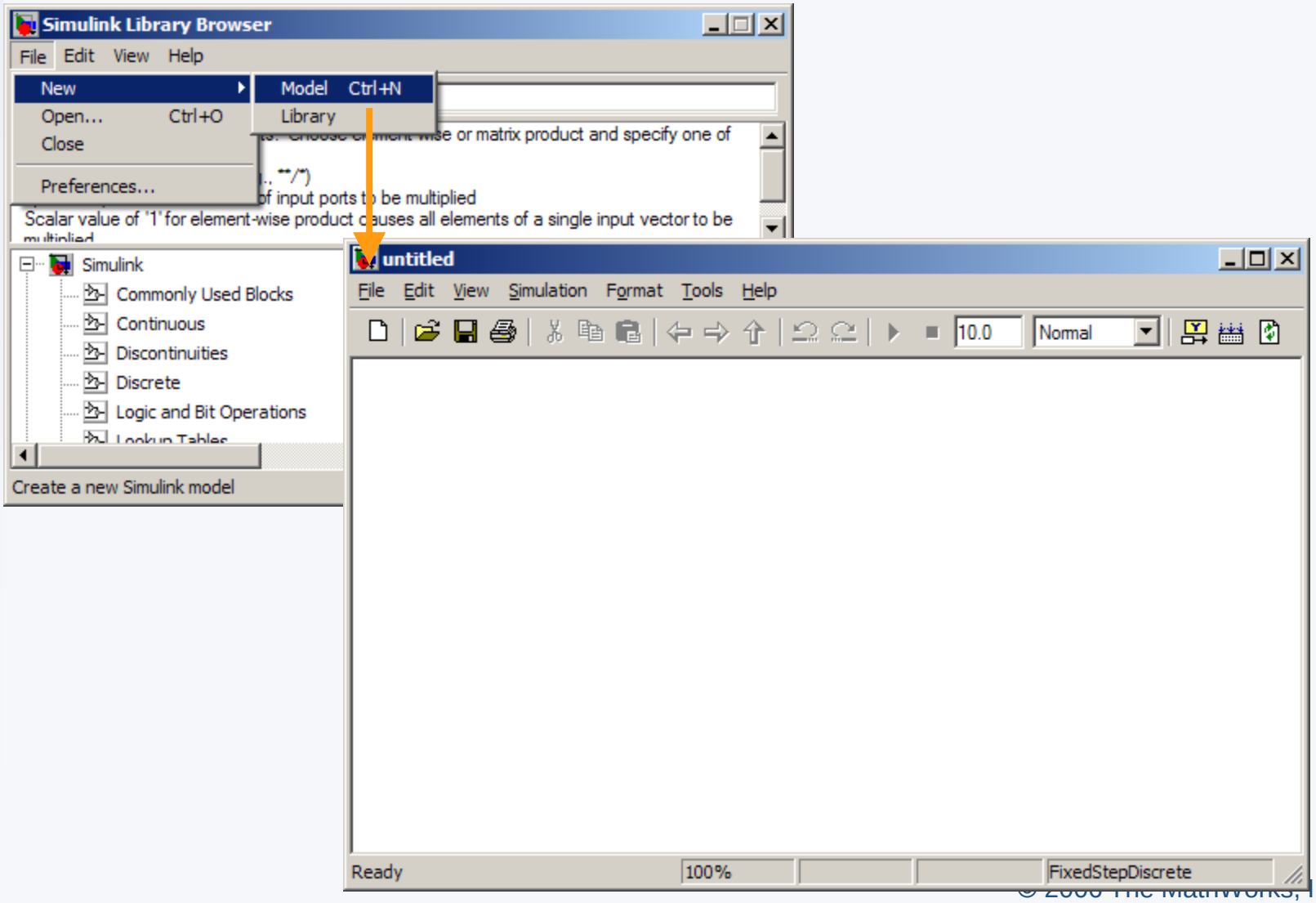
Block Description

Blockset

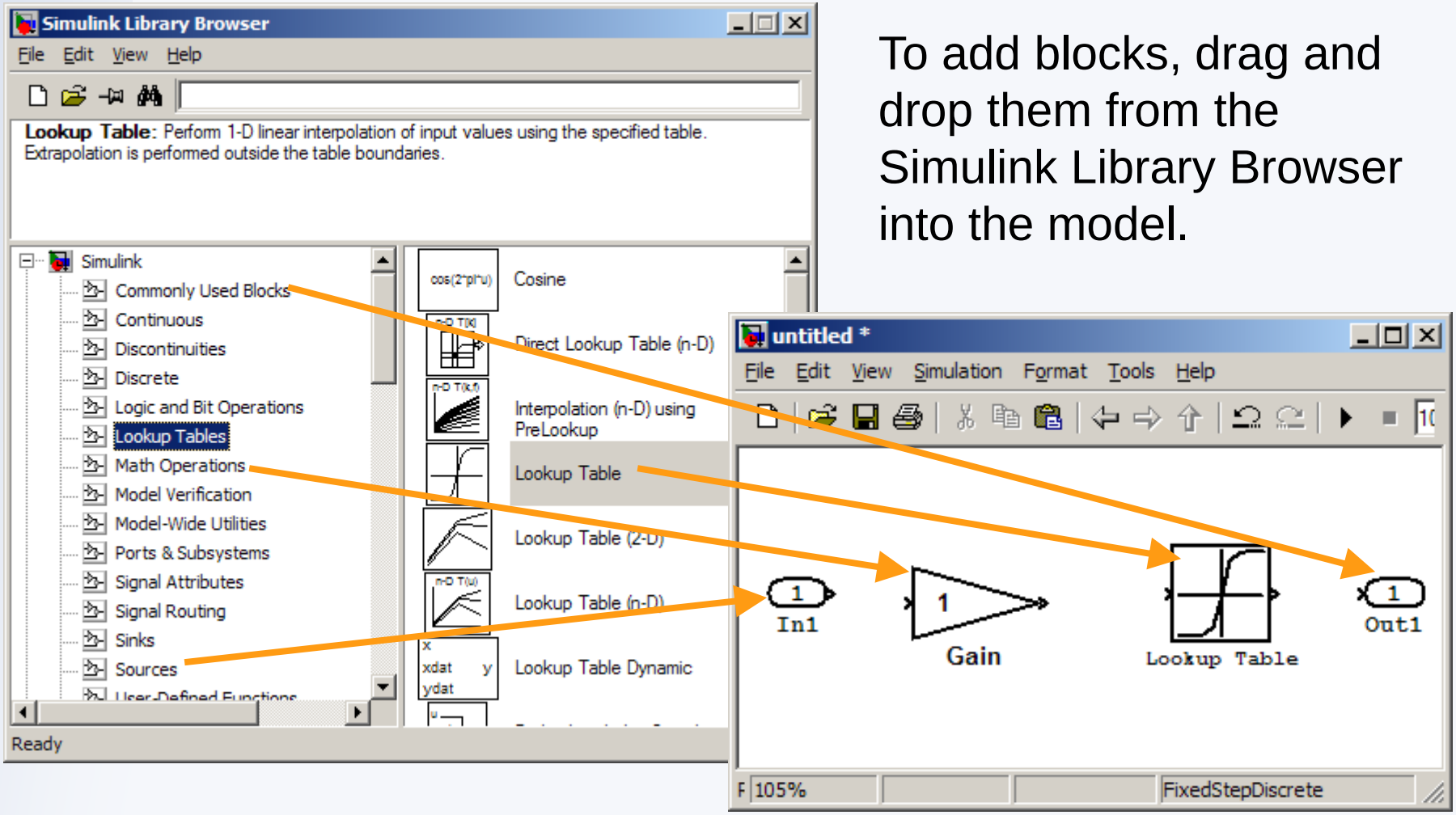
Library

Block

Building a Block Diagram for the Model



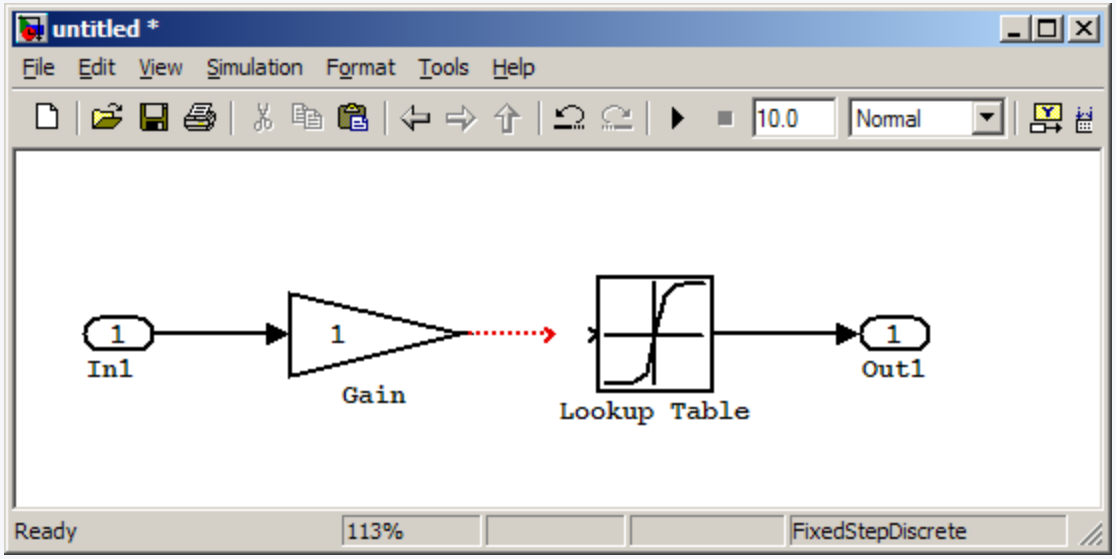
Adding Blocks



To add blocks, drag and drop them from the Simulink Library Browser into the model.

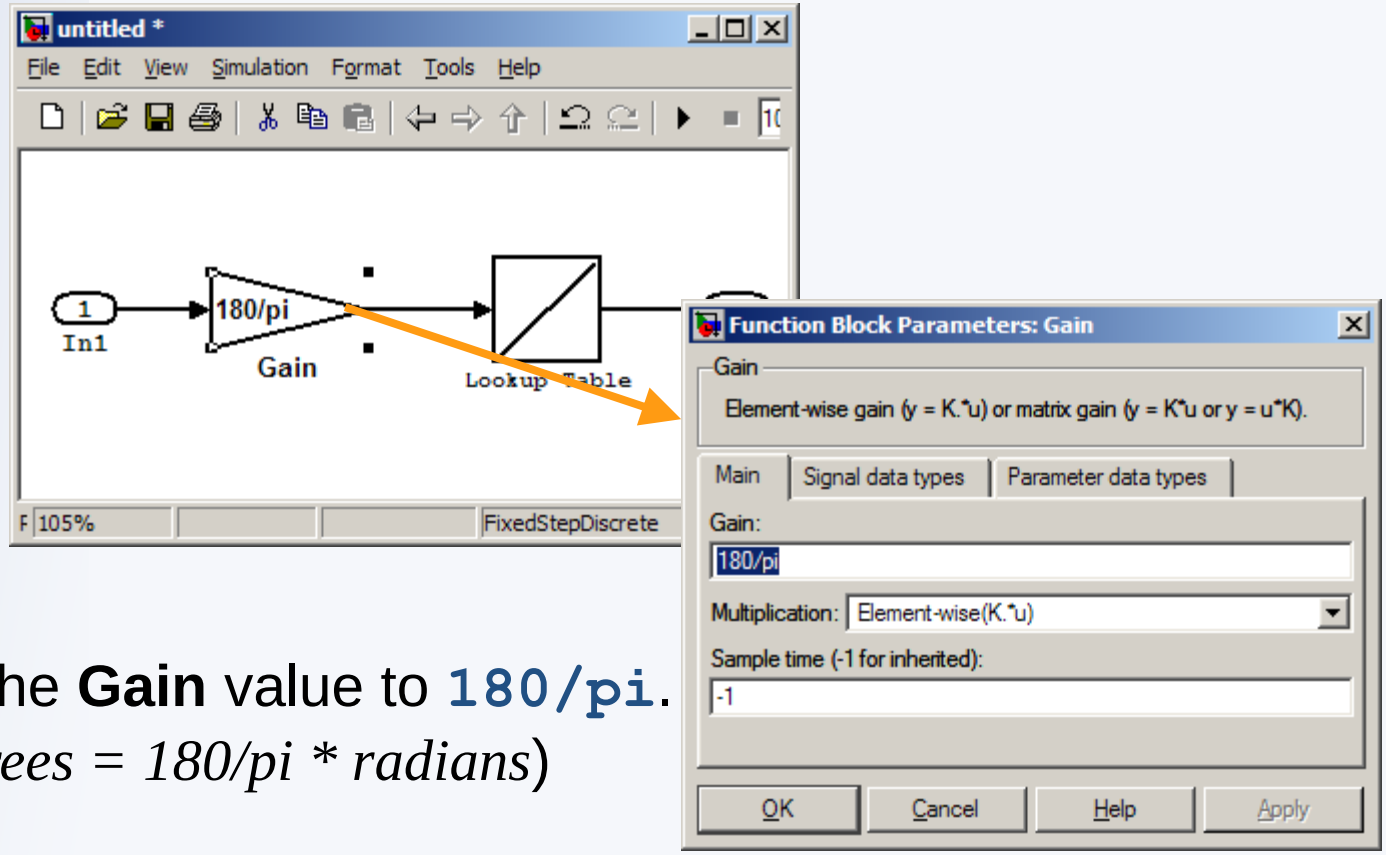
Connecting Blocks

- To connect blocks, select the output port of the source block, and then left-click and drag a line to the destination block.



Defining the Block Parameters

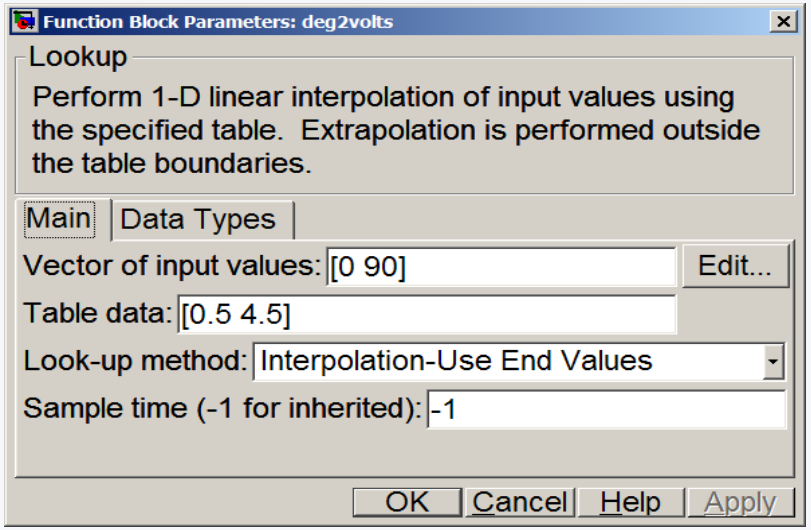
- To view and modify block parameters, double-click the block icon.



Set the **Gain** value to `180/pi`.
(*degrees = 180/pi * radians*)

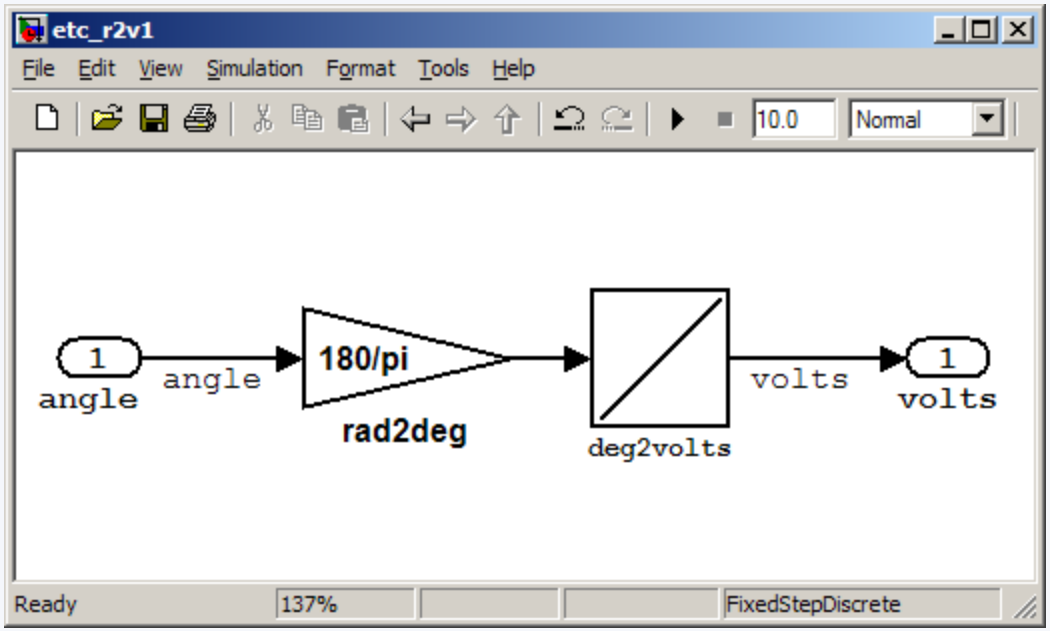
Defining the Lookup Table Parameters

- To compute y from the throttle angle in degrees using the Lookup Table block, define the following parameters:
  - The **Vector of input values** are `[0 90]`
  - The **Vector of output values** are `[.5 4.5]`
  - Select `Interpolation-Use End Values` as the **Look-up method**.



Labeling Blocks and Signals

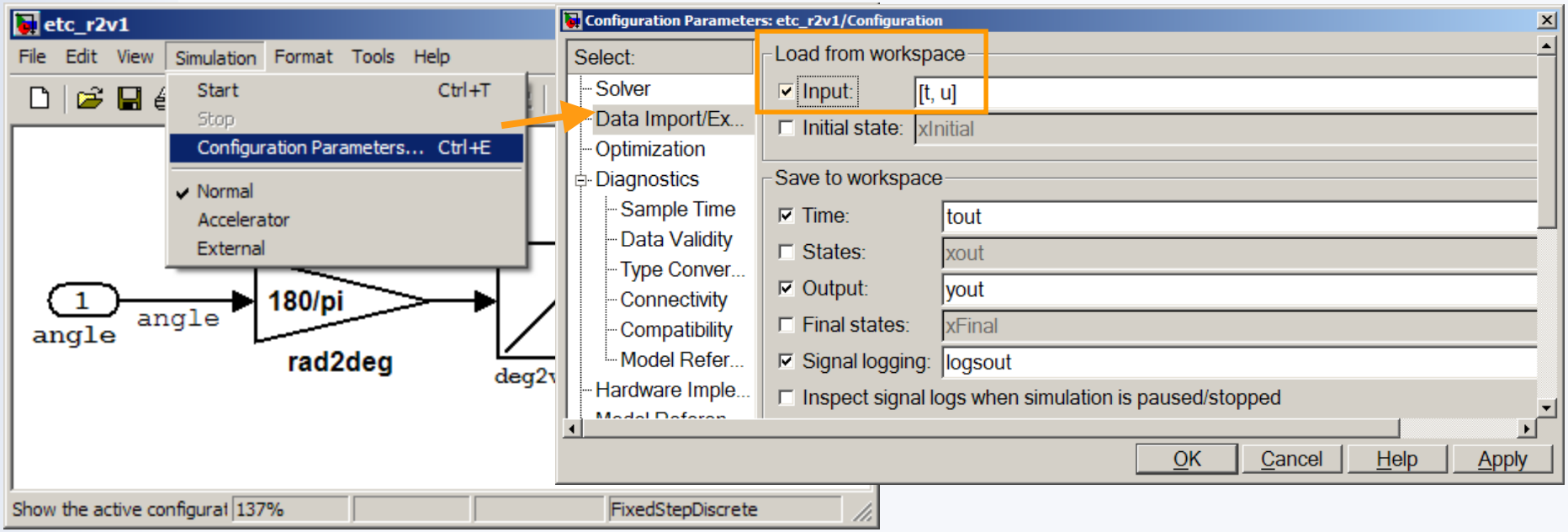
- To rename a block, click the block label and edit.
- Block labels must be unique.
- To label a signal, double-click the signal line and enter text.




```
>> etc_r2v1
```

Defining the System Input

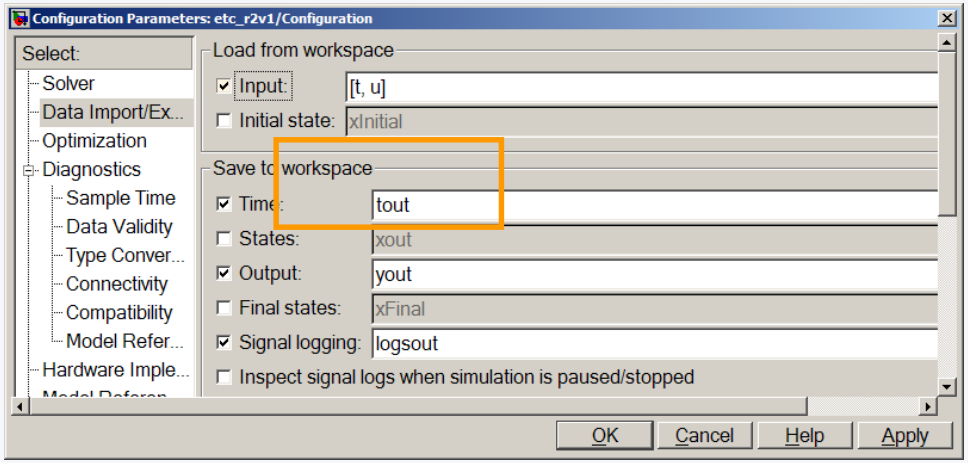
- Signals fed in from root-level Inports can be loaded from the MATLAB workspace.
- Select the Data Import/Export option from the Configuration Parameters dialog box.




```
>> t = linspace(0,10,100)';
>> u = linspace(0,pi/2,100)';
```

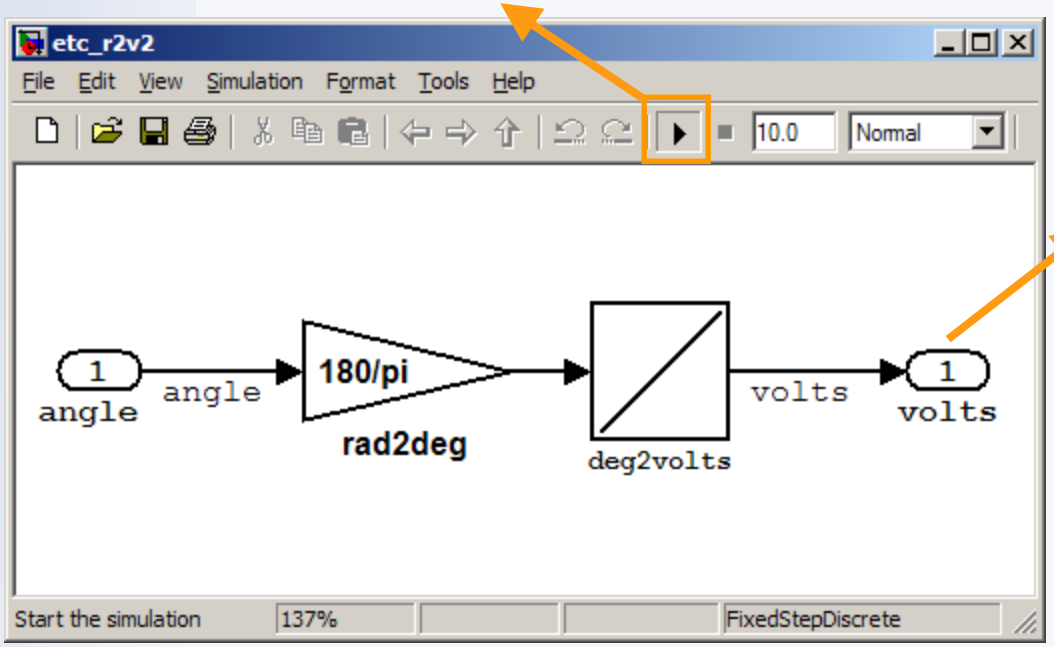
Defining the System Output

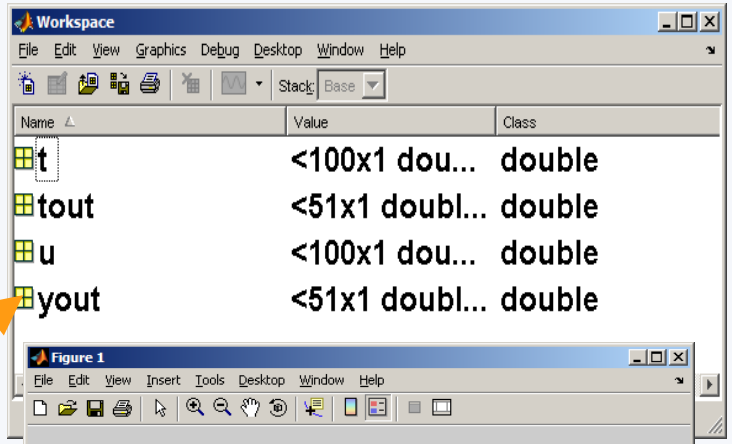
- Signals fed to root-level Outport blocks can be saved to the MATLAB workspace.
- Signals are written to the workspace when the simulation is stopped or paused.
- Select the **Data Import/Export** option from the Configuration Parameters dialog box.
- Select **Output** and **Time** from **Save to workspace**. The voltage signal is written to the variable `yout`.

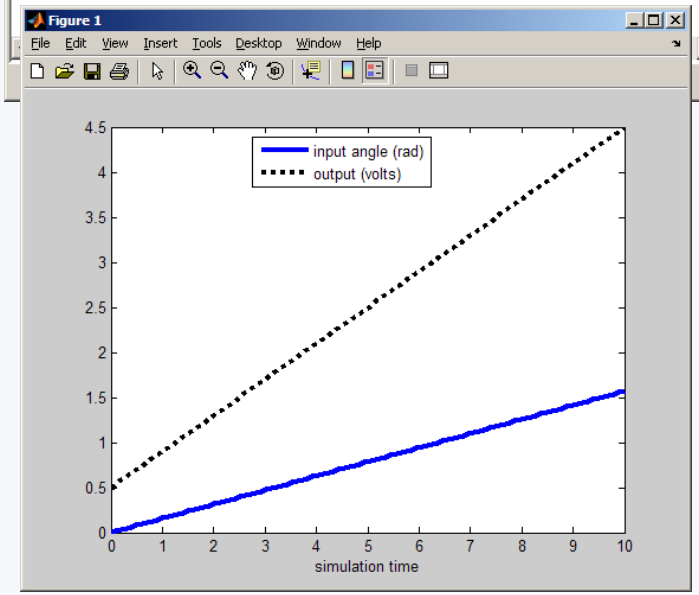


Simulating the Model and Visualizing the Response

Start Simulation

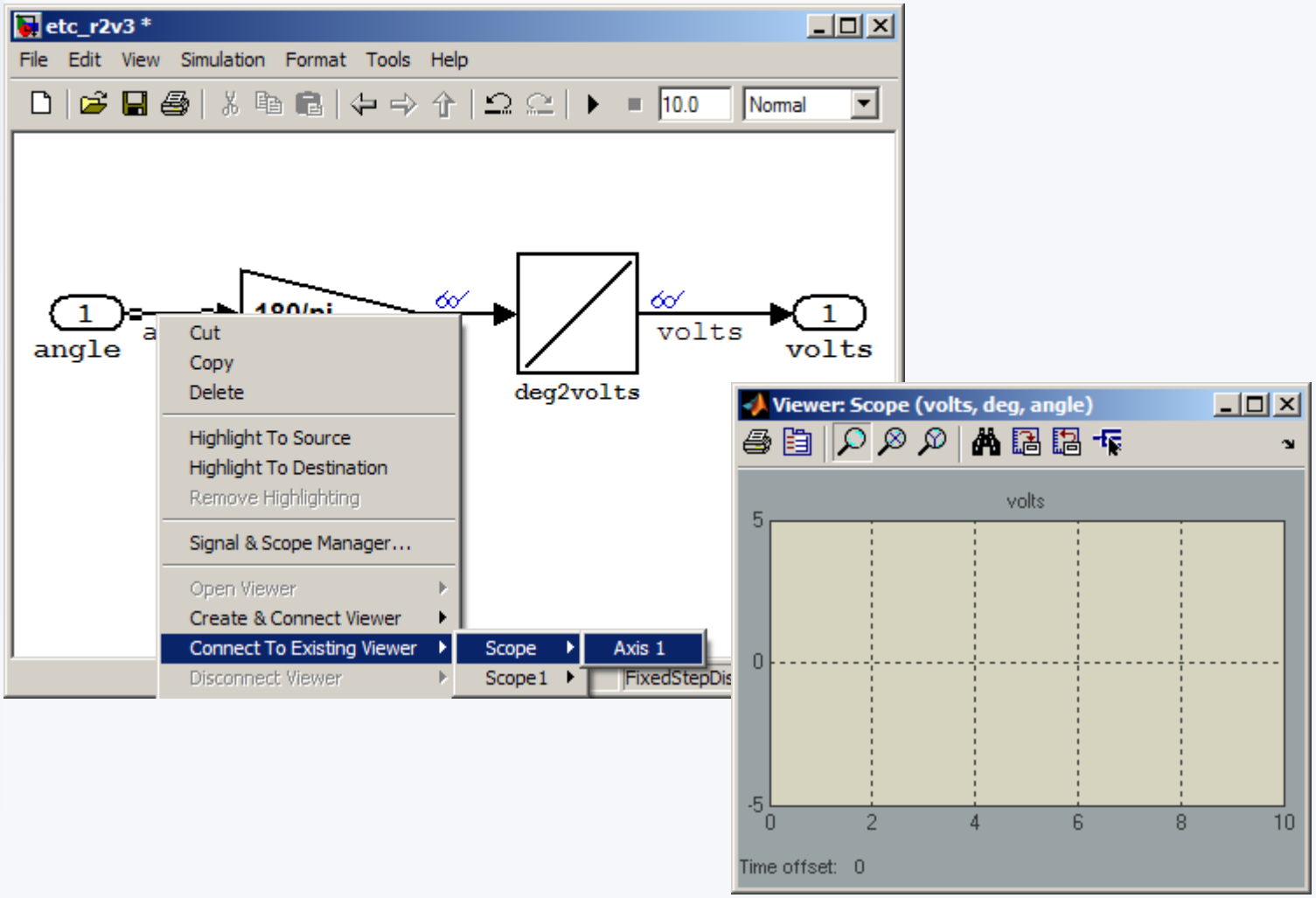







```
>> plot(t,u,tout,yout,'k:')
>> xlabel('simulation time')
>> legend('input angle (rad)','output (volts)')
```

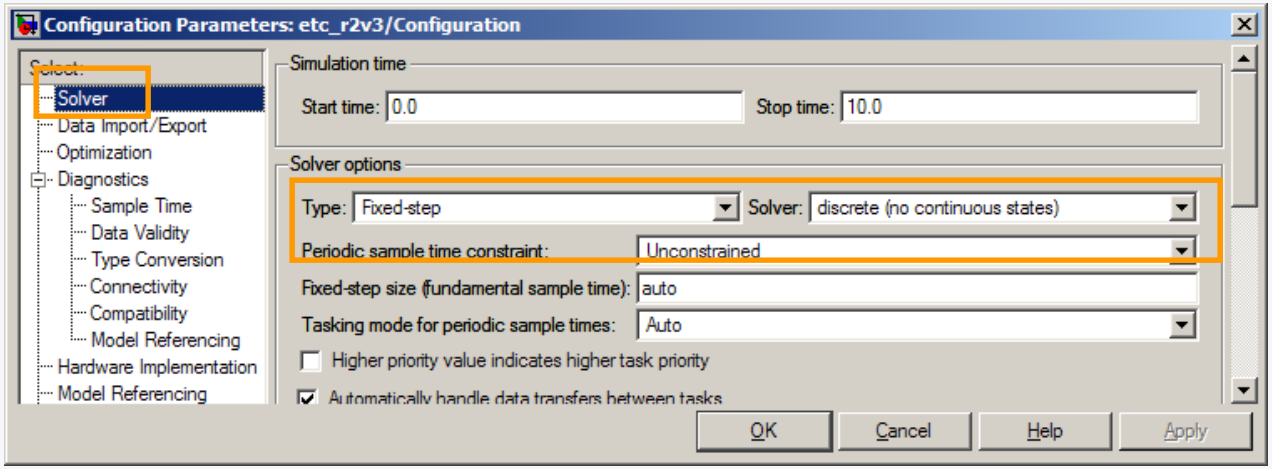
Adding Signal Viewers



Modifying Solver Settings

To select a solver,

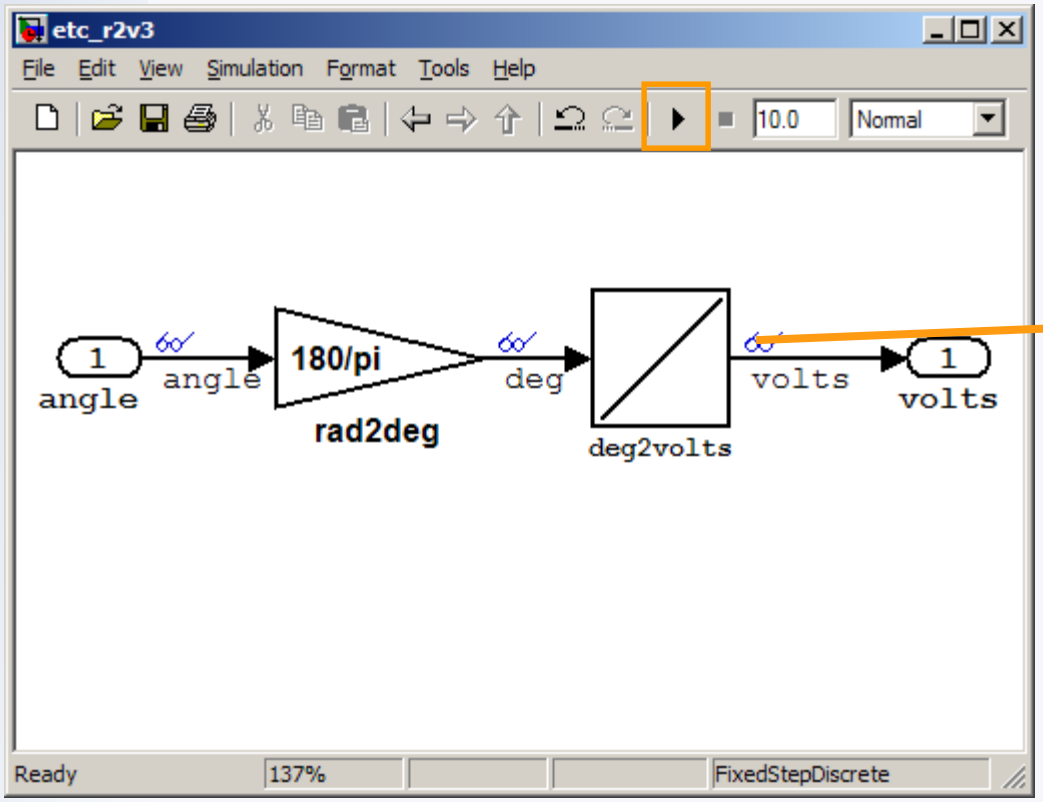
- Select **Simulation** → **Configuration Parameters**.
- Select the **Solver** option at the left of the dialog.
- Set the **Type** to `Fixed-Step` and the **Solver** to `discrete(no continuous states)`
- Select **OK** to confirm settings.

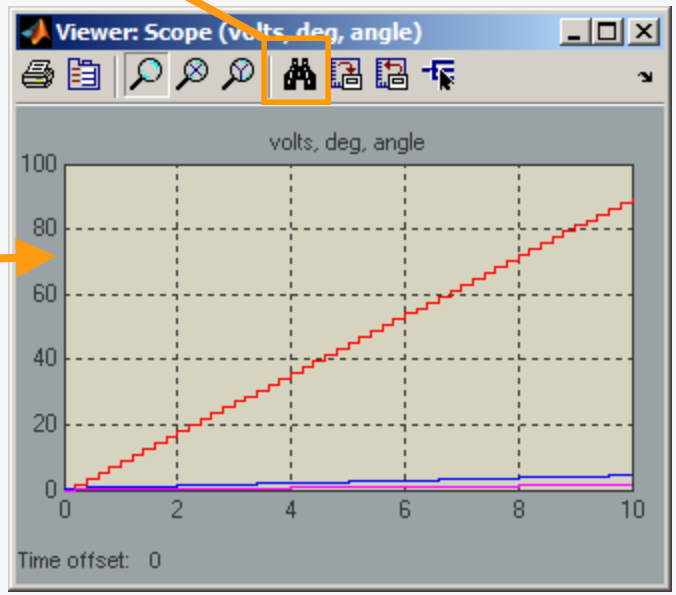



```
>> etc_r2v3
```

Simulating and Analyzing the Response

Auto-scale scope axis






```
>> etc_r2v3
```

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