Quick Start Tutorial

Simulink and Advanced Topics in MATLAB

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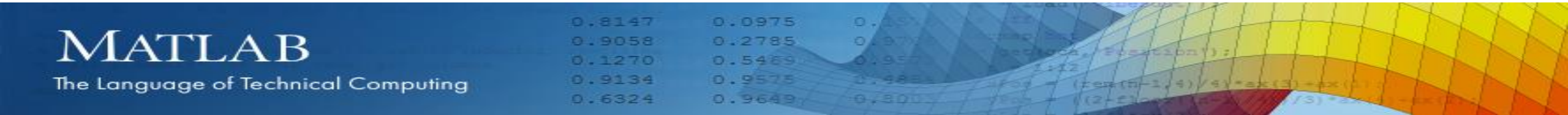
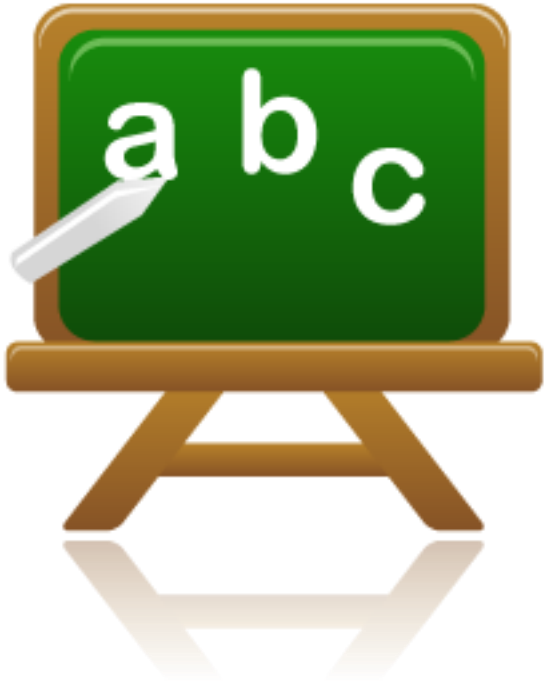
What is MATLAB?

- MATLAB is a tool for technical computing, computation and visualization in an integrated environment.
- MATLAB is an abbreviation for MATrix LABoratory
- It is well suited for Matrix manipulation and problem solving related to Linear Algebra, Modelling, Simulation and Control Applications
- Popular in Universities, Teaching and Research

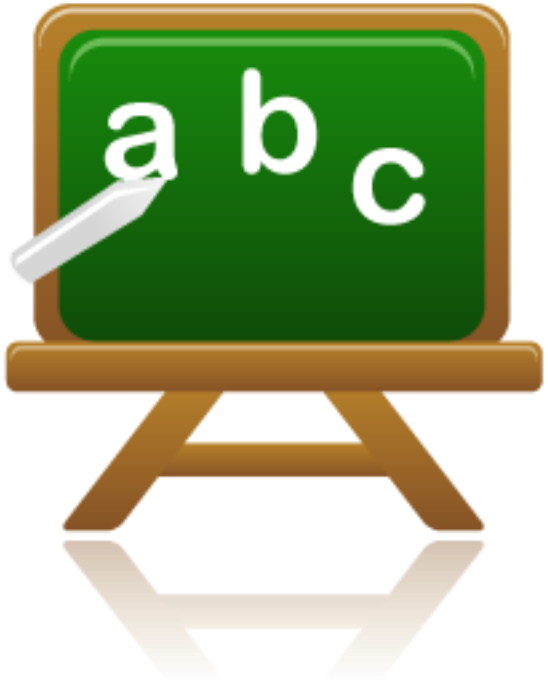


Lessons



1. Introduction to Simulink
2. Combining Simulink & MATLAB (Data-driven Modelling)

Lesson 1



Introduction to Simulink

What is Simulink?

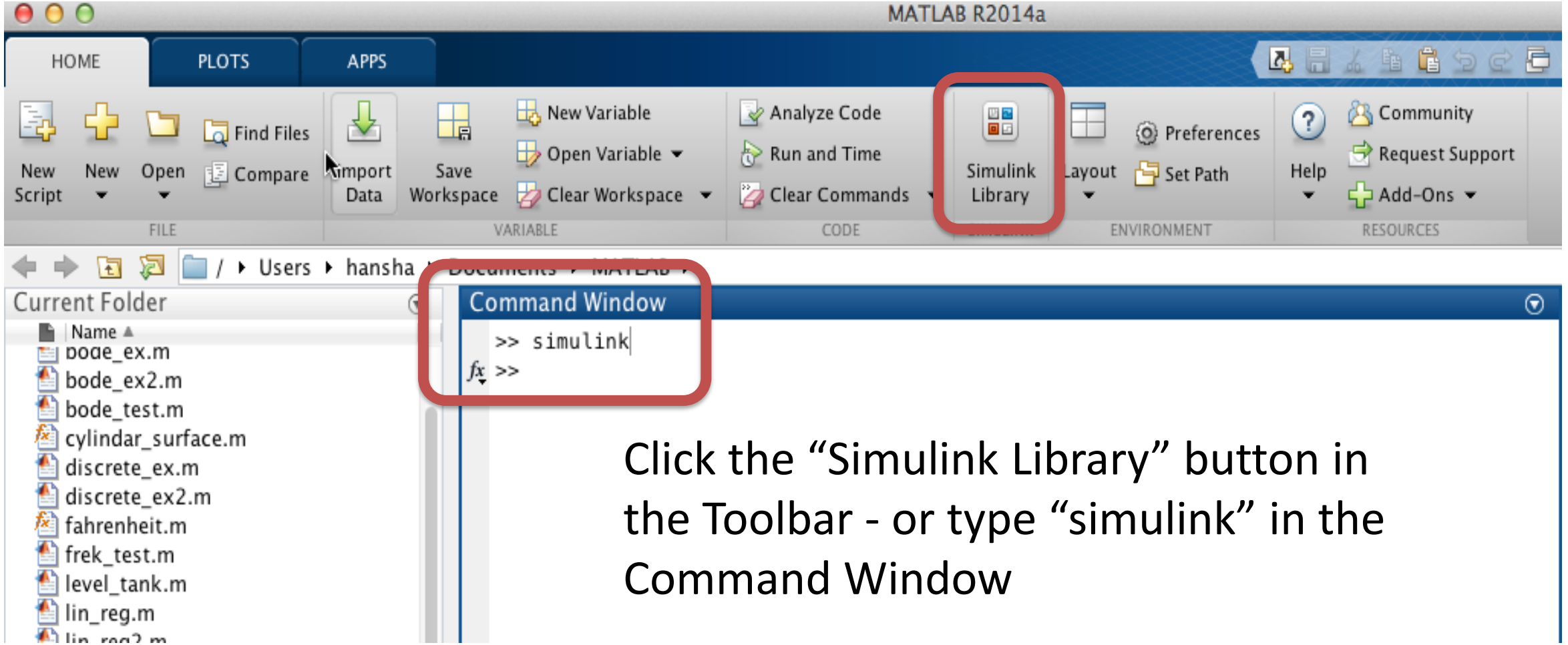
Simulink Overview

http://www.mathworks.com/videos/simulink-overview-61216.html

What is Simulink?

- Simulink is an “add-on” to MATLAB.
- You need to have MATLAB in order to use Simulink
- Simulink is used for Simulation of dynamic models
- In Simulink we create a Graphical Block Diagram for the system (based on the differential equations(s))

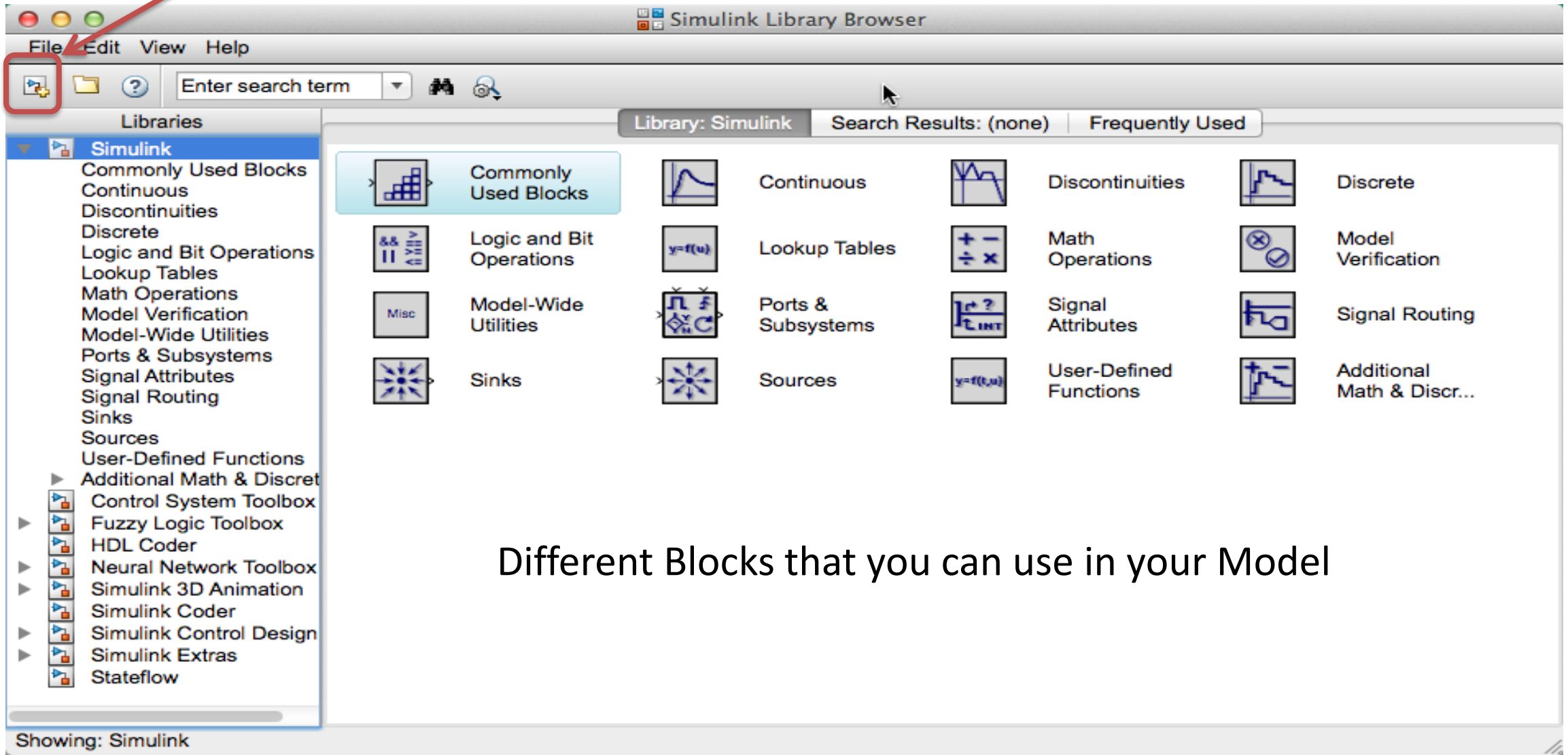
Start Simulink from MATLAB



Click the “Simulink Library” button in the Toolbar - or type “simulink” in the Command Window

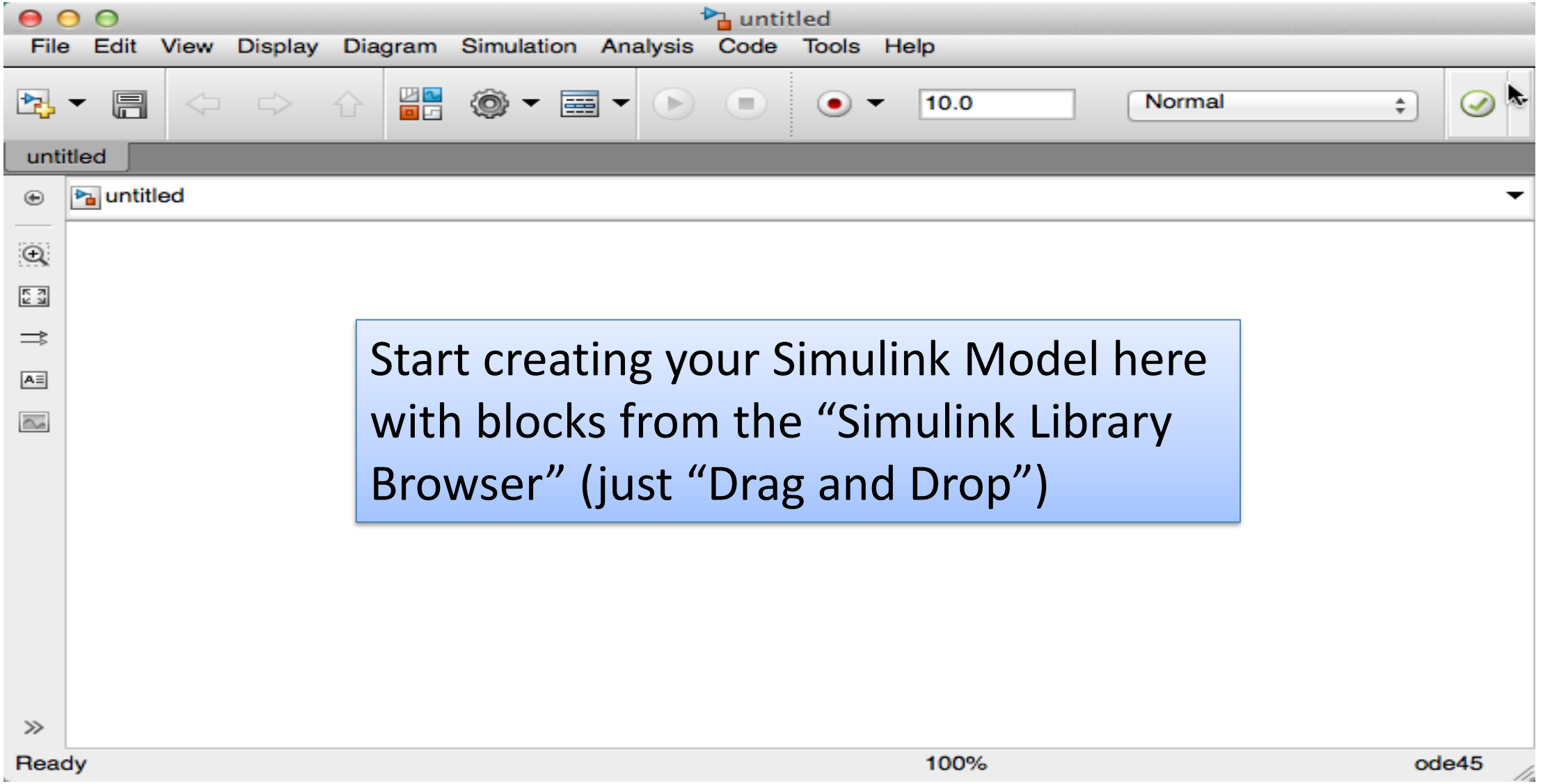
Simulink Library Browser

Click here to create a new Simulink Model



Different Blocks that you can use in your Model

Simulink Model Editor

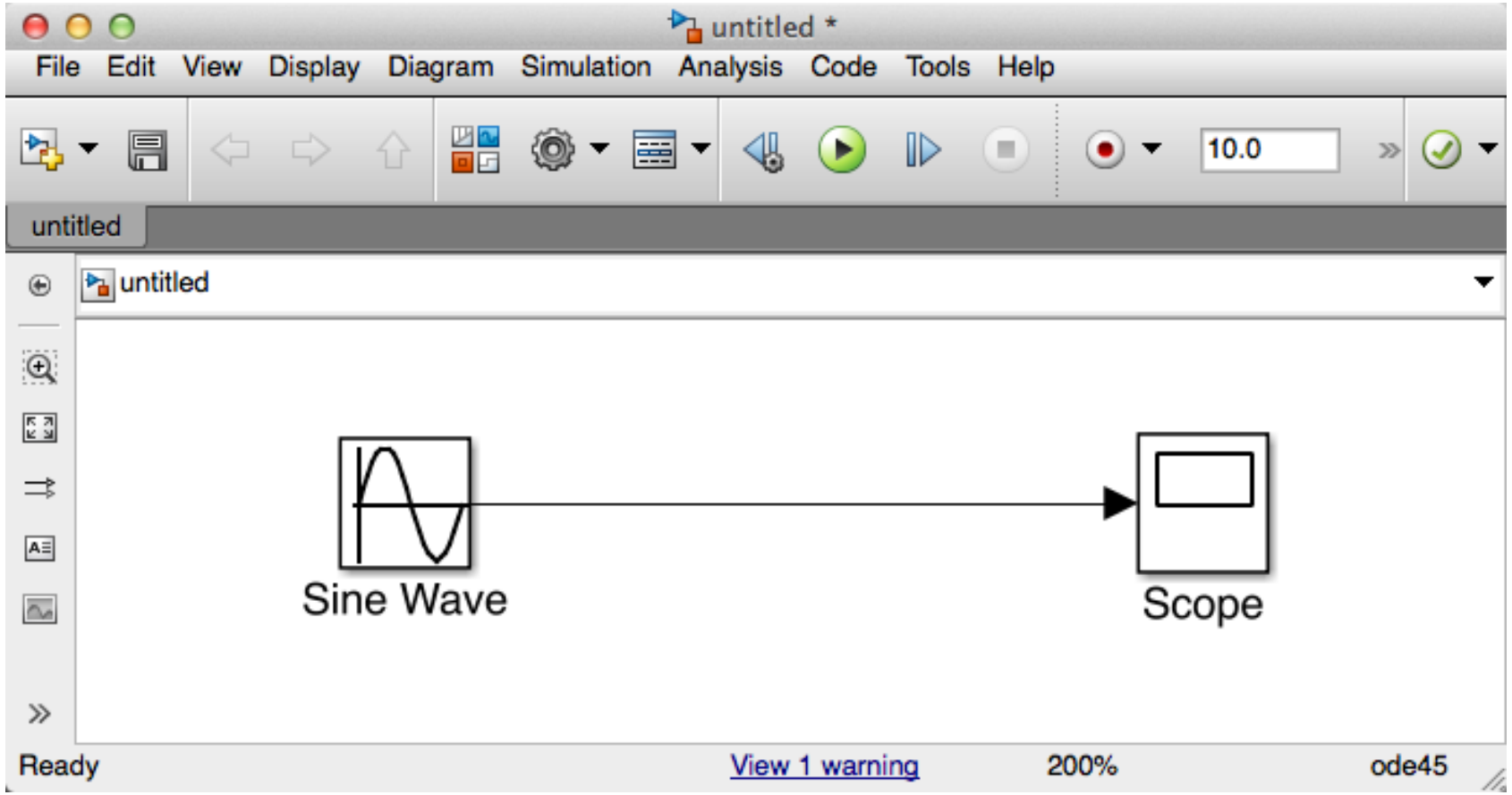


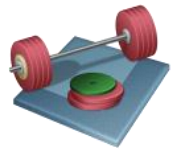
Getting Started with Simulink

Getting Started with Simulink

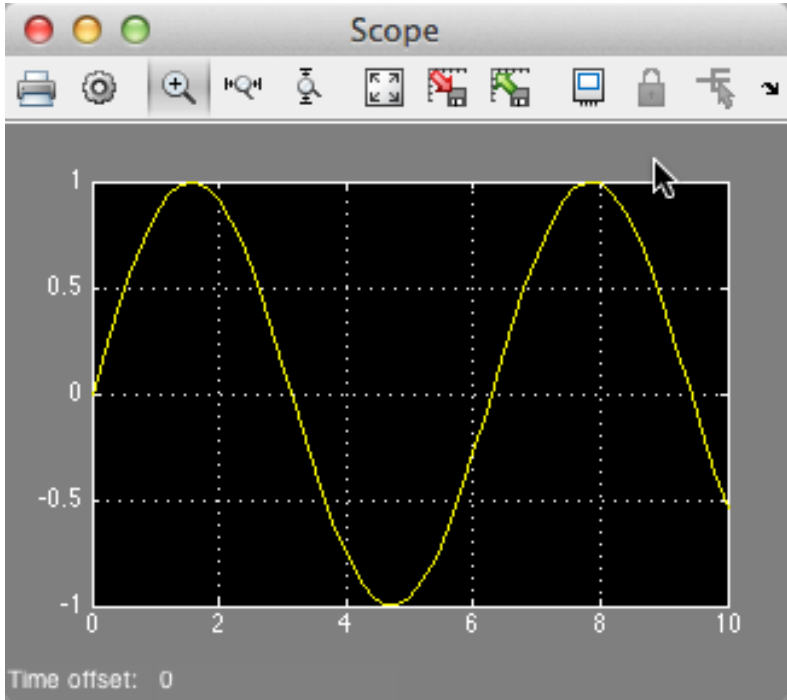
http://www.mathworks.com/videos/getting-started-with-simulink-69027.html

My First Simulink Example

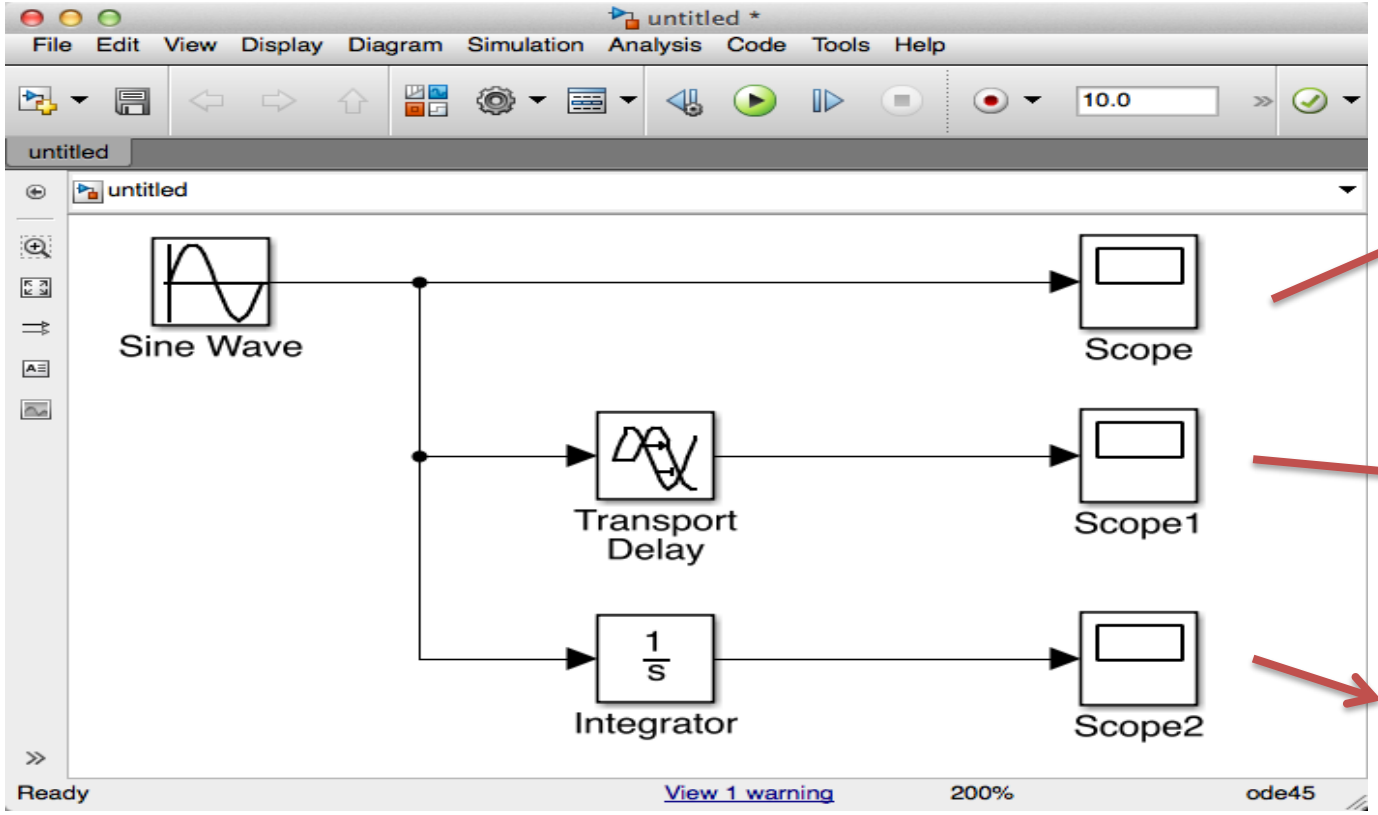


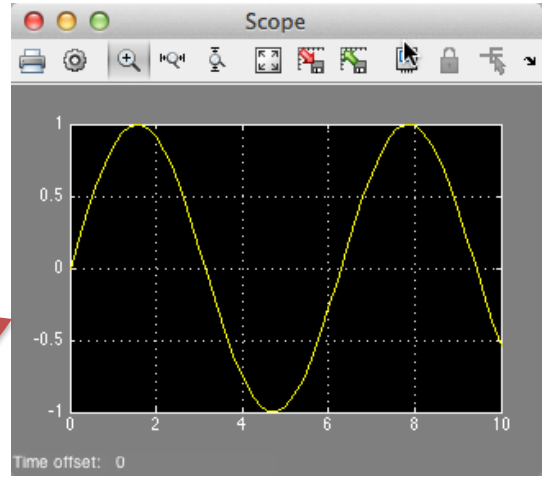


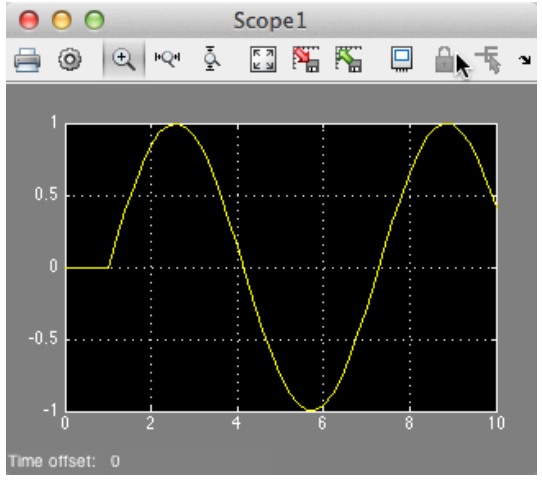
Students: Try this example

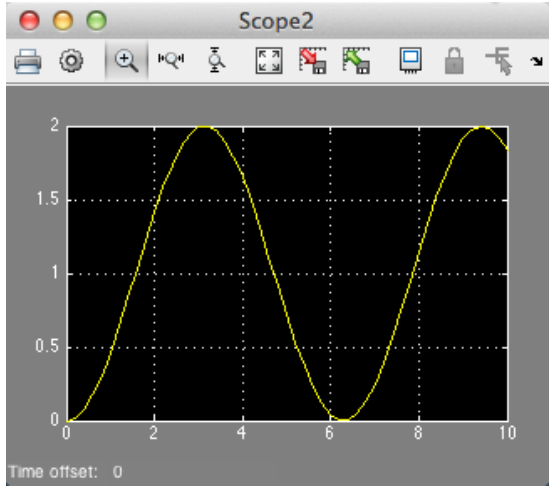


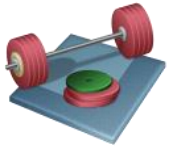
My Second Simulink Example











Students: Try this example

Example

My First Simulink Model

Model:

$$\dot{x} = ax$$

Where $a = -\frac{1}{T}$

T is the Time constant

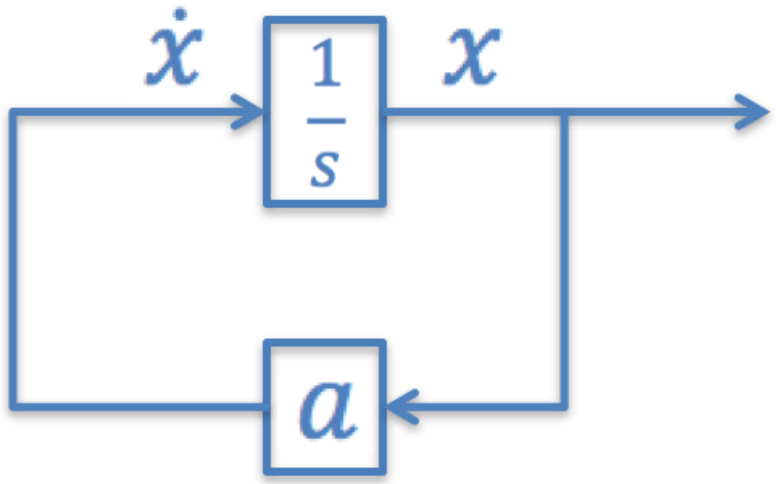
Use the following:

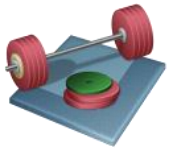
$$T = 5$$

$$x(0) = 1$$

$$0 \leq t \leq 25$$

We start by drawing a simple Block Diagram for the model like this (Pen & paper):

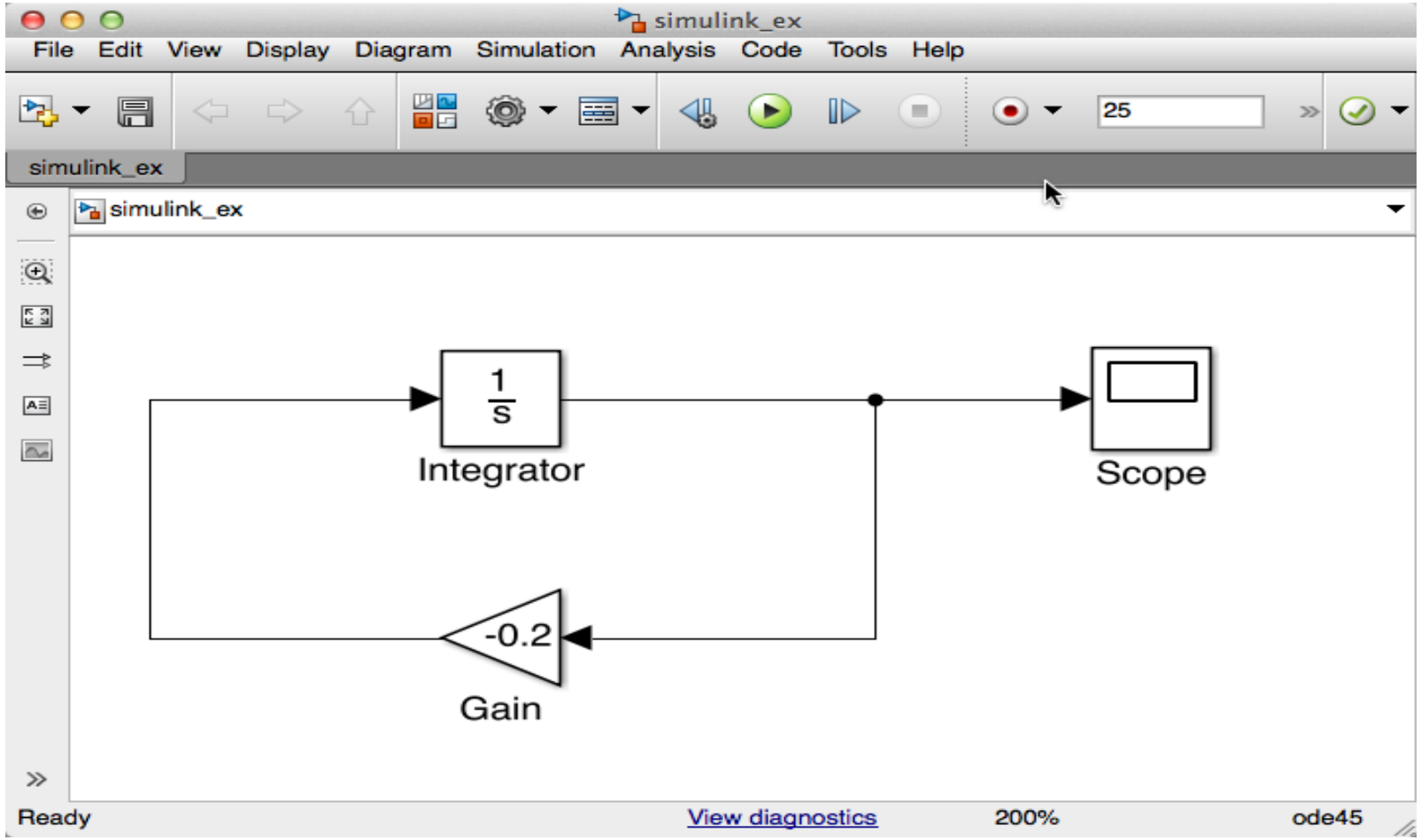


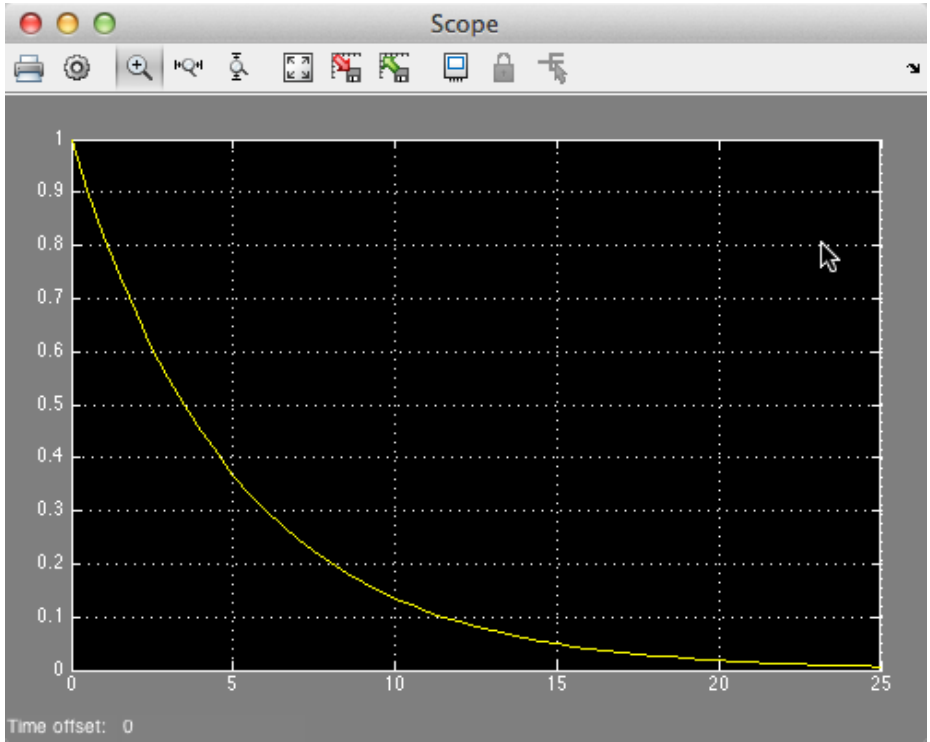


Students: Create and simulate this block diagram with Simulink

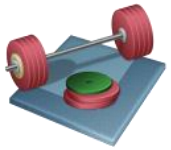
Solution

My First Simulink Model





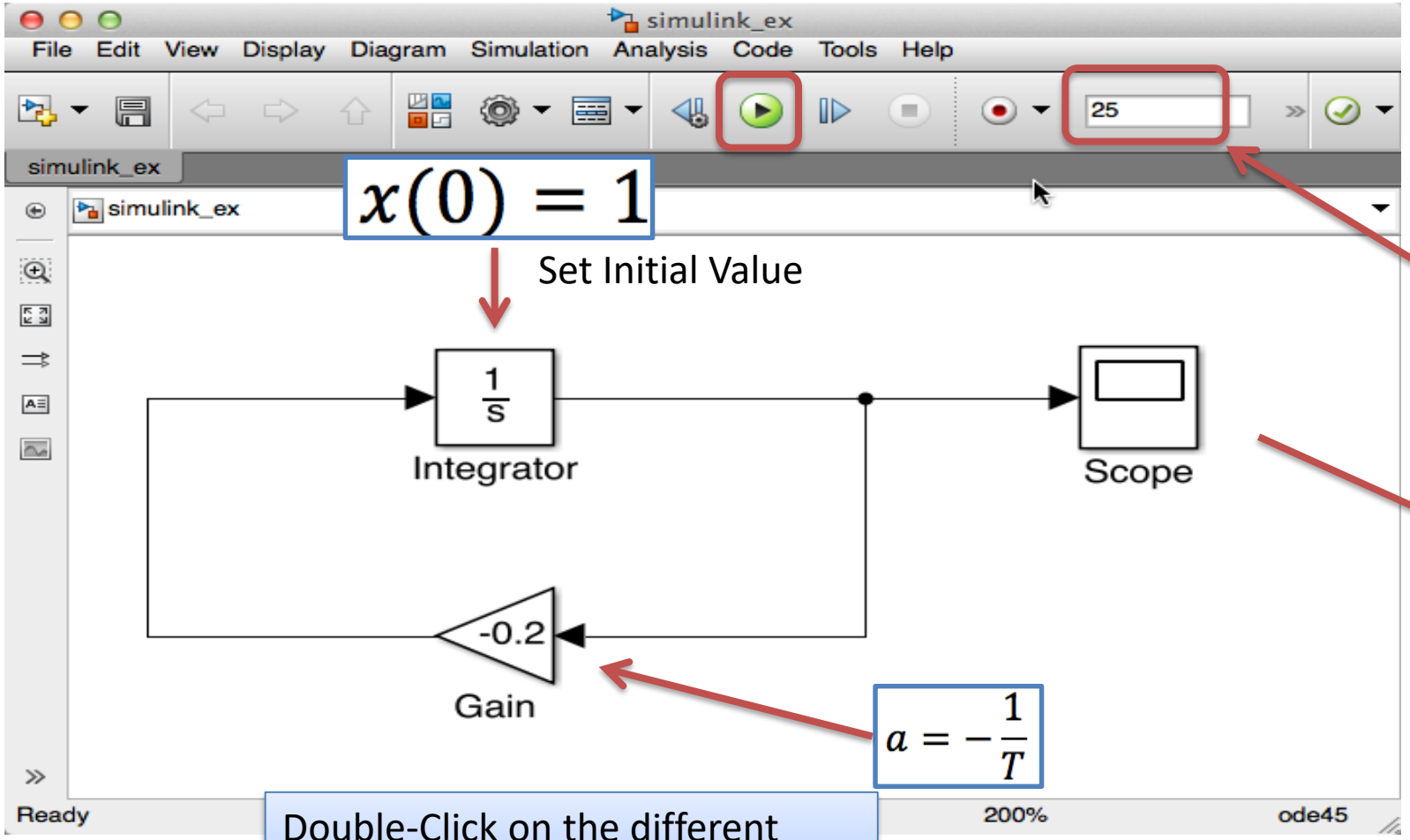
As you see we get the same results as in MATLAB Training, Part II:



Students: Try this example

Solution

My First Simulink Model

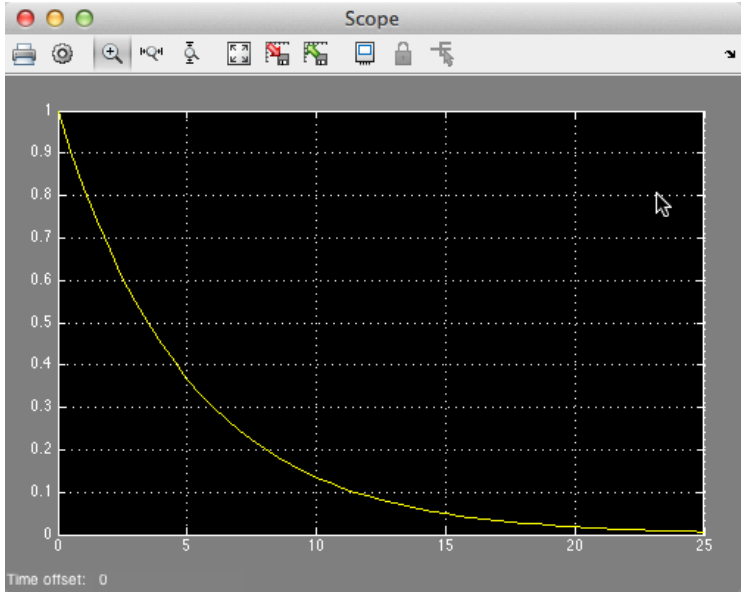


Start the Simulation by clicking this icon

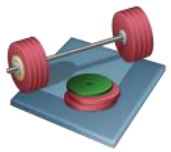
Simulation Time

$0 \leq t \leq 25$

See the Simulation Results



Double-Click on the different Blocks to enter values



Students: Try this example

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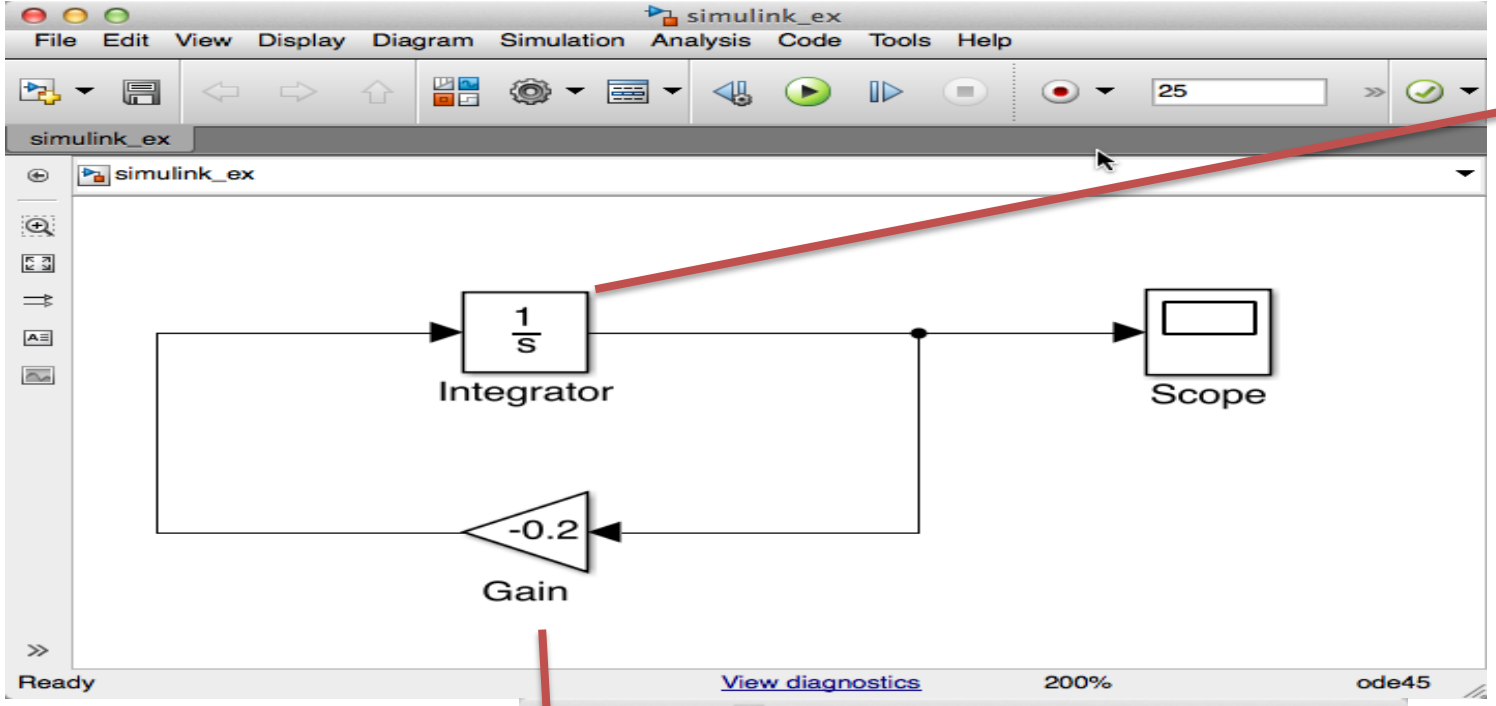
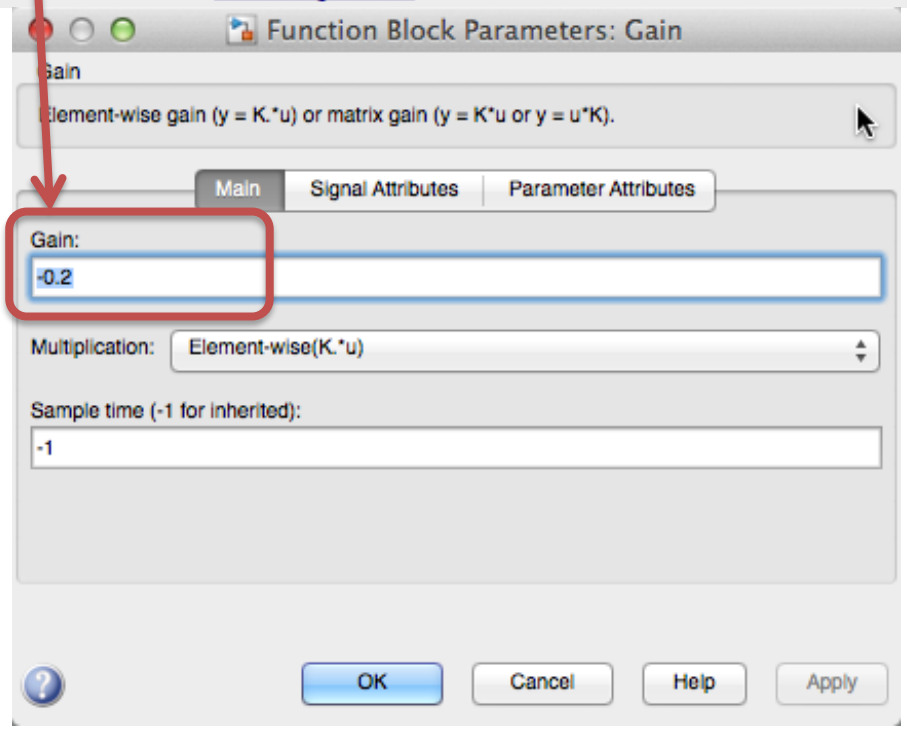
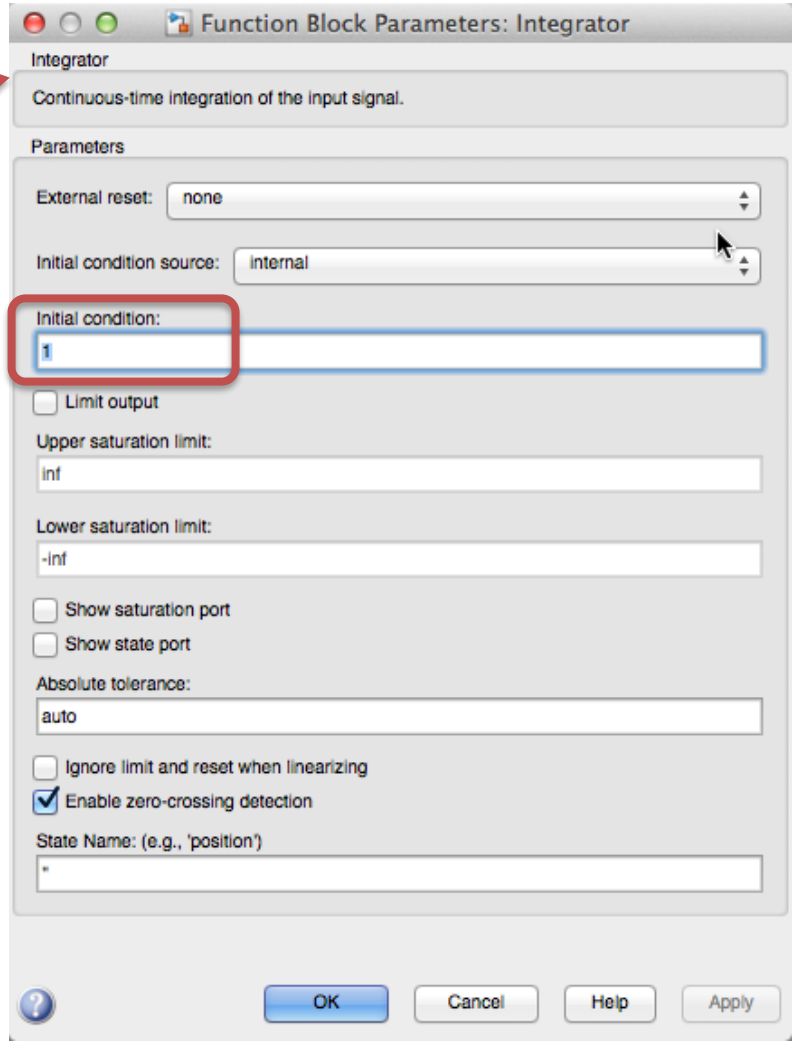
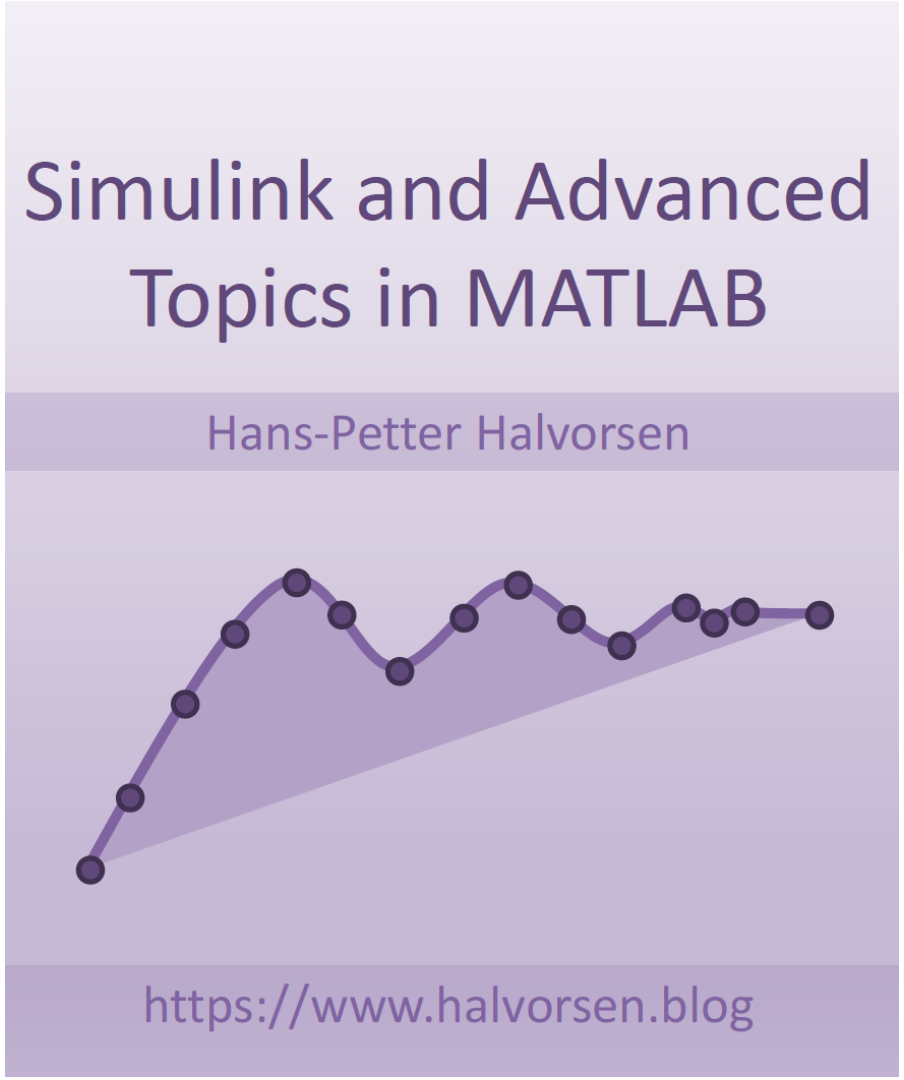

simulink_ex
File Edit View Display Diagram Simulation Analysis Code Tools Help
25
simulink_ex
simulink_ex
1
s
Integrator
Scope
-0.2
Gain
Ready
View diagnostics
200%
ode45


Function Block Parameters: Gain
Gain
Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).
Main
Signal Attributes
Parameter Attributes
Gain:
-0.2
Multiplication:
Element-wise(K.*u)
Sample time (-1 for inherited):
-1
OK
Cancel
Help
Apply


Function Block Parameters: Integrator
Integrator
Continuous-time integration of the input signal.
Parameters
External reset:
none
Initial condition source:
internal
Initial condition:
1
Limit output
Upper saturation limit:
inf
Lower saturation limit:
-inf
Show saturation port
Show state port
Absolute tolerance:
auto
Ignore limit and reset when linearizing
Enable zero-crossing detection
State Name: (e.g., 'position')
OK
Cancel
Help
Apply

Whats next?

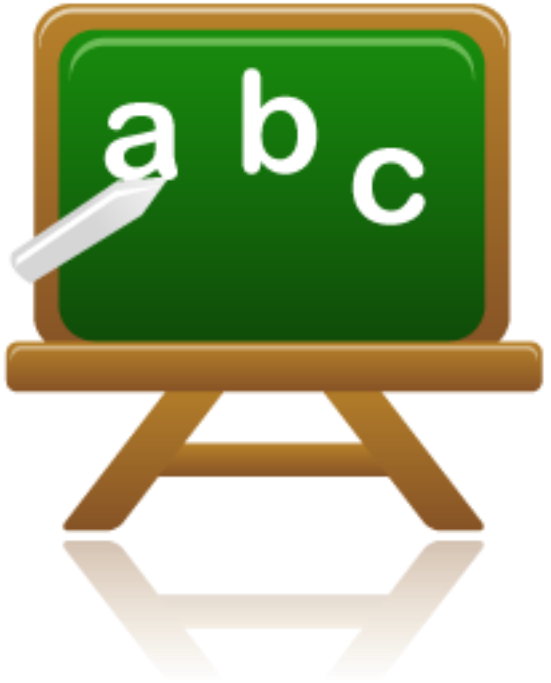
Learning by Doing!



Self-paced Tutorials with lots of Exercises and Video resources

Do as many Exercises as possible! The only way to learn MATLAB is by doing Exercises and hands-on Coding!!!

Lesson 2



Combining Simulink & MATLAB

(Data-driven Modelling)

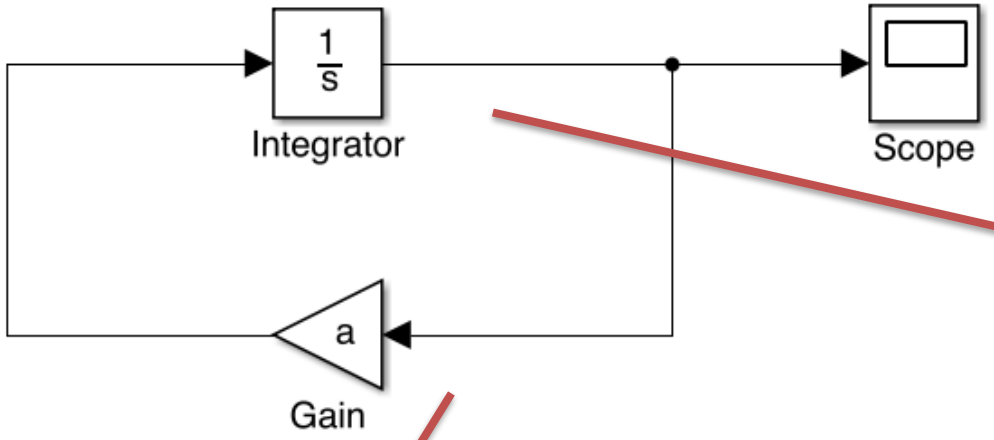
Data-driven Modelling

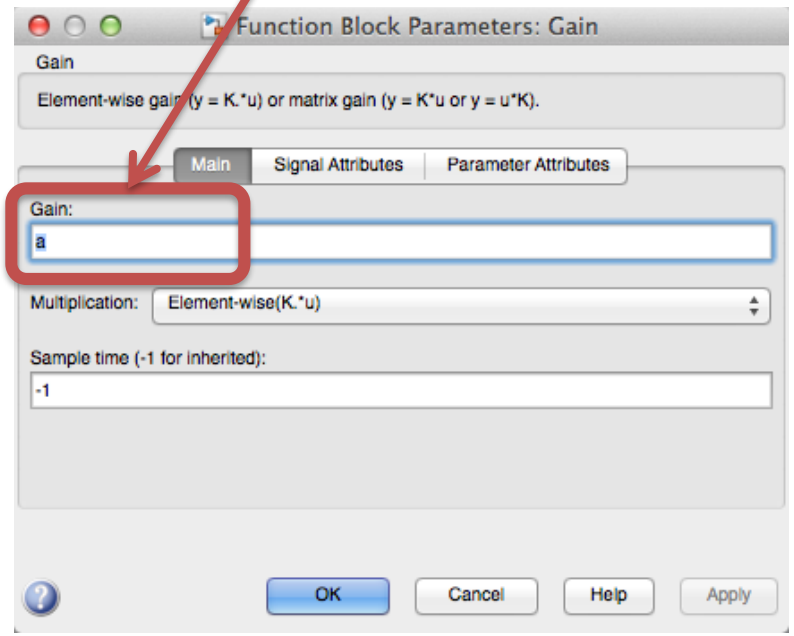
- You may use Simulink together with MATLAB in order to specify data and parameters to your Simulink model.
- You may specify commands in the MATLAB Command Window or as commands in an m-file (Script).
- This is called data-driven modeling
- Instead of using values directly we use variables instead - This is more flexible because we can easily change Simulation Parameters without touching the Simulink Model

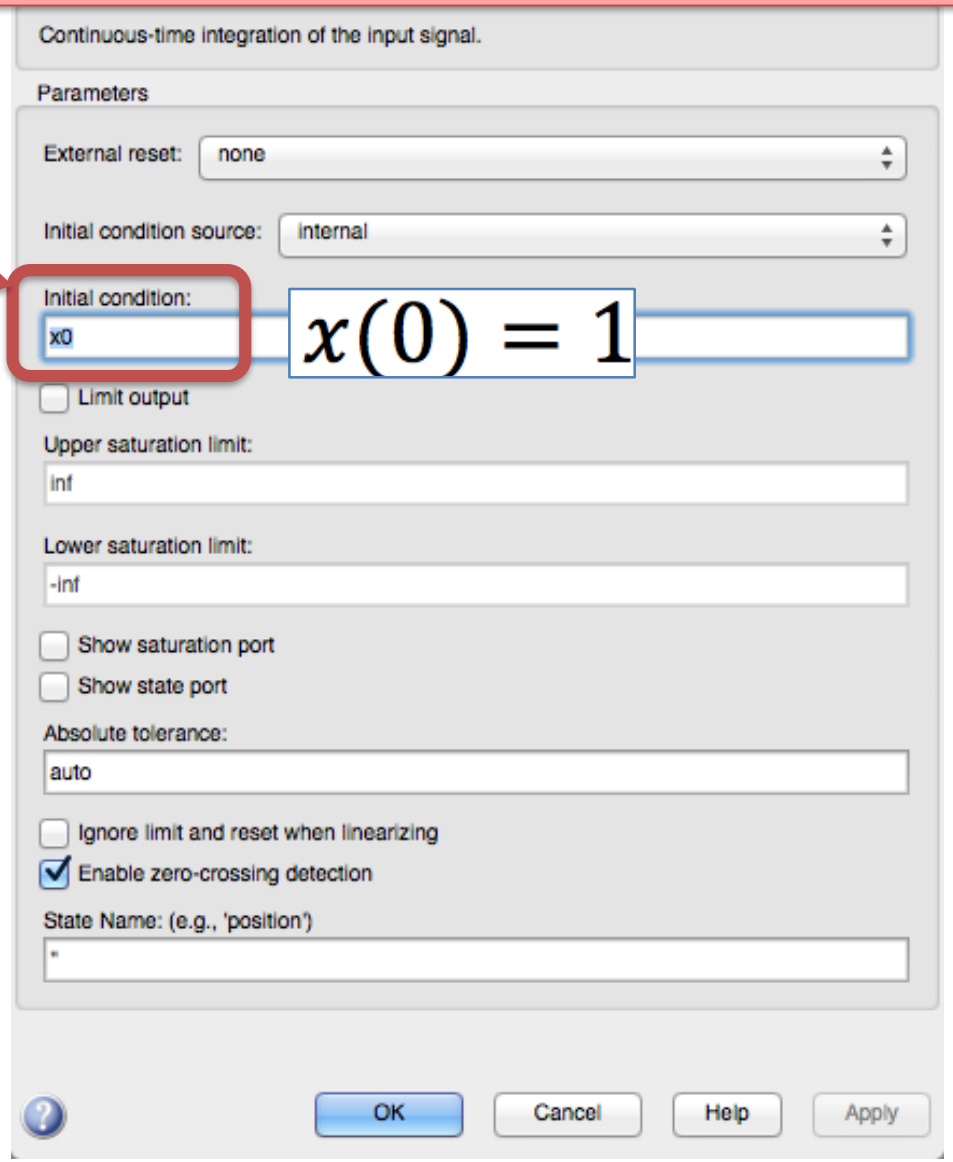
Example

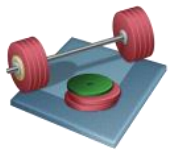
$$\dot{x} = ax$$

Instead of using values directly we use variables instead – This is more flexible because we can easily change Simulation Parameters without touching the Simulink Model







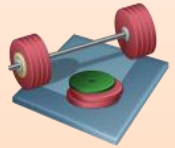


Students: Try this example

Data-driven Modelling

MATLAB Script for running the Simulink Simulation:

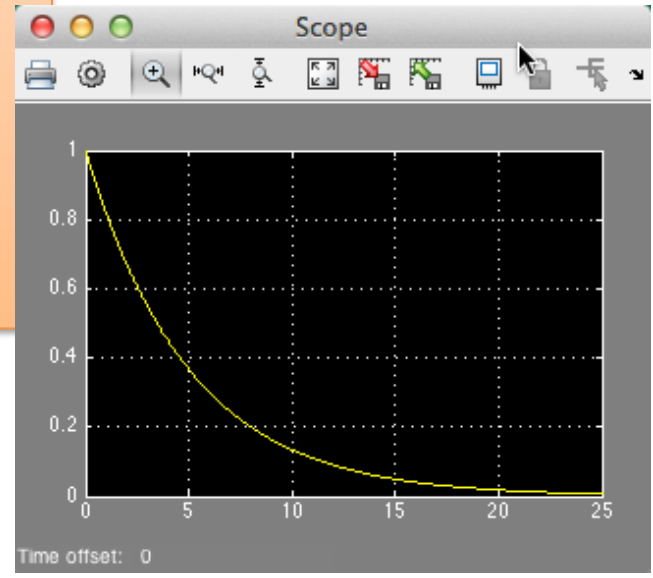
```
clear
clc

%Set Simulator Settings
x0=1;
T=5;
a=-1/T;
t_stop=25; %[s]
T_s=t_stop/1000; %[s]
options=simset('solver', 'ode5', 'fixedstep', T_s);

%Starting Simulation
sim('simulink_ex2', t_stop, options);
```



Students: Try this example.
Try also to change some of the Simulation Parameters.

This is the Name for our Simulink Model

We get the same results:

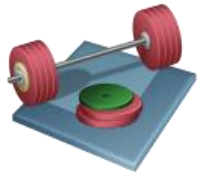


Example – Control System

The System is given as:

$$\dot{x} = -ax + bu$$

Where u may be the Control Signal from e.g., a PID Controller

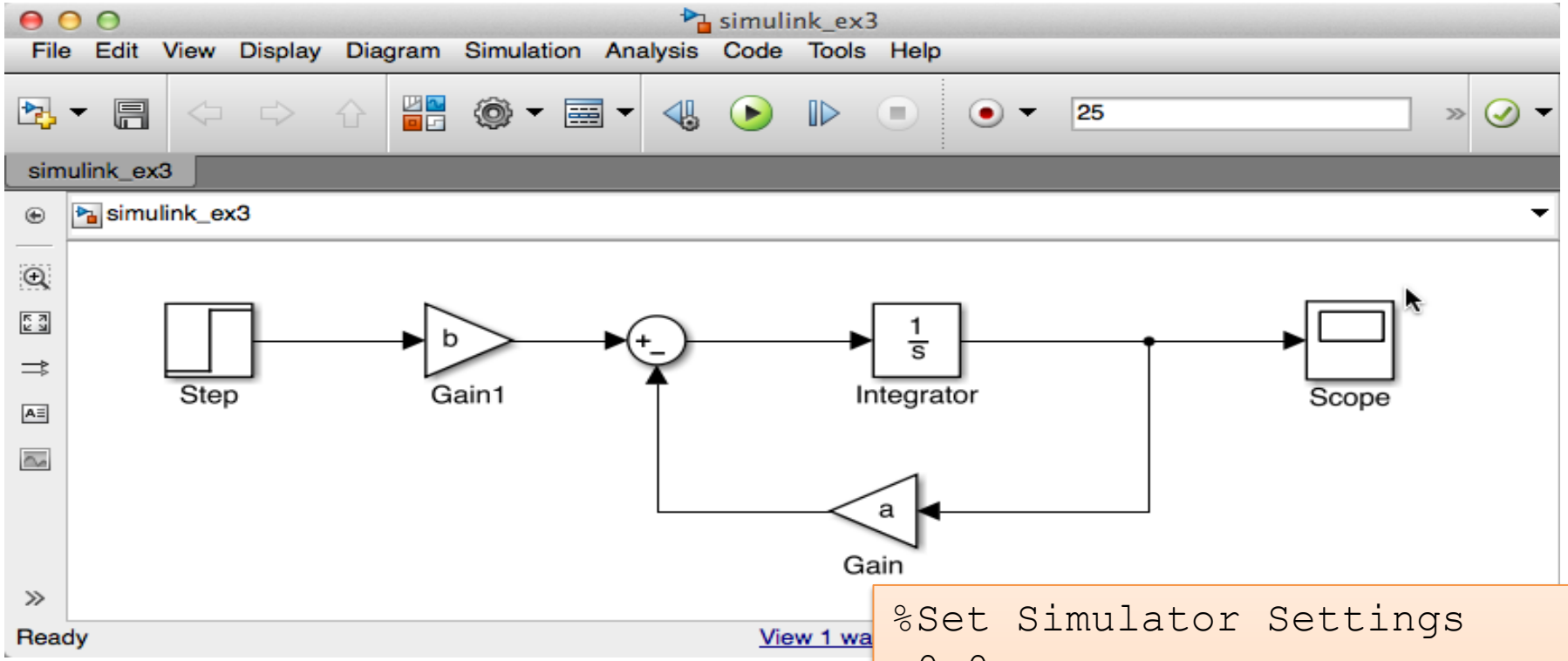


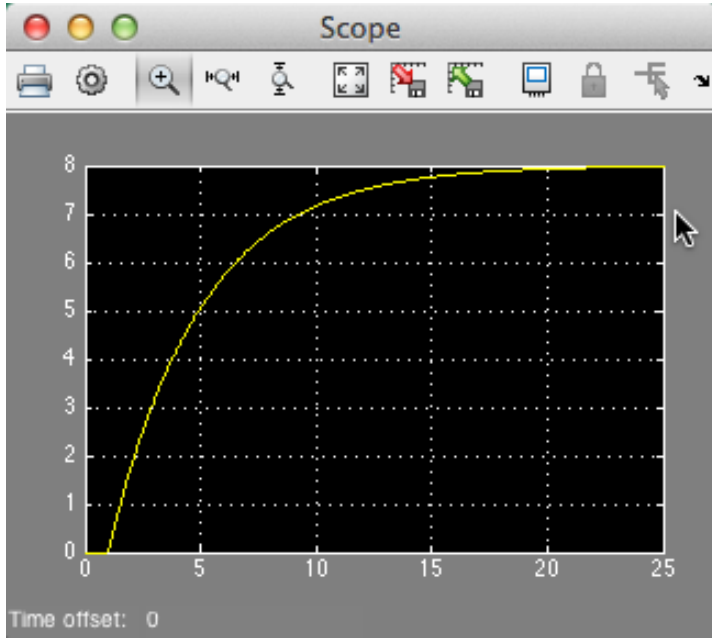
Students: Simulate this system in Simulink + MATLAB (i..e, find the Step Response of the system)

Set $a = 0.25$ and $b = 2$

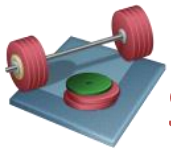
Solution

$$\dot{x} = -ax + bu$$





We get the same results as in MATLAB, Part II

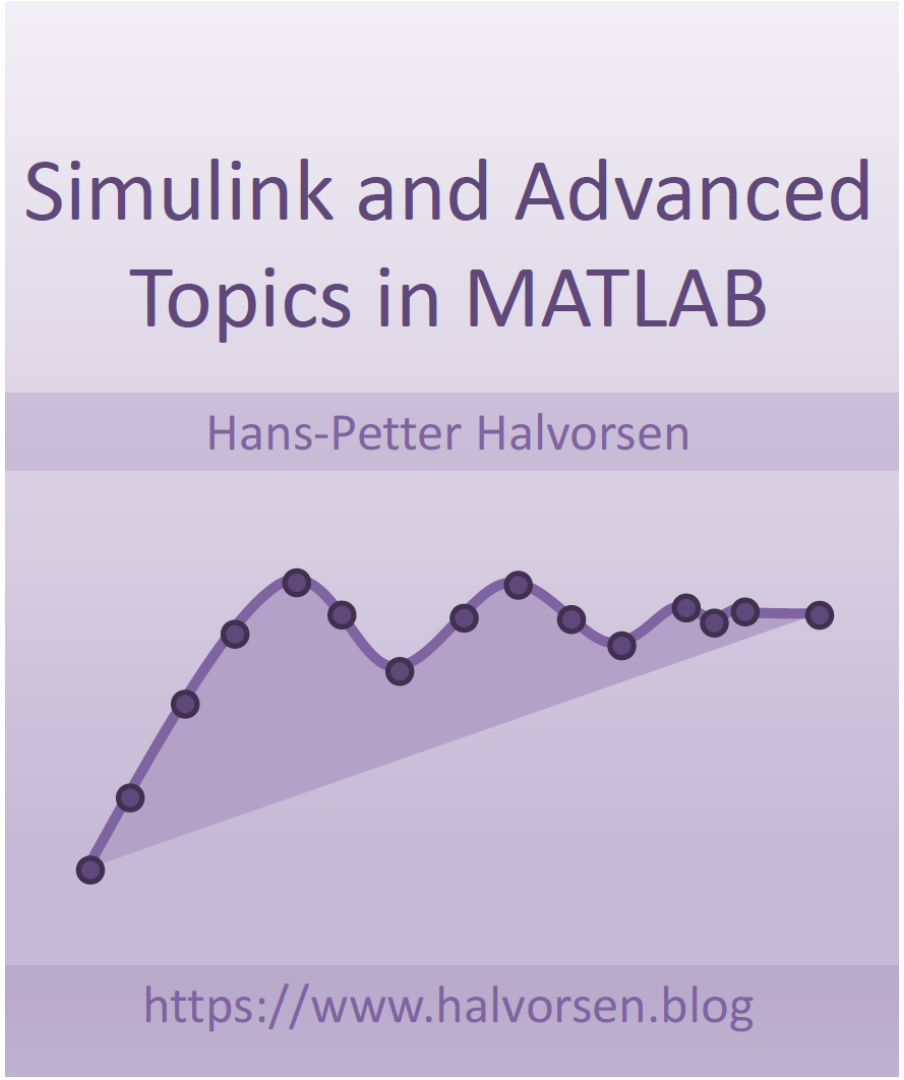


Students: Try this example

```
%Set Simulator Settings
x0=0;
a=0.25;
b=2;
t_stop=25; %[s]
T_s=t_stop/1000; %[s]
options=simset('solver', 'ode5', 'fixedstep', T_s);

%Starting Simulation
sim('simulink_ex3', t_stop, options);
```

Whats next?

Learning by Doing!



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