How to Build a Simple Stateflow Model

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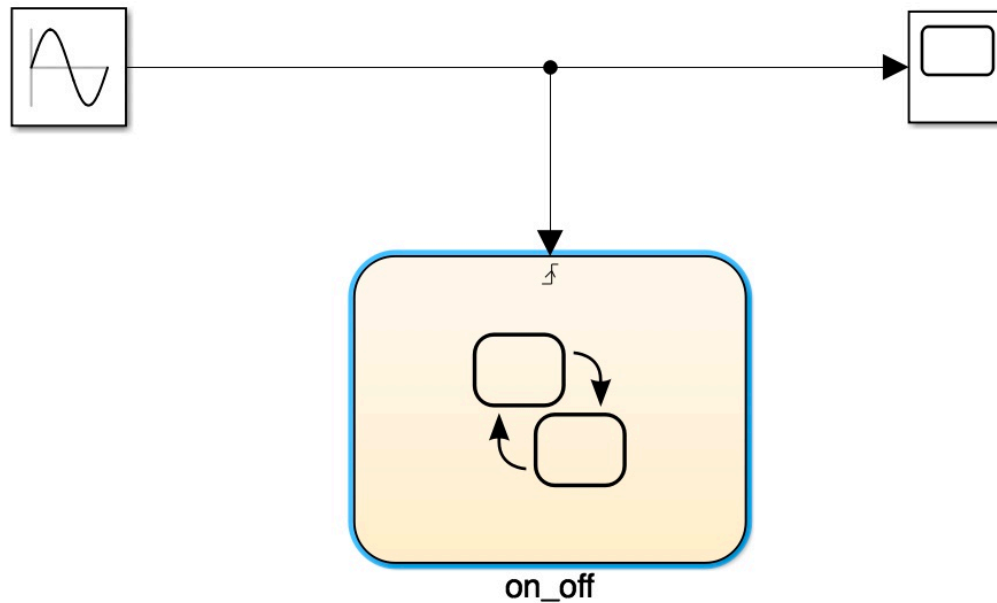
EECS 461

Introduction

- These slides will show you how to build a simple Stateflow model using Matlab release 2018a.

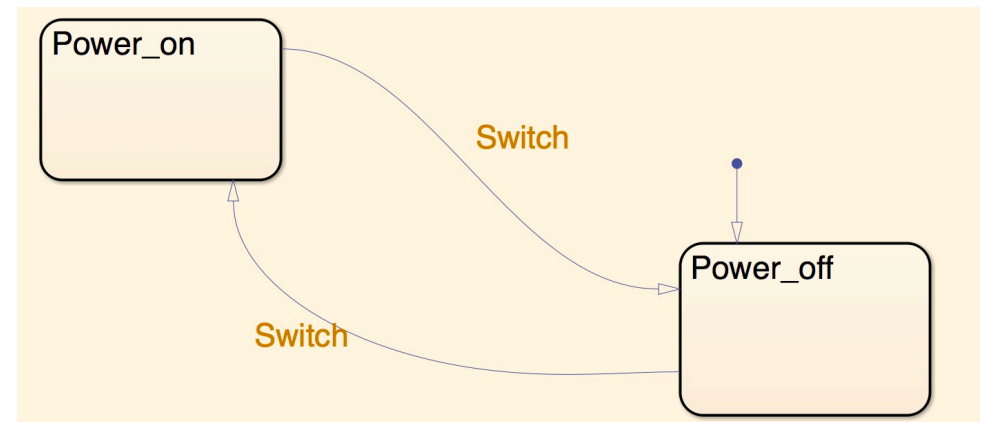- This is the version of Matlab we use in the lab.

Power Switch Simulink Model

- Simulink model of a power switch that toggles on and off at the zero crossings of a sine wave


on_off

Inside the State Chart

- Two states of the power switch: on and off
- Transitions between the states happen whenever the event "Switch" occurs
- By default, the initial state is "off"

Running the Simulation

- Open the scope by clicking on it

- Run the simulation by selecting "run" from the simulation menu, or by clicking the green arrow

- There are many scope options available from the pull-down menus that allow you to zoom in or out, log data, change the color and line width, etc.
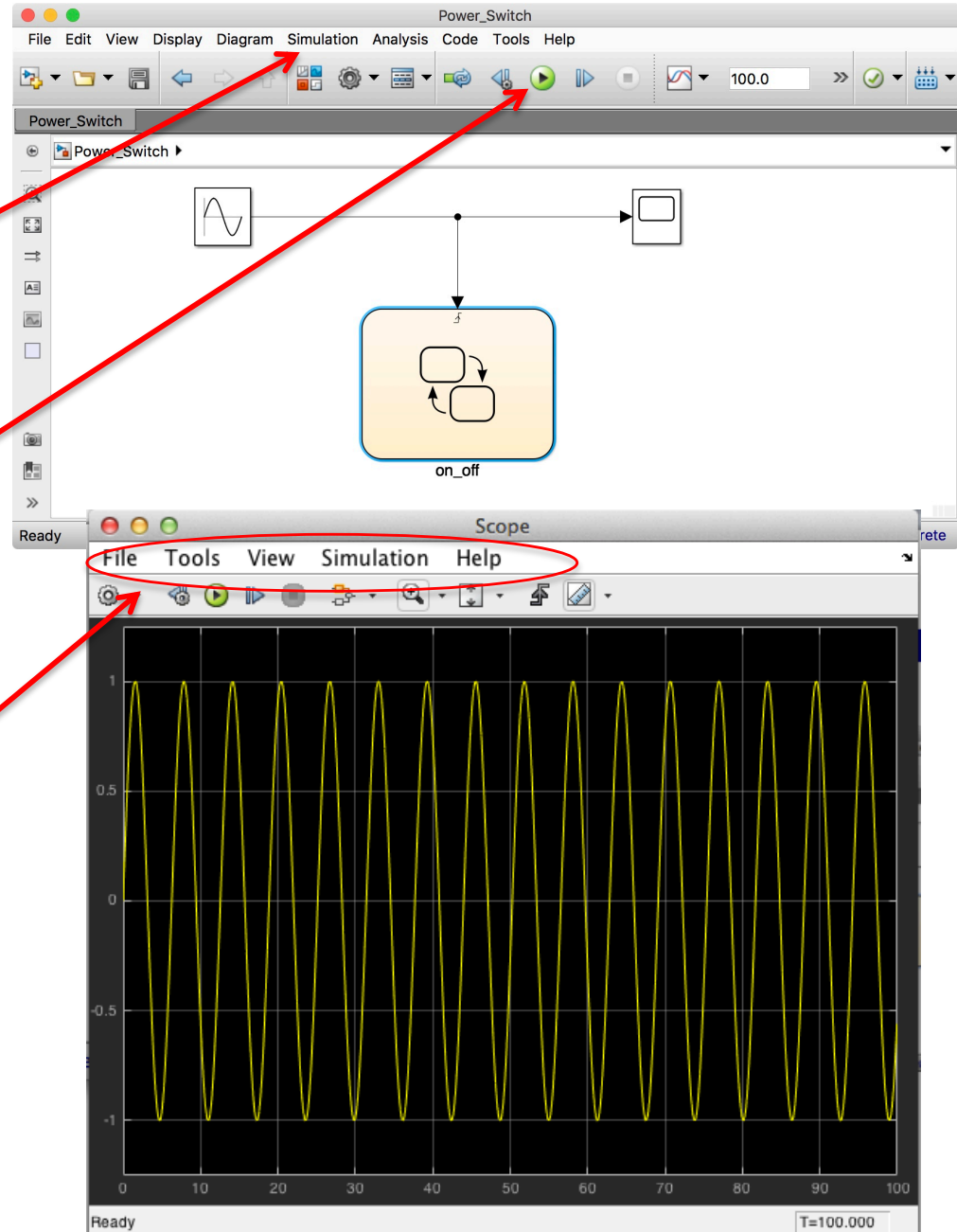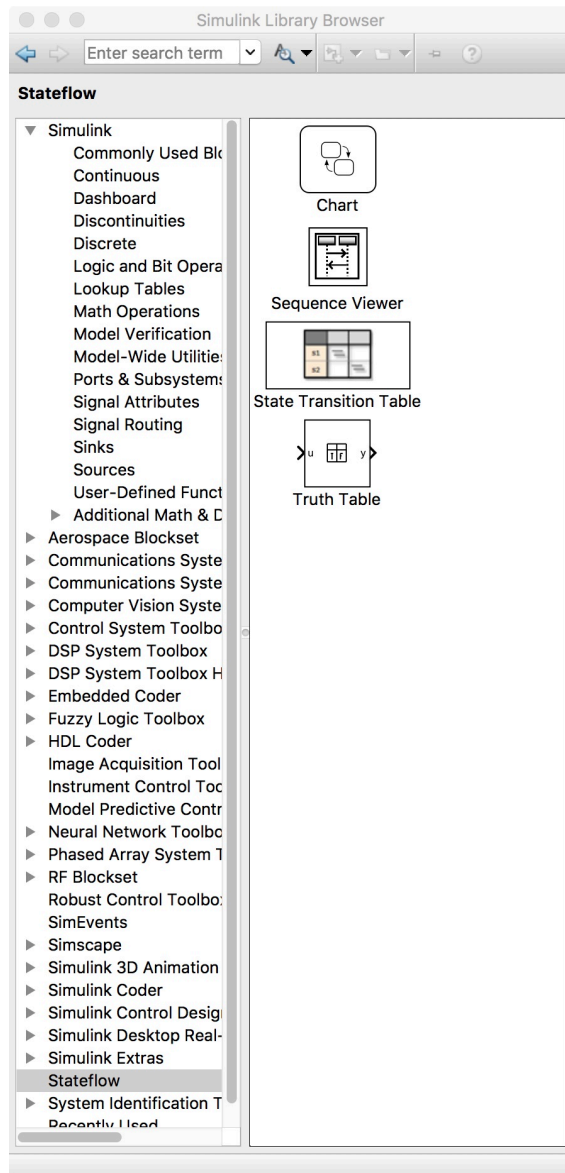
Create Simulink Model

- Launch Simulink
- Create a Blank Model
from the Simulink Start Page
- Open the Library Browser
from the View menu
- Save the model with a name like "my_switch"
- Near the bottom of the Library Browser you will find Stateflow. Select it and the Stateflow block set will appear on the right side of the browser
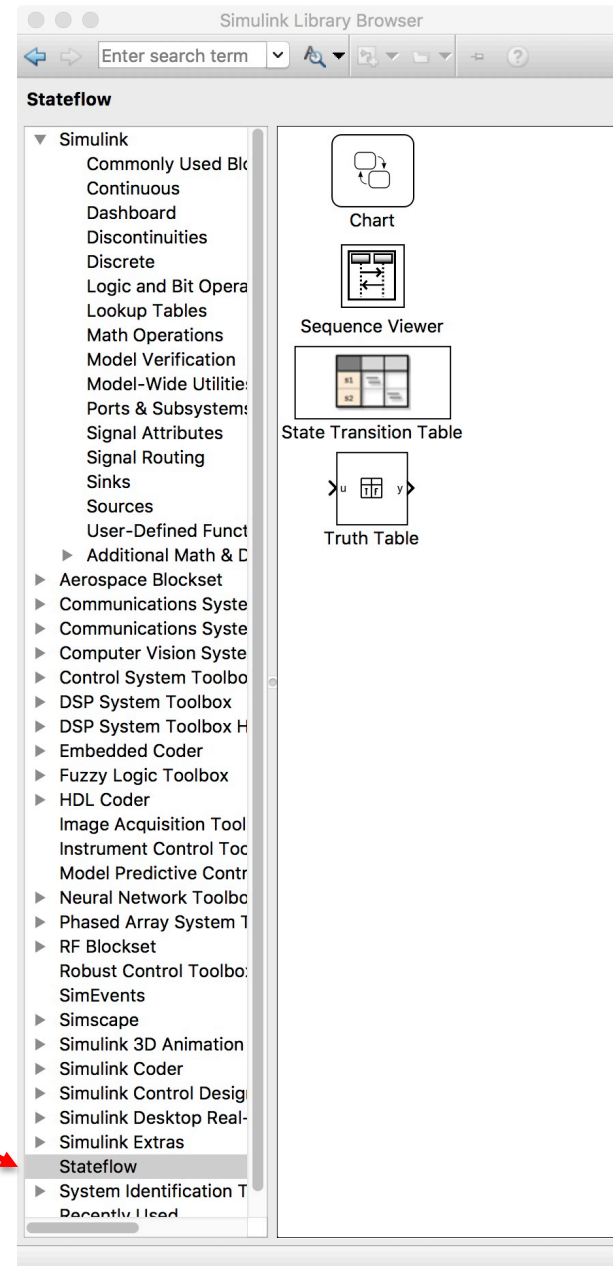
Add Statechart to Simulink Model

Drag and drop statechart from the browser into the Simulink model. The default name is "Chart," so you'll want to change it to something like "on_off"
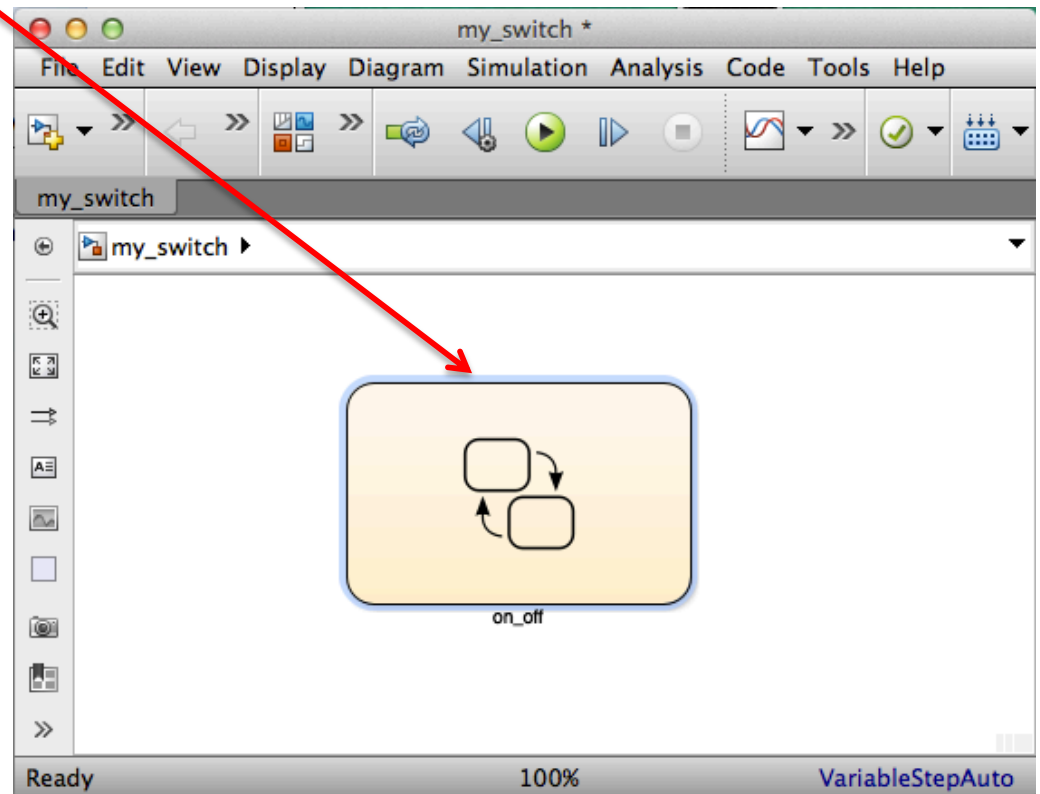
Adding States to a Statechart

- Open statechart "on_off" by double clicking
- Drag two states from the menu on the left side of the chart into the model
- The first will have an arrow entering it. Place it on the lower right.
- Name the states "Power_on" and "Power_off" by editing the "?" in the upper left corner
- To delete a state, just select it and hit "delete"
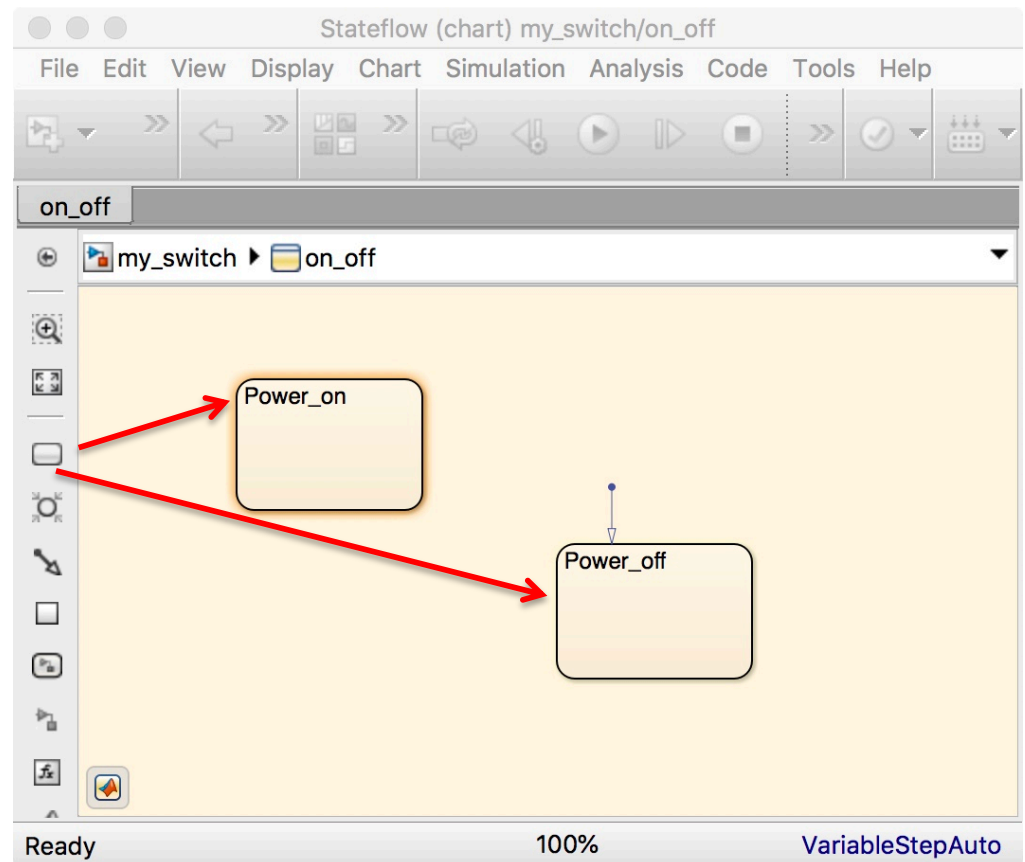
# Creating Transitions between States

- To create a transition between states, hold the cursor over the border of the starting state – it will turn into crosshairs
- Hold down the mouse button and drag the mouse to the terminal state – this will create a transition (denoted by an arrow) connecting the states
- Click on the transition and replace the resulting "?" with the name of the event that causes the transition. In this example, we'll call our event "Switch"*
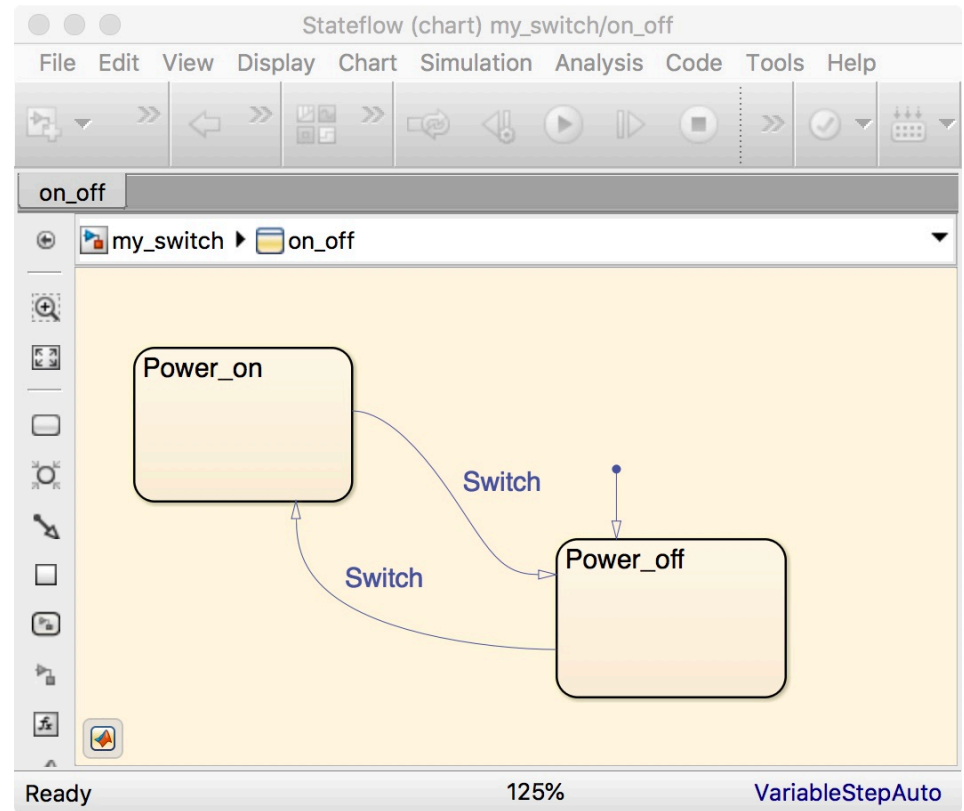
* Lower case "switch" is a reserved word in Stateflow and will cause an error. Be sure to call it upper case "Switch" or a different name!

The Default Transition

- The arrow entering the first state added to the chart indicates the **initial transition**, or initial state.

- The initial state may be changed by clicking on the arrow and hitting delete.

- A new default transition may be added by dragging the arrow icon from the menu to the border of the desired initial state
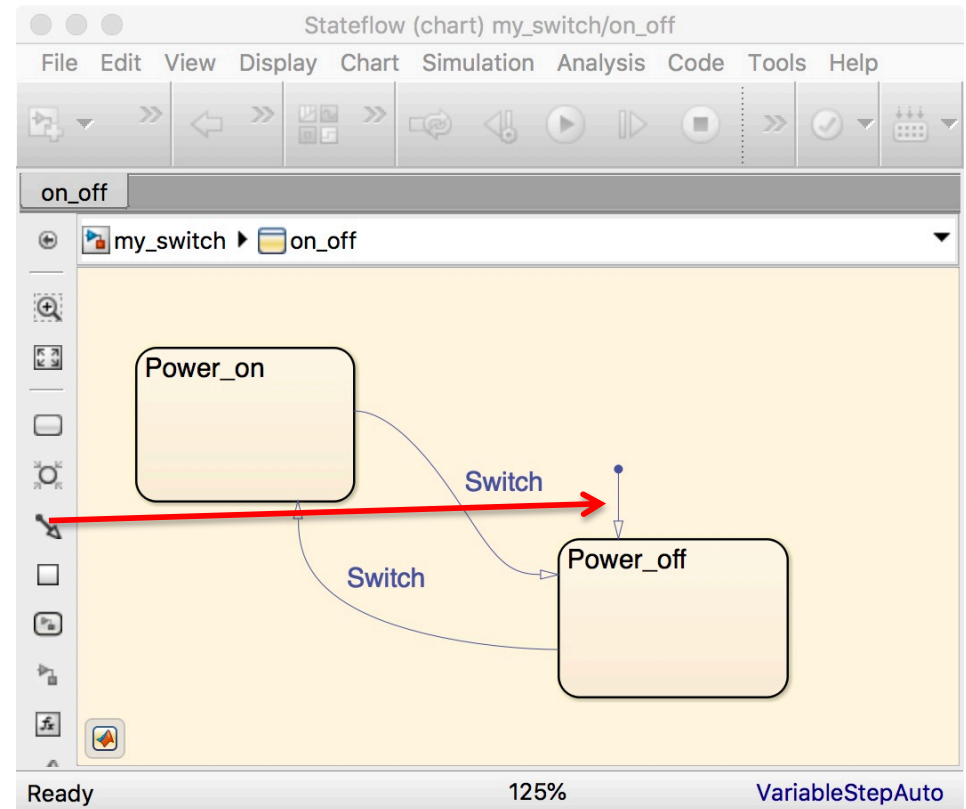
Adding an Event

- From the "Chart" pull-down menu, select "Add Inputs and Outputs" and then "Event Input from Simulink"

- A window will open allowing you to name the event ("Switch"), and to specify that the event triggers on the rising edge of the sine wave

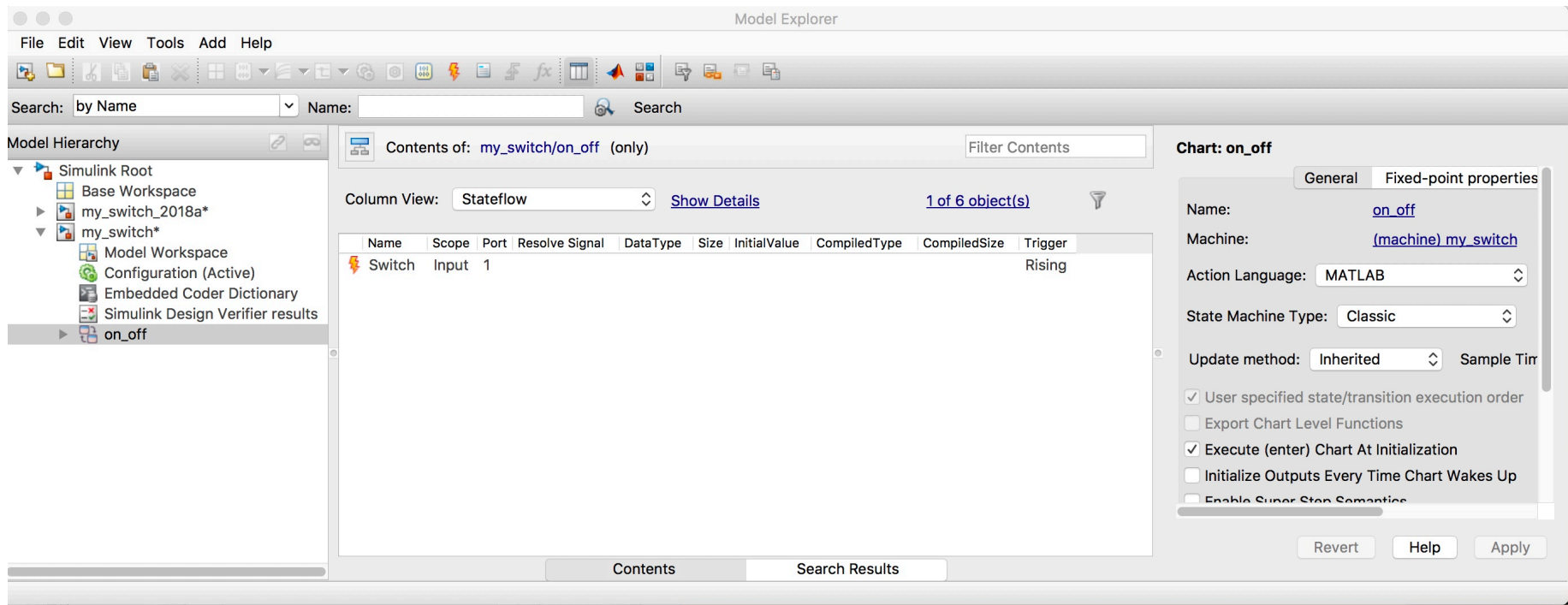- You may get an error message warning you to fix an initialization problem. Be sure to do so!
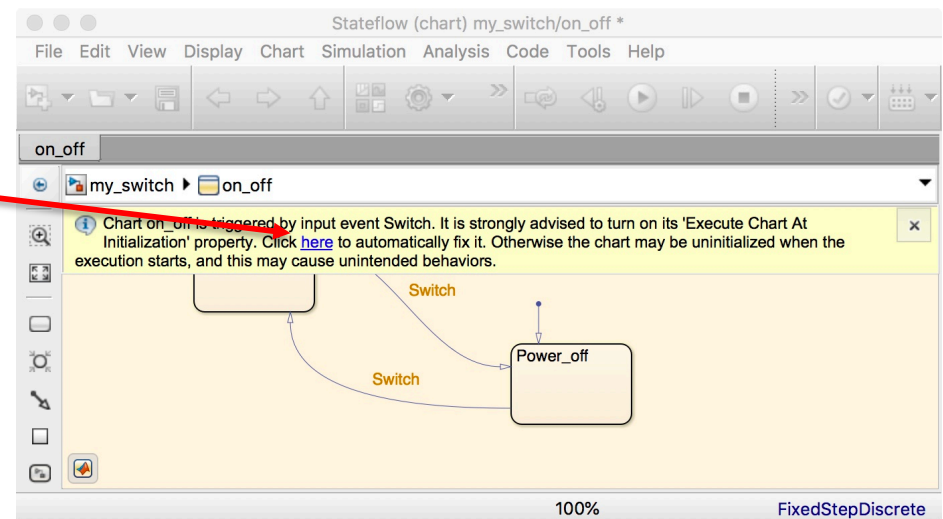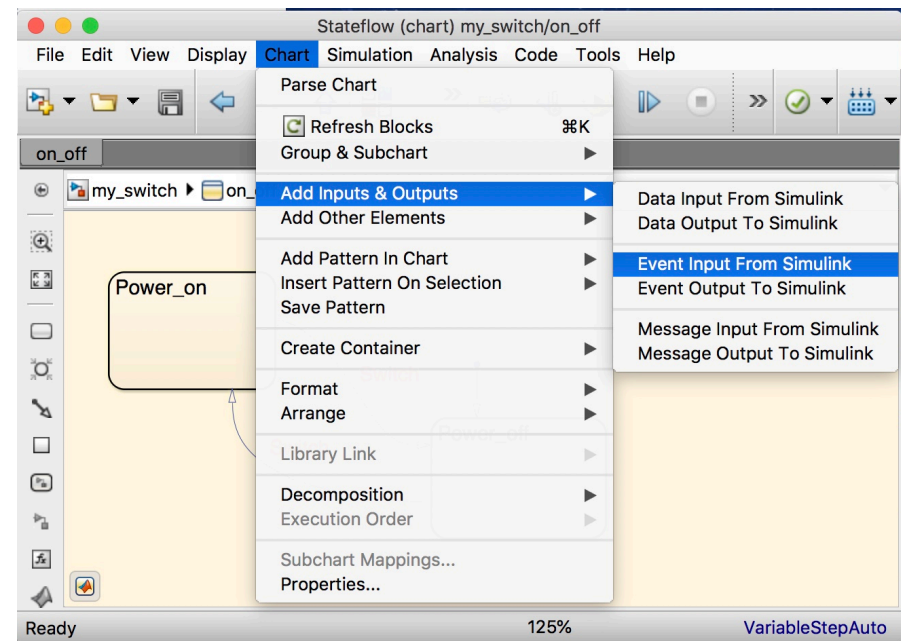
Open the Model Explorer

- Navigate to the Model Explorer by selecting from the "View" menu

- The Model Explorer lets you edit the event you have just defined and add new events

- The Model Explorer is shown on the next page
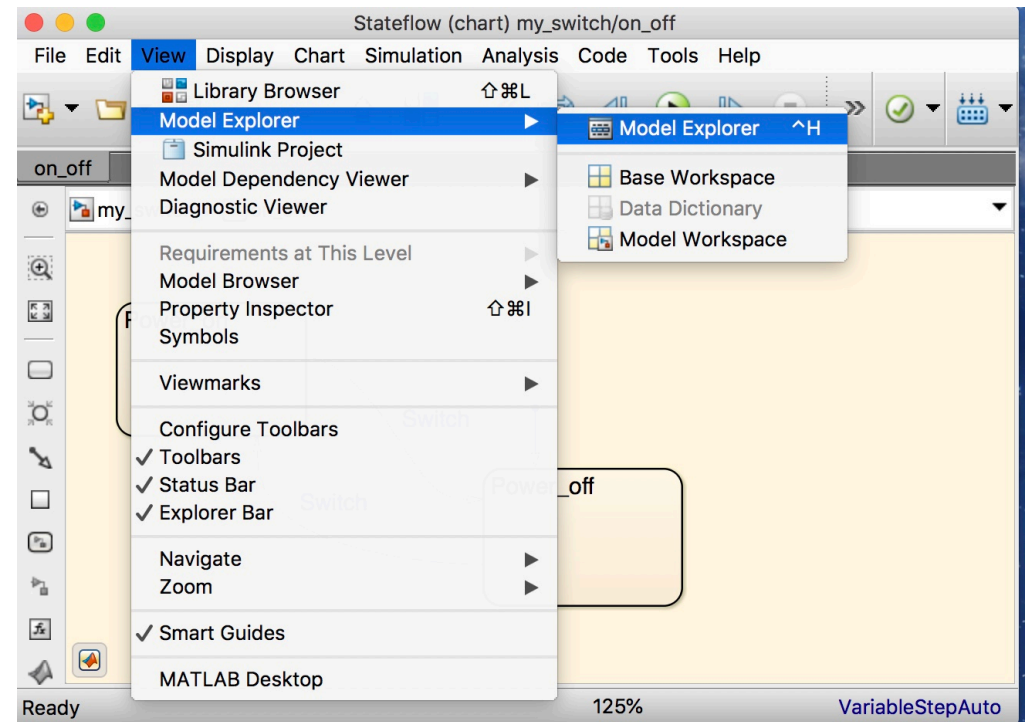
The Model Explorer

- Note the event is named Switch, it is triggered on Rising edges, and the Execute Chart at Initialization box is checked.
- If there were multiple events, they would each have a different Port number

Adding the Sine Input

- Return to the top-level Simulink Diagram

- The statechart "on_off" now has an input port. If you examine it closely, you will see that the port represents the rising edge of a signal (because we specified our trigger to be "rising edge")

- Add a sine wave input and a scope from the "sources" and "sinks" blocks in the Library Browser

- Connect them as shown. You may use the default sine wave parameters
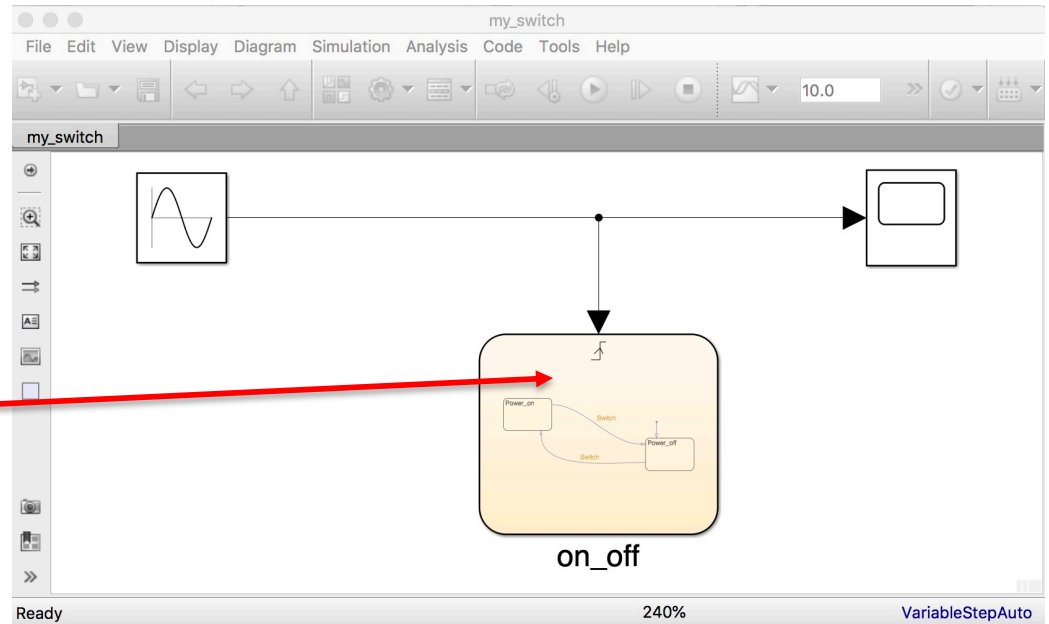
Configuration Parameters

- From the "Simulation" menu select "Model Configuration Parameters"
- Expand the window by clicking "Solver Details"
- Specify Stop Time = 100 and choose "Fixed Step" solver "discrete (no continuous states). Specify a sample time of 0.001
- Be sure to hit "Apply" before closing the window
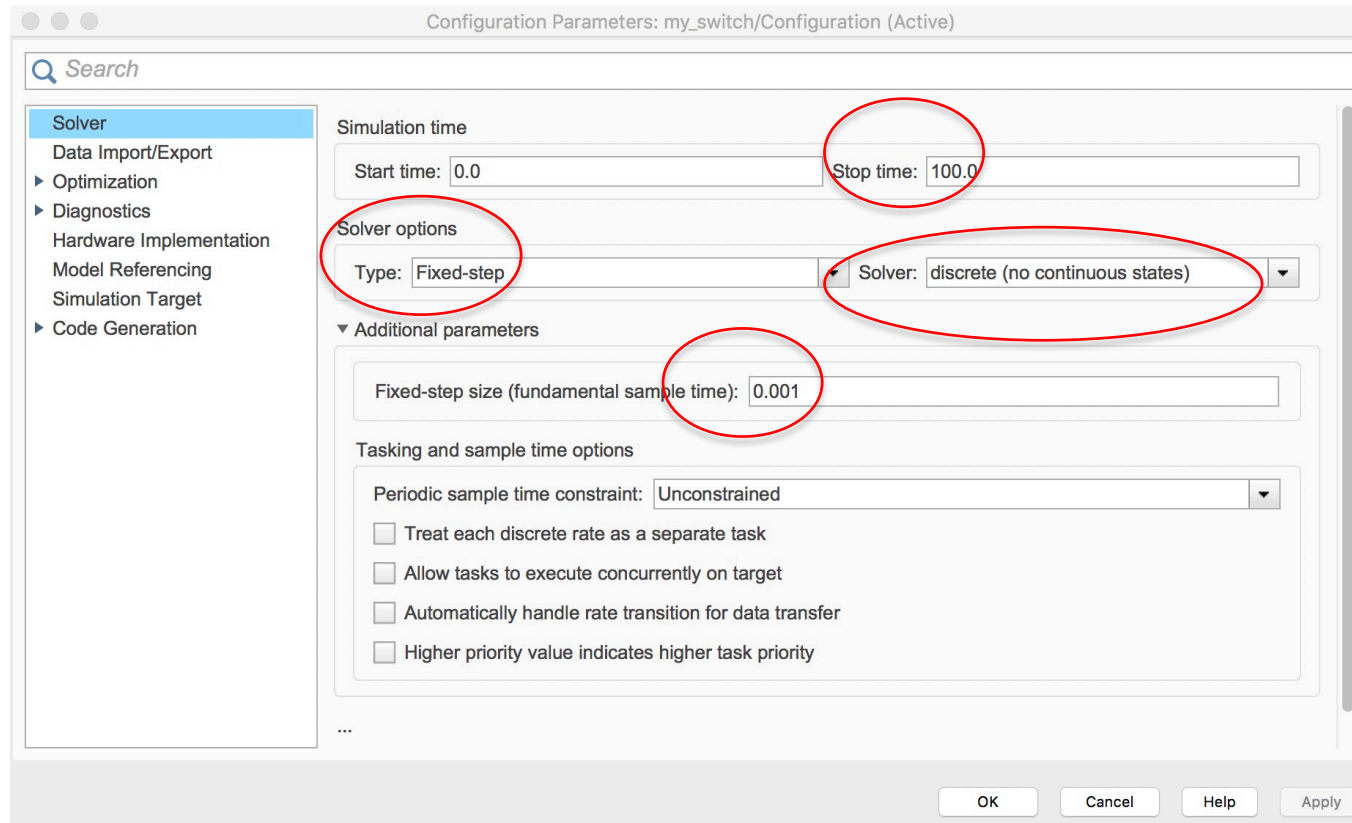
Running the Simulation

- When you run the simulation, you should see the Power_on and Power_off states change color at each rising zero crossing of the sine wave.

Add Data to Count Transitions

- If we want to count the number of transitions from Power_on to Power_off, we need to add an output and an action to our statechart
- Go back to the "Add Inputs and Outputs" menu, but this time select "Data Output to Simulink" to add data ''counter'' with Scope "Output".
- Specify counter as type double, and with initial value zero
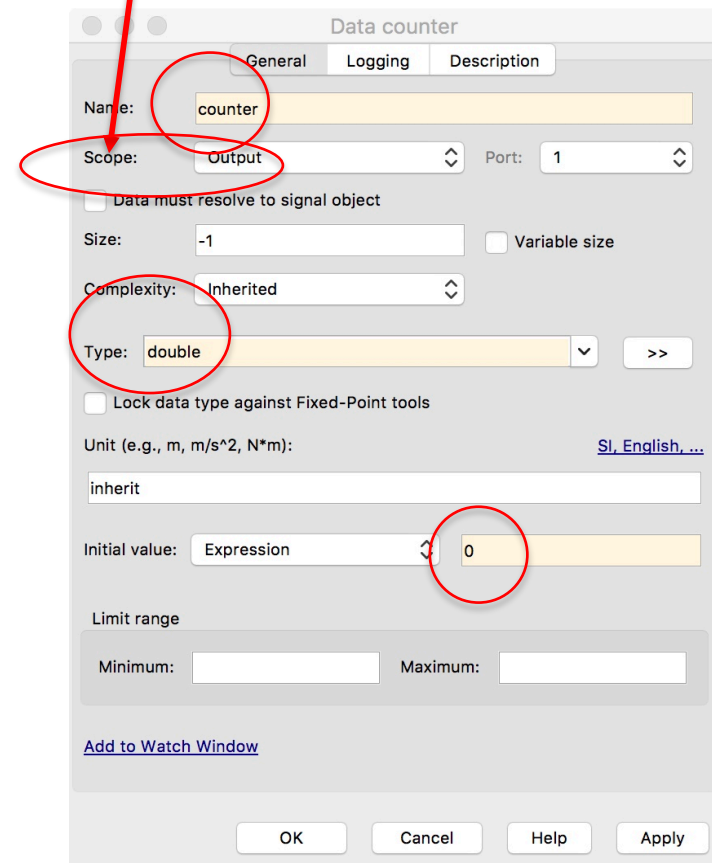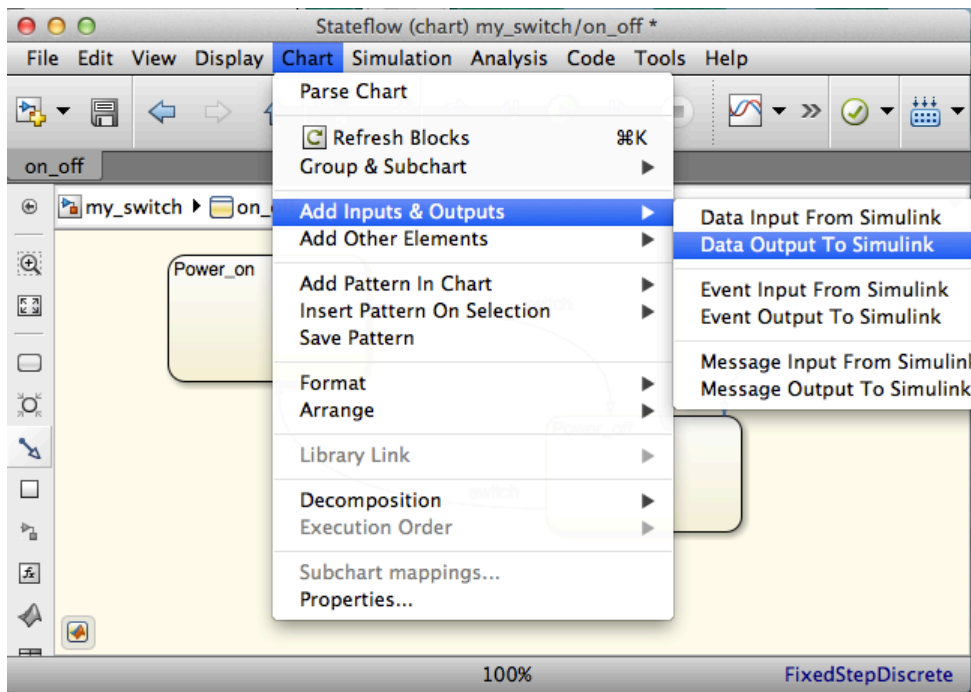
Increment the Counter

- Increment the counter every time the event "Switch" occurs by placing the action "counter = counter + 1" in {curly braces} following each occurrence of "Switch."

- End the action with a semicolon inside the closing brace to prevent the value of the counter from being printed to the screen each time it is incremented
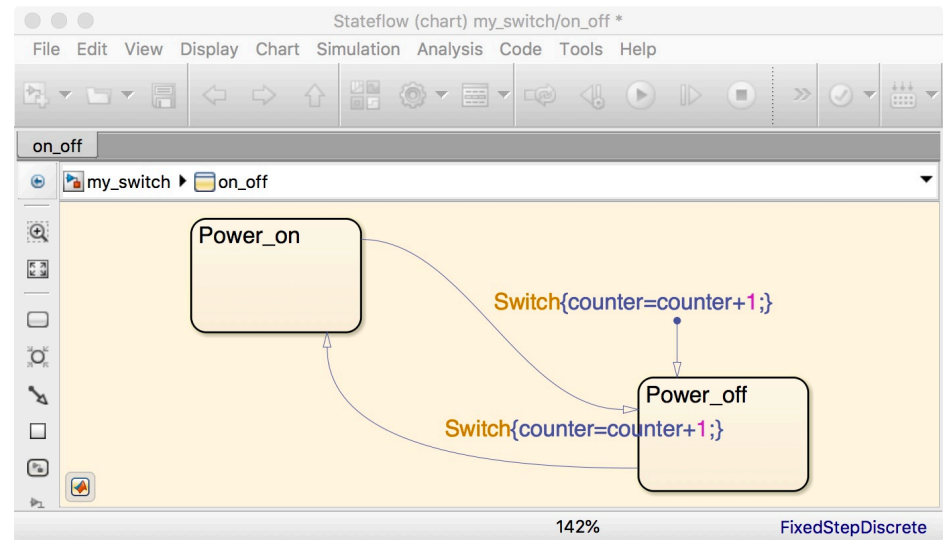
Counting the Transitions

- Add a display block from the Library Browser/Sinks menu and connect it to the data output port "counter"
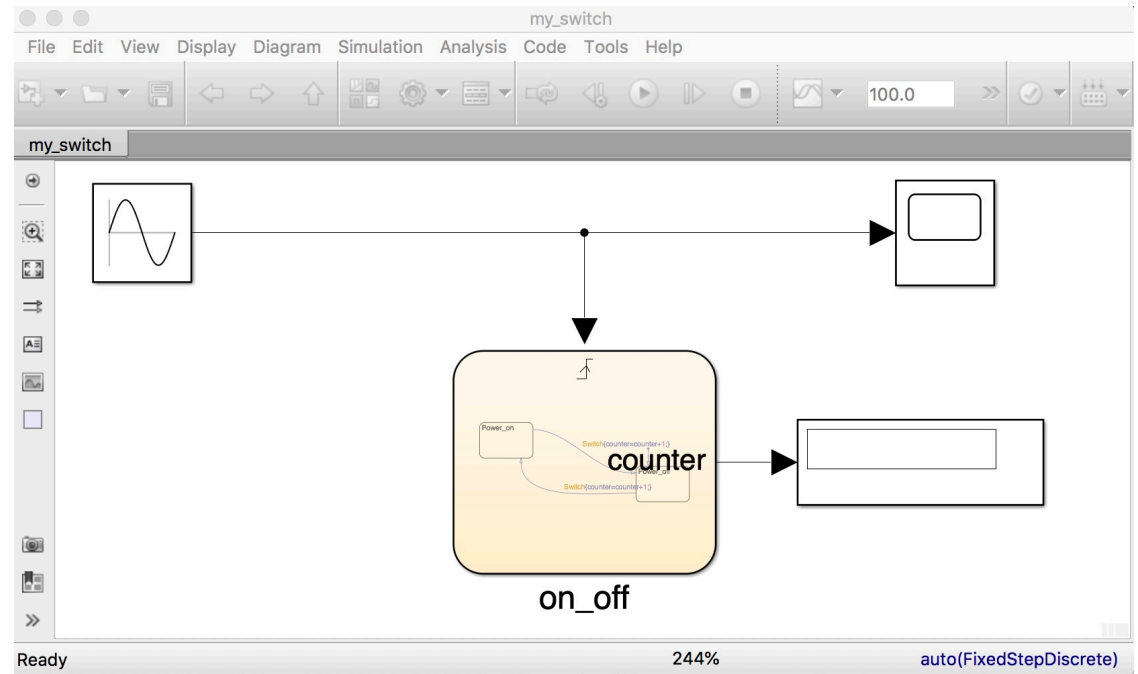
Toggle a Bit

- Add a new data output "light" with
  - Initial value = 0
  - Data Type = double
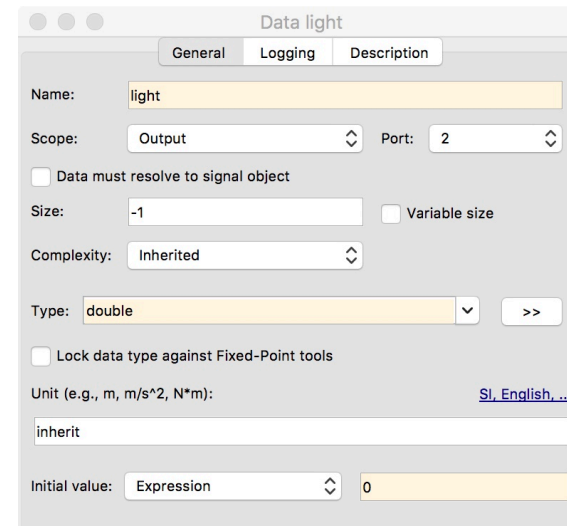
- Set light = 0 in the Power_off state
- Set light = 1 in the Power_on state
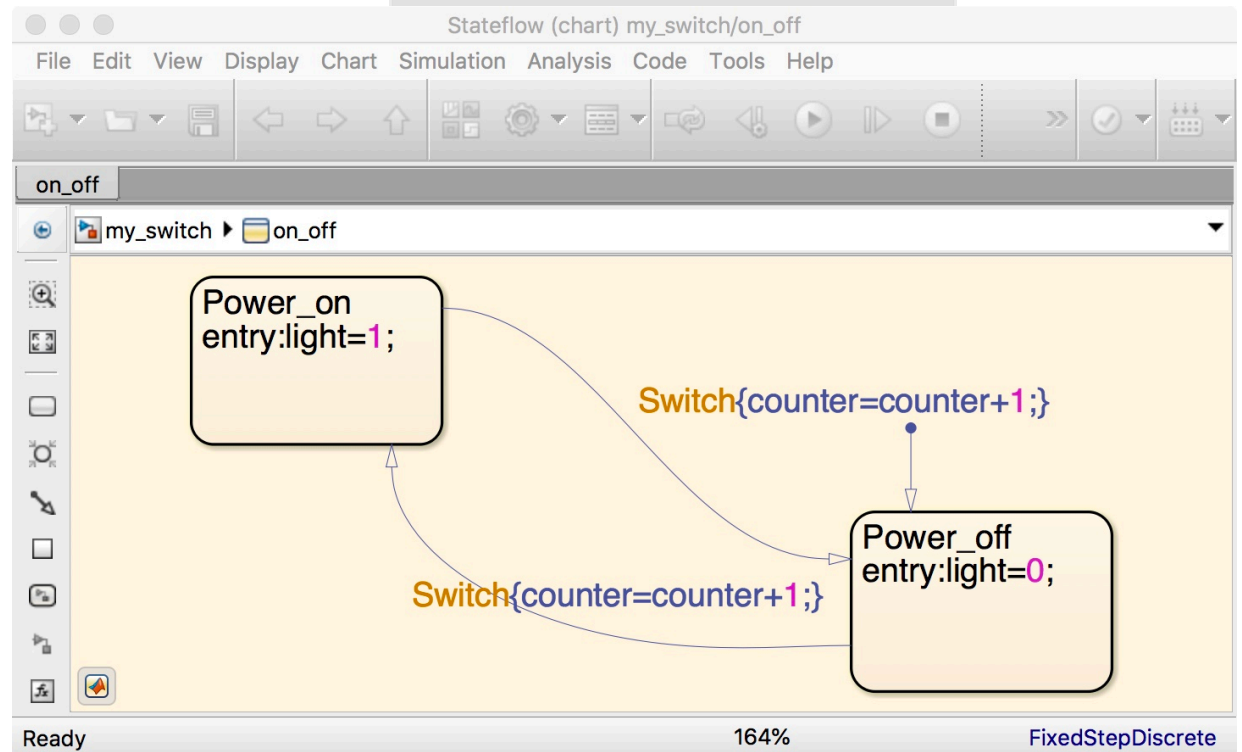
Avoid Crossing Lines

- The output "light" is assigned Port 2 by default, and you could connect it to the scope as illustrated

- It's much better practice to keep your model readable by not crossing lines

- Change ports in the Model Explorer
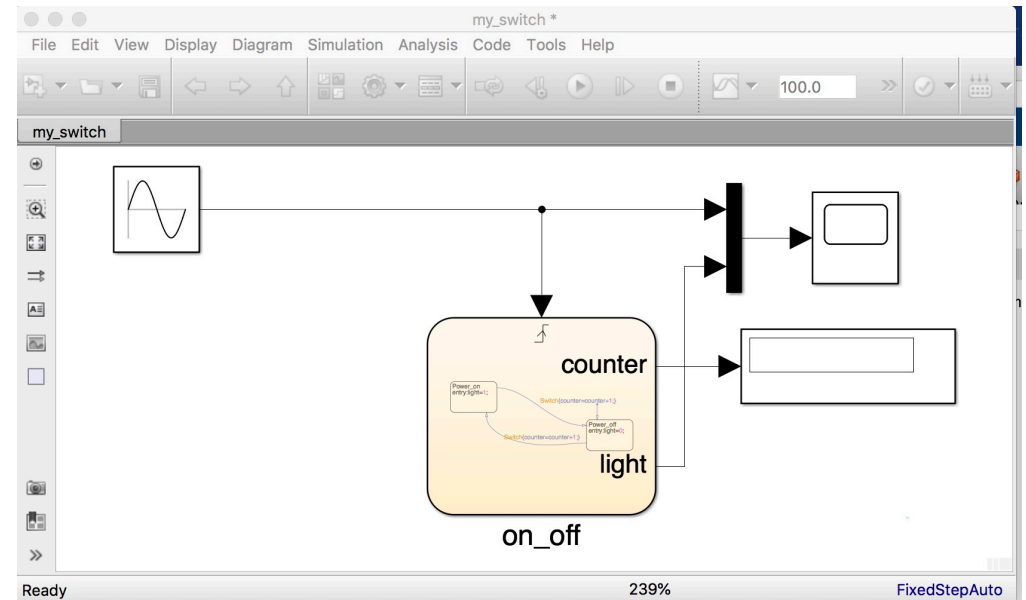
Change Port Values

Port selection

Non-crossing Lines

- Now the model has no crossing lines and is easier to read.
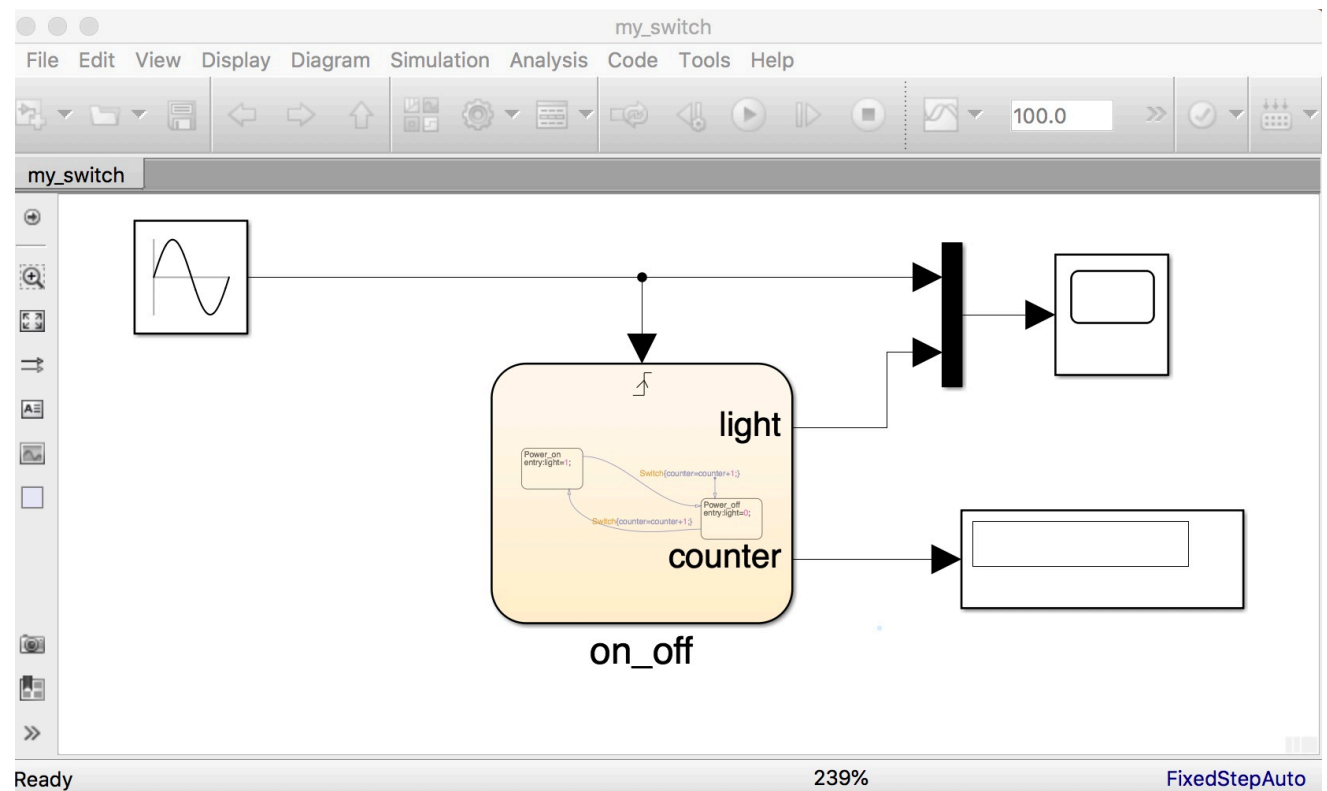
Modeling Preferences

- Alternatively, you can make your model clearer by going to the File menu on the Simulink toolbar, select Simulink Preferences, then select Editor Preferences and choose "Line Hop". Your lines will do something like that shown on the right.

- You can also use this menu to change your font selection and a number of other things.
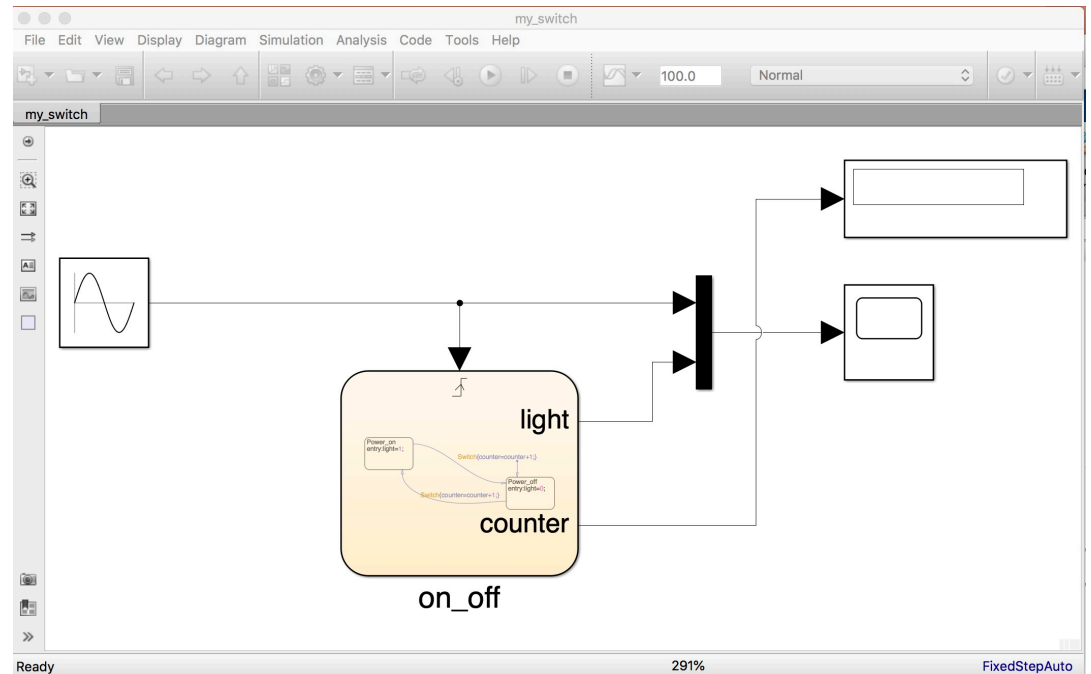
Display a Square Wave
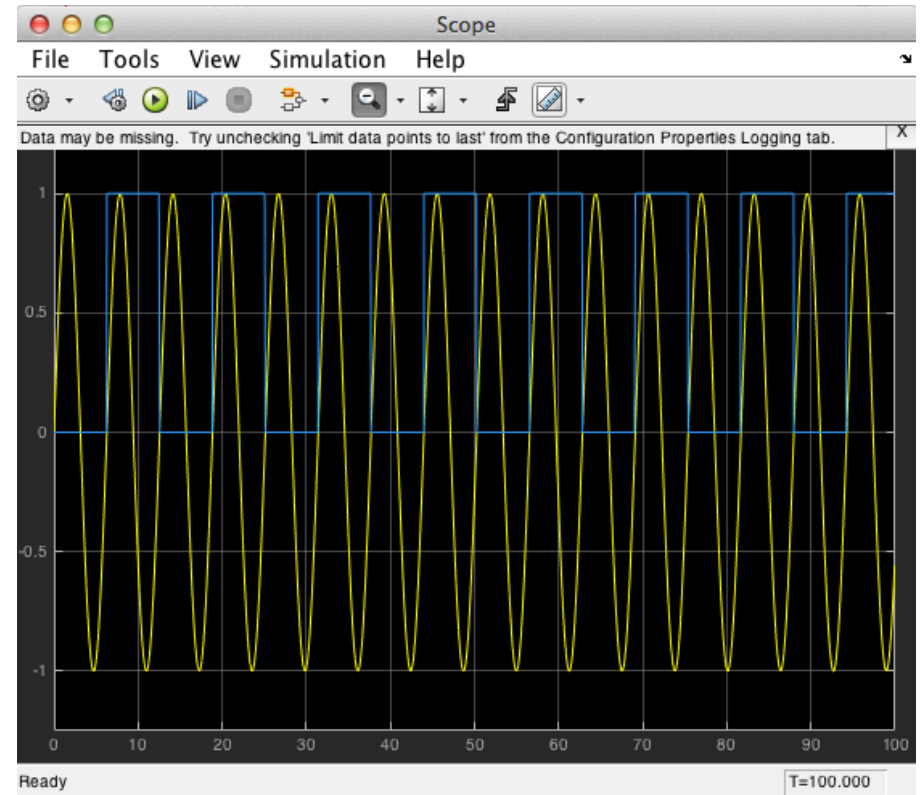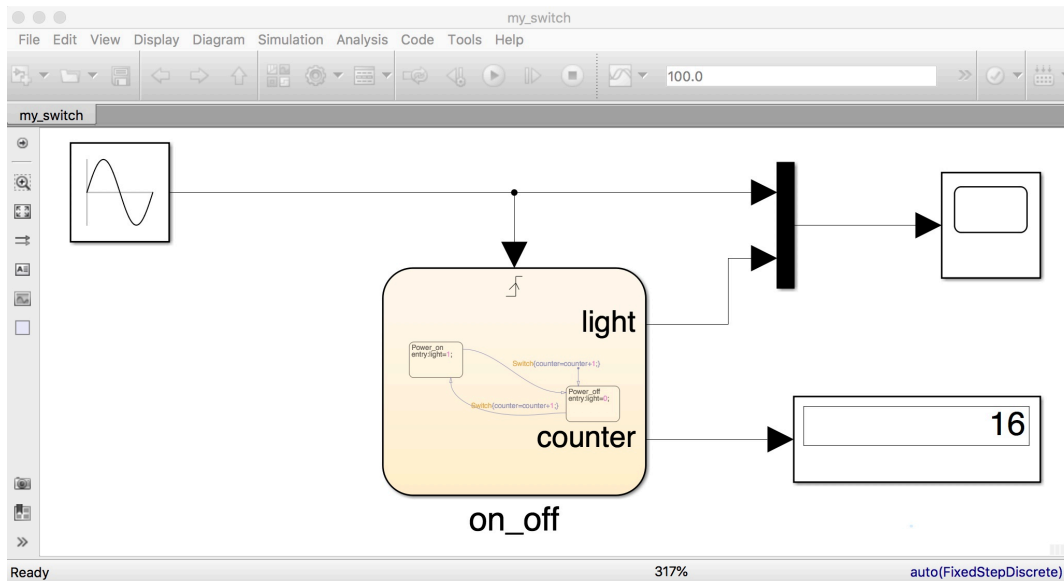
Running the simulation shows a square wave that toggles between 0 and 1 at rising zero crossings of the sine wave

Adding Data using Model Explorer

- Suppose we want to use data defined in the Matlab workspace
- We can add data to the model using Add menu in the Model Explorer

Use a Parameter Defined in Workspace

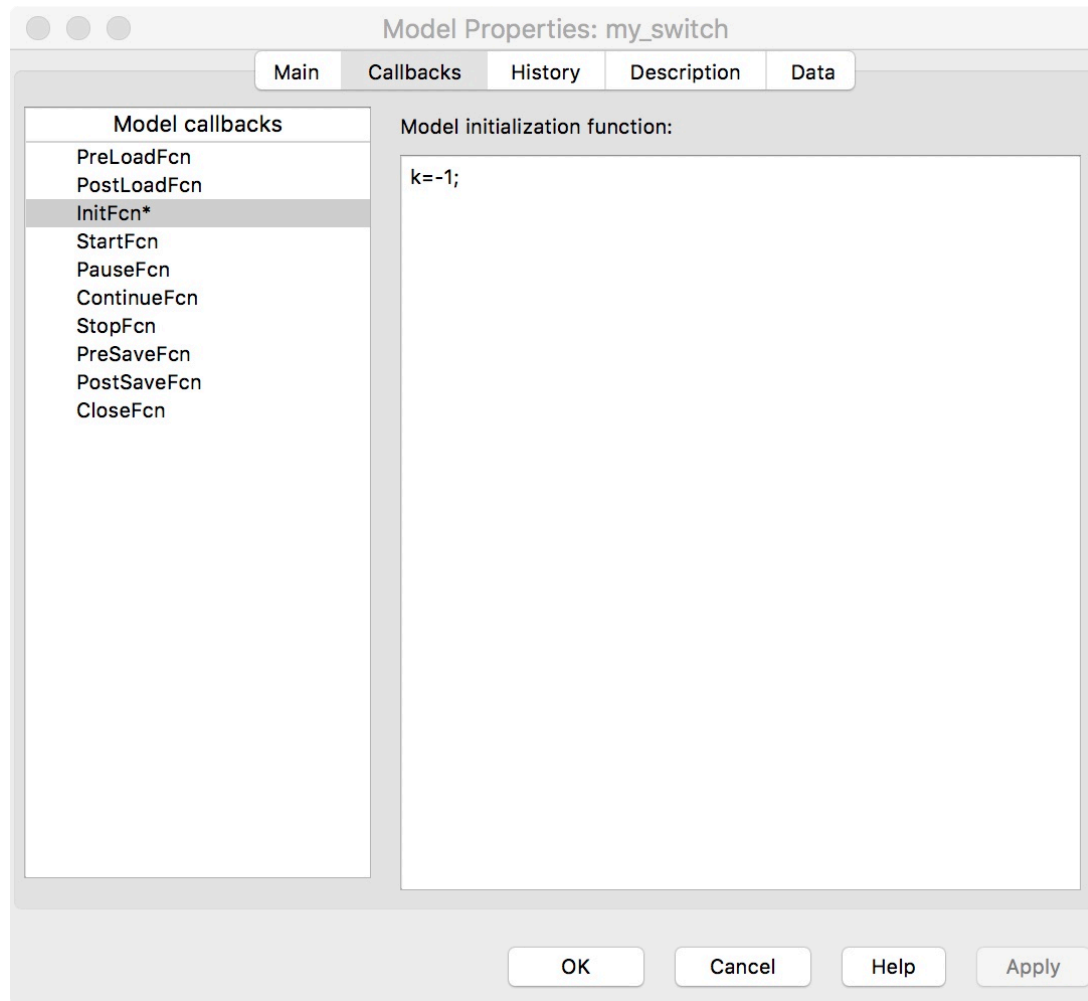- Add data with Name "k", Scope "parameter", and Type "double"

Model Properties

Navigate to the Menu "File/Model Properties/Model Properties"
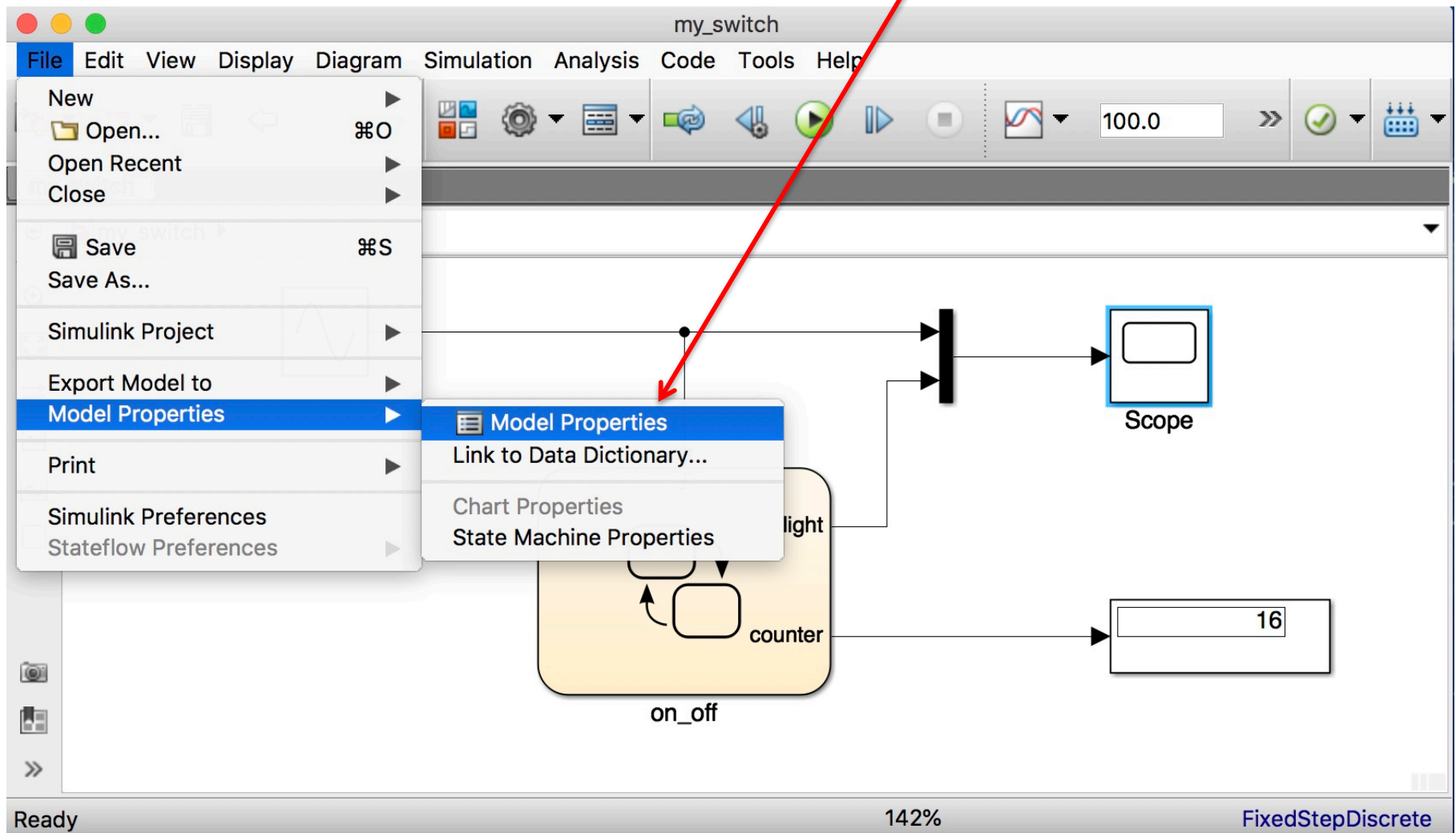
Model Callbacks

- Navigate to "Model Properties/Callbacks/InitFcn"
- Define the value of the parameter k.

Using the Parameter

Set light equal to k and run the simulation to see an inverted square wave