Introduction to Mobile Robotics with MATLAB and Simulink
Unit 3: Intro to Simulink

By MathWorks Student Competition team

What is Simulink?

- Graphical modeling environment
- Used for both simulations and software deployment by engineers and scientists
- Benefits:
    - Test code before programming hardware
    - Easy to understand models and logic
    - Automatically generate code
    - Extensive libraries for controls/robotics
   - Facilitates collaboration and design sharing

Why Simulink?

Engineers and Scientists Worldwide Rely on Simulink

Huawei

"When we do 5G prototyping design and development, we build the whole air access link-level simulation using MATLAB and Simulink, and import the parameters of this model – from the antenna to the new waveform – from the field testing... We can see the whole system's performance, and identify potential issues."

— Kevin Law, Director of Algorithm Architecture and Design
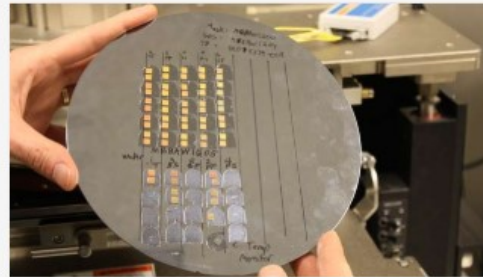
Fujitsu Laboratories of America

"By including circuit-level simulation results in our Simulink models we can simulate millions of cycles with the accuracy needed to account for noise and other transient effects. Simulink is the only tool fast enough for our jitter-tolerance simulations."

— William Walker, Vice President

Rensselaer Polytechnic Institute

"A primary benefit of using MATLAB and Simulink in our research is the availability of toolboxes for computer vision, image processing, and control system development. All the tools we need are in one environment that is easily integrated with other software for robotics and automation systems."

— Dr. John Wen, head of the Industrial and Systems Engineering department
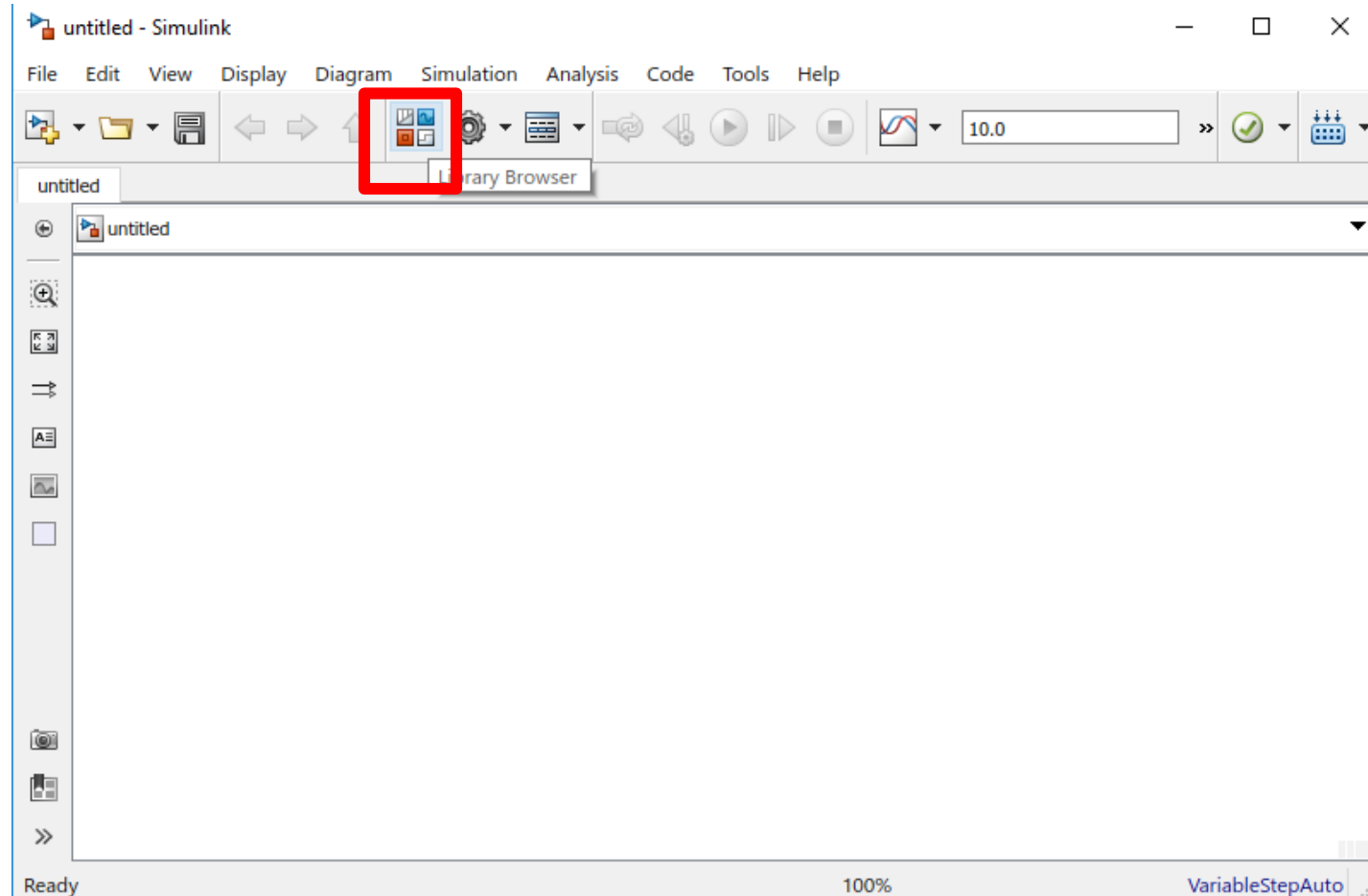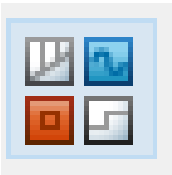
Opening Simulink

- Use the Simulink button on the MATLAB toolbar

- Create a new blank (empty) model by selecting "**Simulink Model**" under the "**New**" button on the MATLAB toolbar
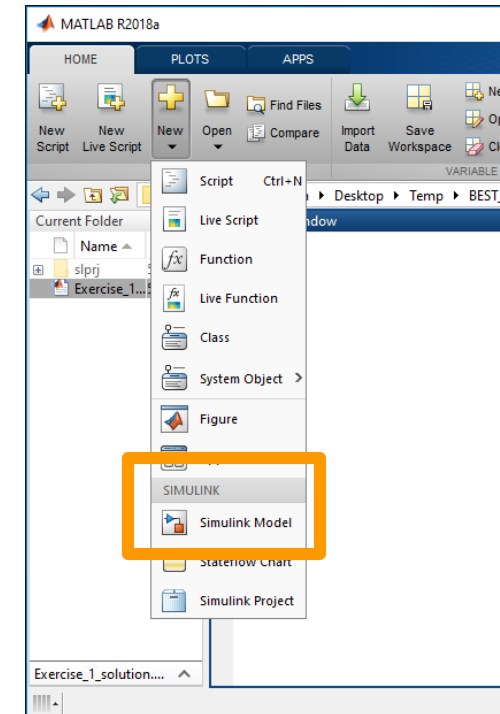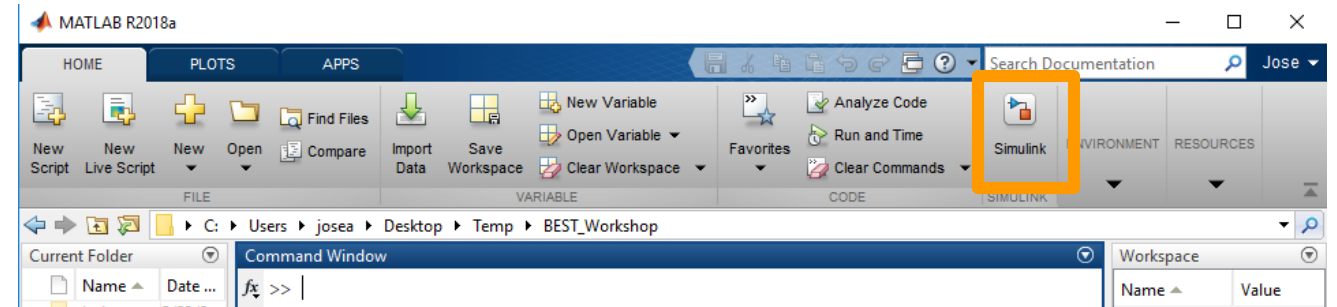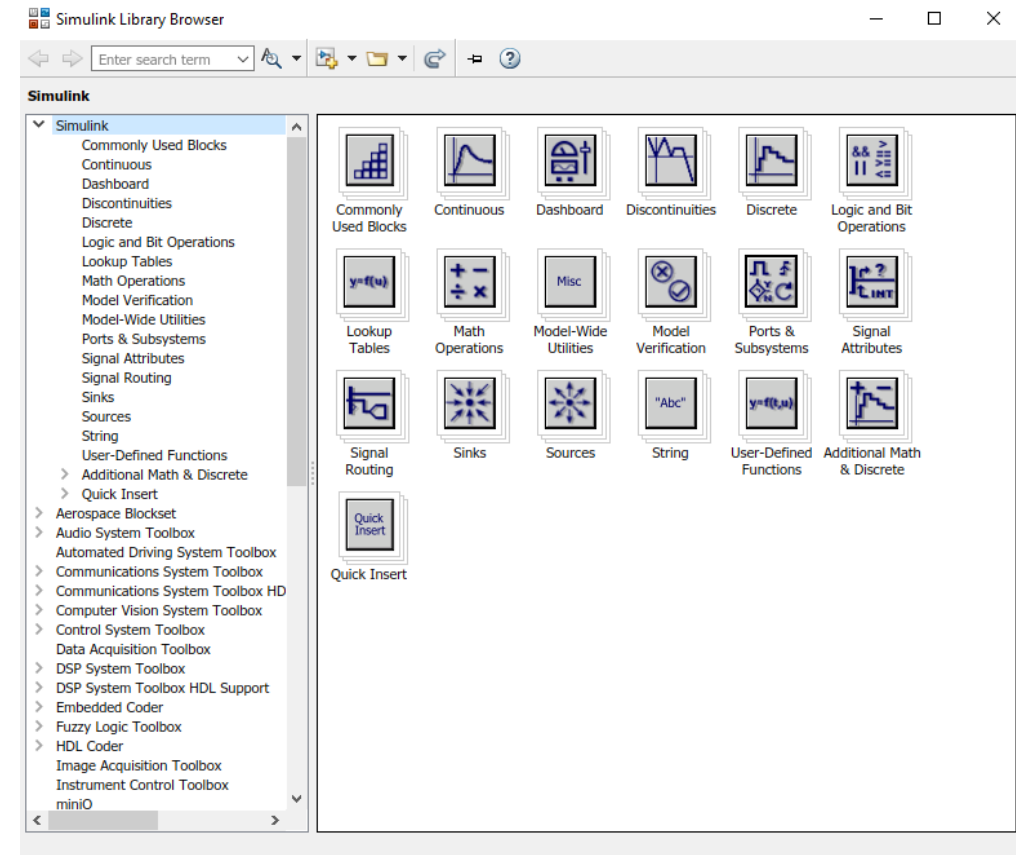
Opening Simulink Libraries

- To open the libraries of blocks, press the library browser button (Next to the gear icon)

Browsing Simulink Libraries

- You can browse all the blocks available to create models from this window

- Click and drag blocks to position them on the blank Simulink canvas

Creating a Simulink Model

- To connect two blocks with a signal line simply click on the arrow in the block and drag it to the input port on the block you wish to connect it to
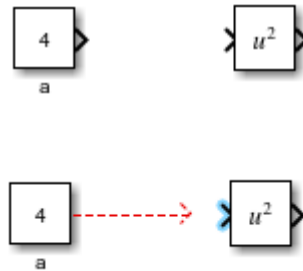
Creating a Simulink Model

1. Open the "**Hypotenuse_start.slx**" Simulink file

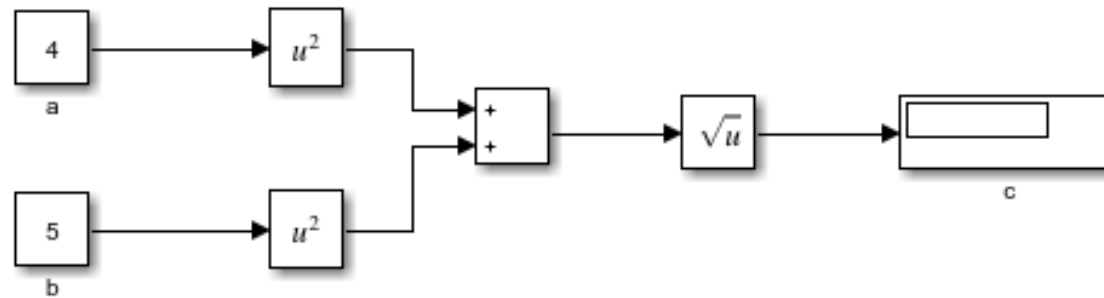2. Implement the calculation of the hypotenuse of a right triangle in Simulink
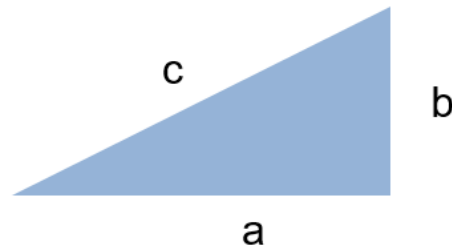
$$a^2 + b^2 = c^2$$

$$\downarrow$$

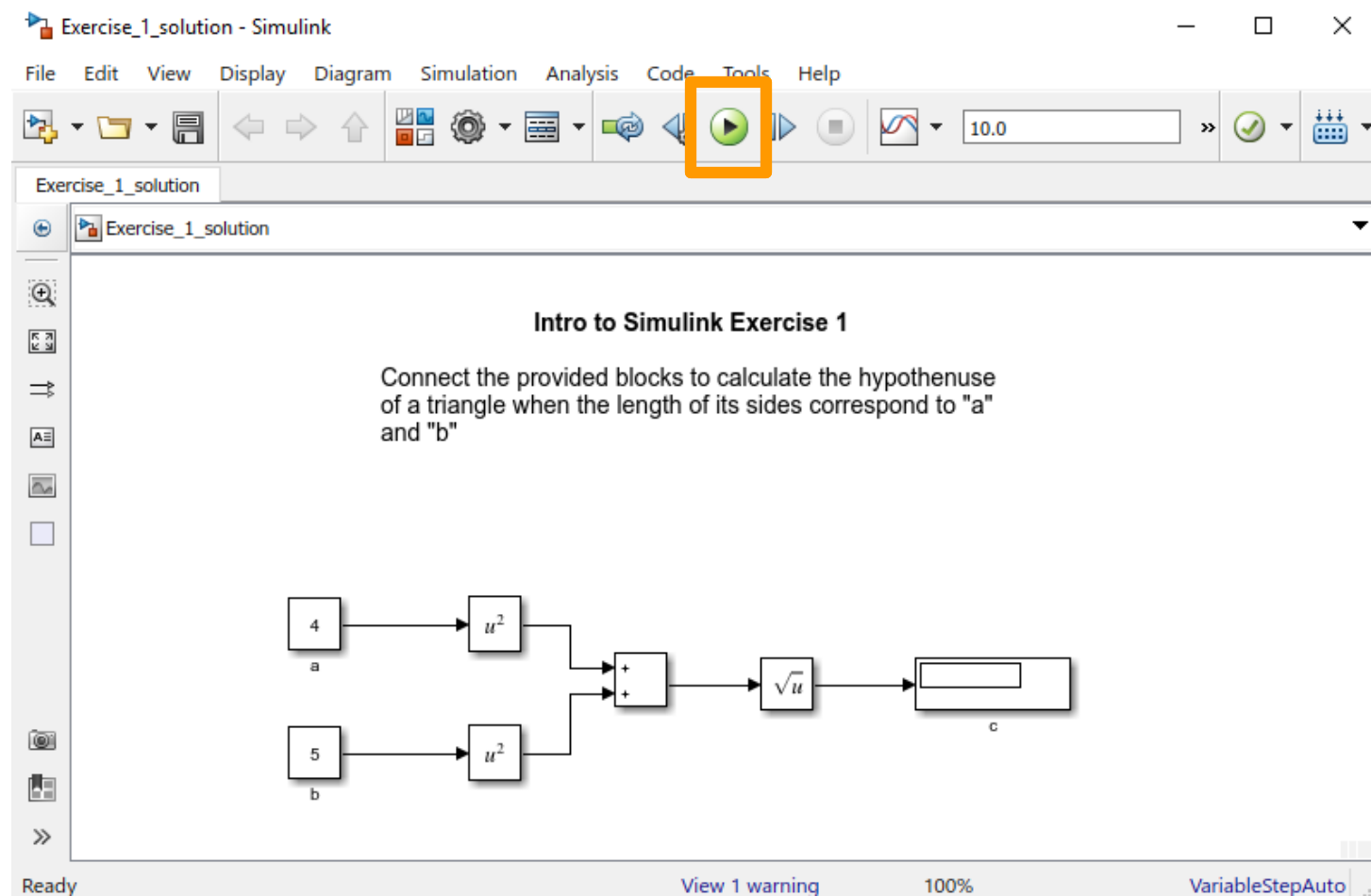$$c = \sqrt{a^2 + b^2}$$

Creating a Simulink Model

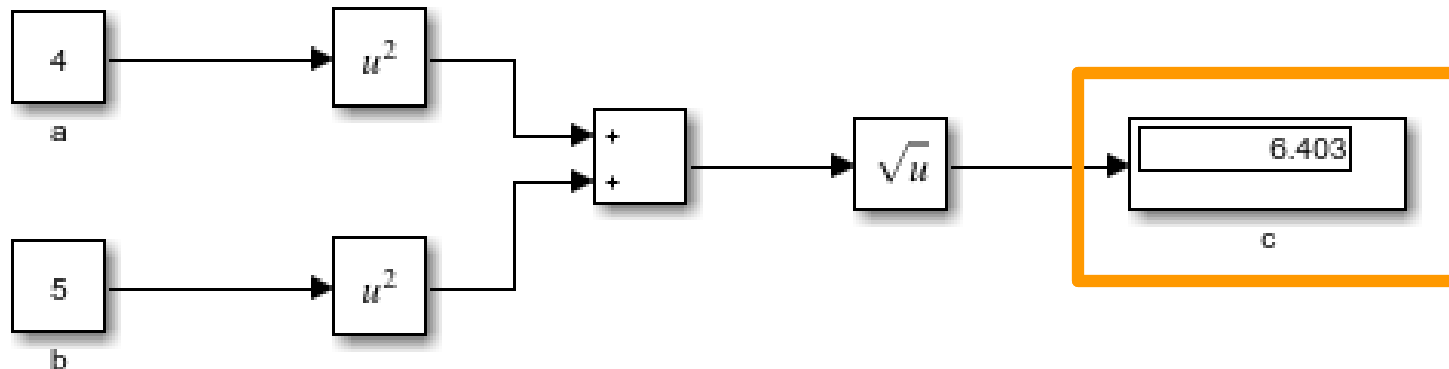- The model should look like as follows:

Running a Simulink Model

- Click the green **Play** button on the toolbar

Running a Simulink Model

- Now the display showing the "c" value should have a numeric answer calculated when the model was run.
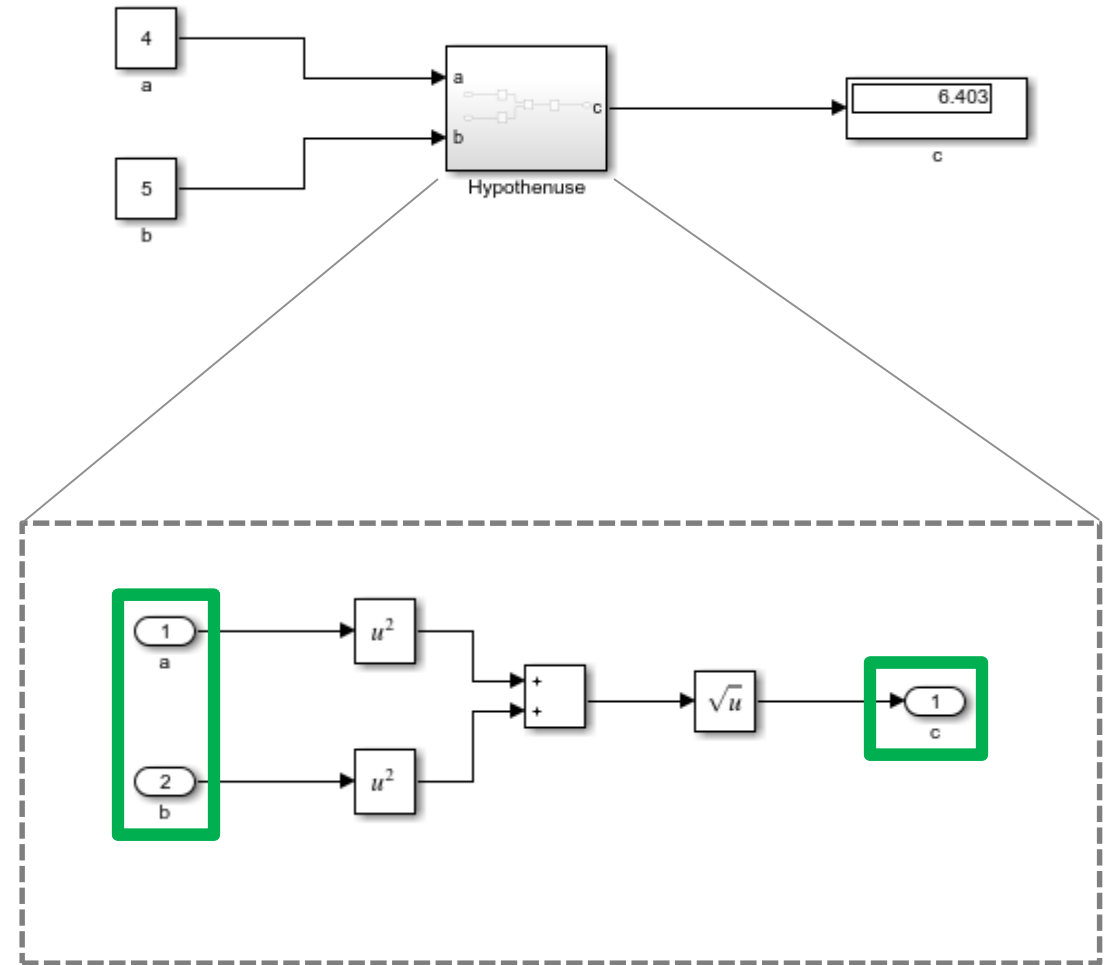
Creating Subsystems

- Subsystems help scale large Simulink models.

- Grouping Simulink blocks in Subsystems make models easier to understand.

1. Select a group of blocks
2. Right click on them
3. Click **"Create Subsystem from Selection"**
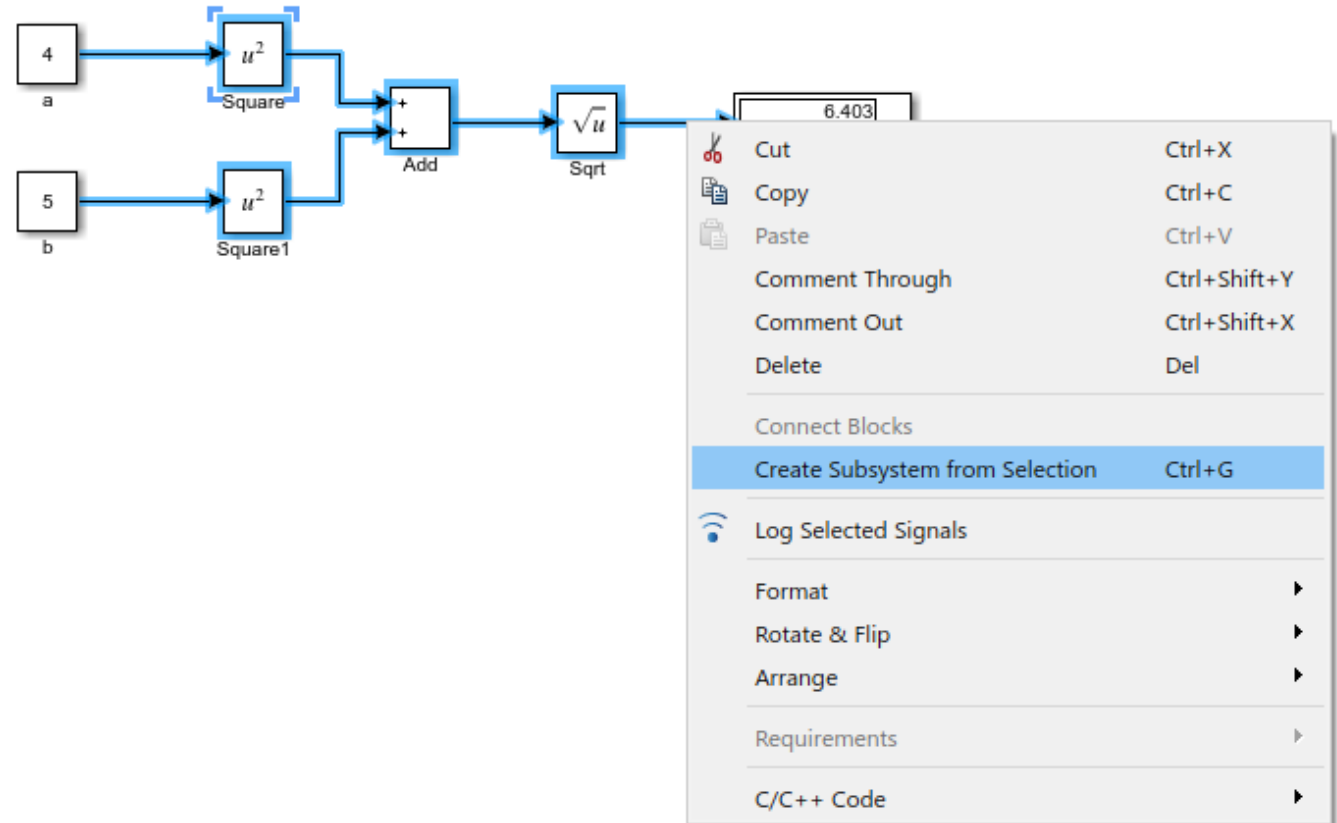
Creating Subsystems

1. Rename the subsystem to **"Hypothenuse"**

2. Double click the subsystem to see its contents.

3. Rename the "**Input ports and output ports**" that provide the connection to the rest of your diagram.

Navigating Subsystems

1. Click the UP arrow in the toolbar to go back to the top-level Simuink models

2. Use the title bar to navigate between subsystems
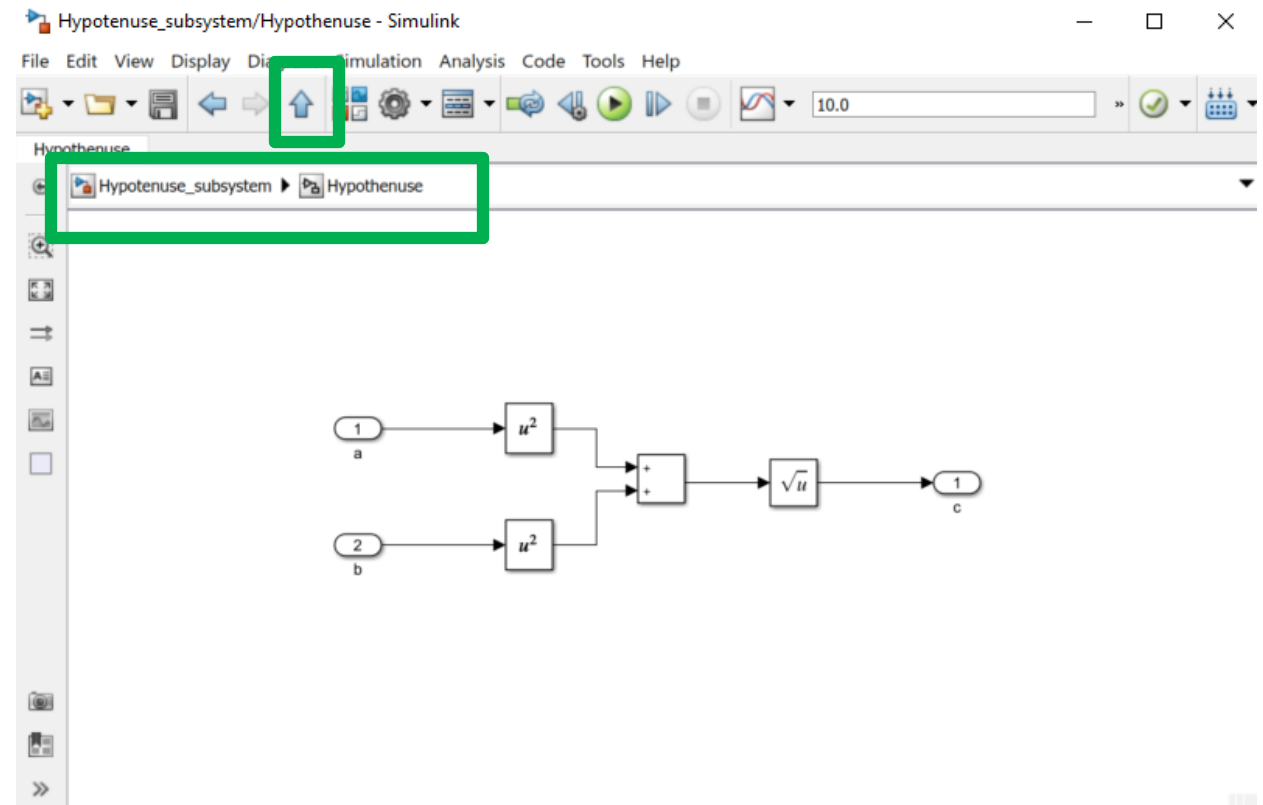
Simplifying models

- Take advantage of Simulink libraries to simplify your models and speed up your programming

1. Find a hypothenuse block by clicking on any blank space on the window and type "hypo"

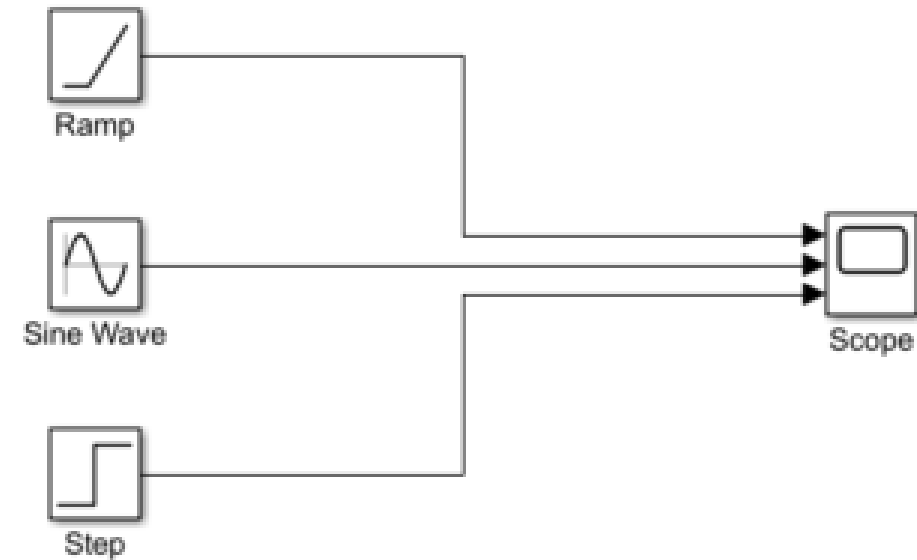2. Run the model to verify the result
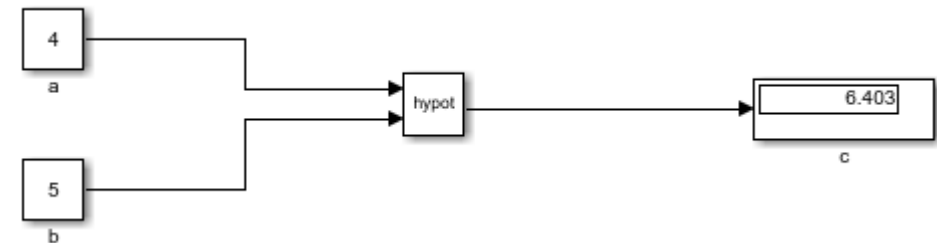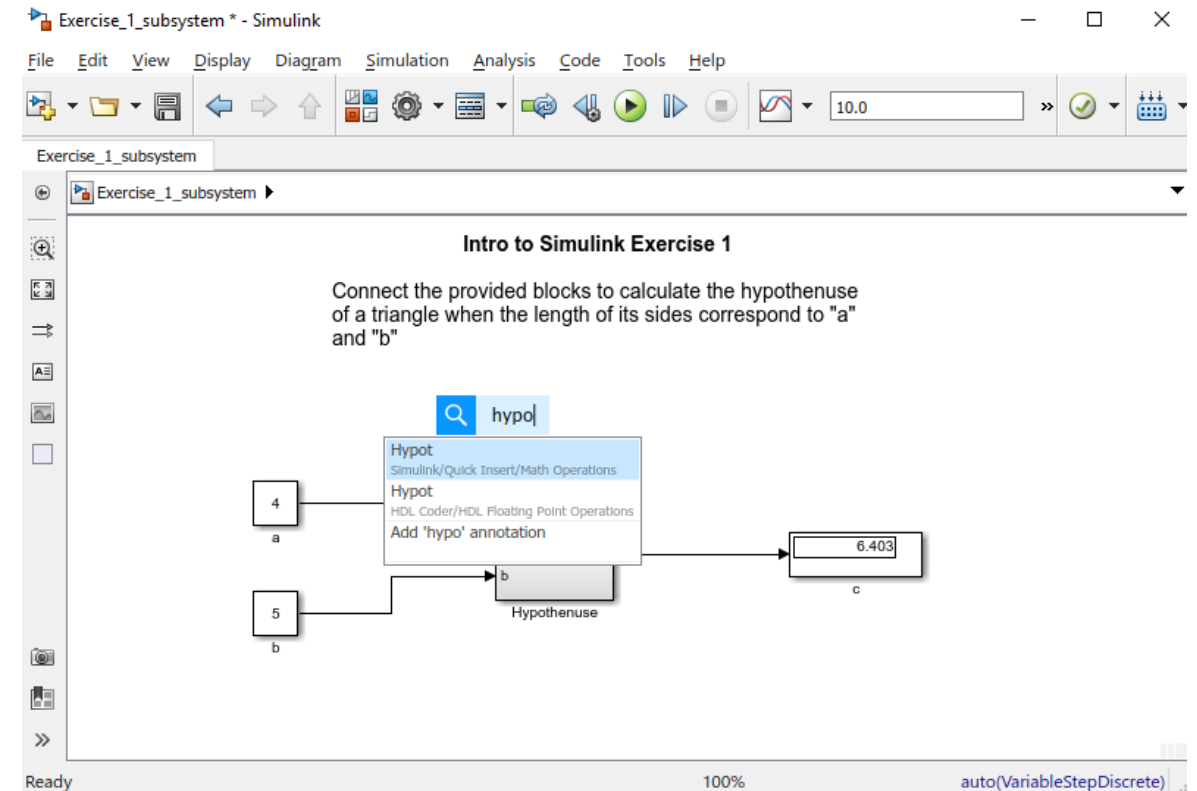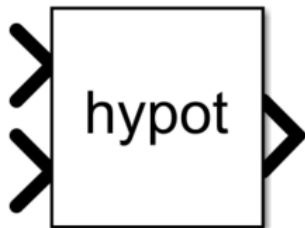
Taking Time into Account

- Simulations perform calculations over a period of time

- This is why Simulink has a play button and a **"Stop Time"**
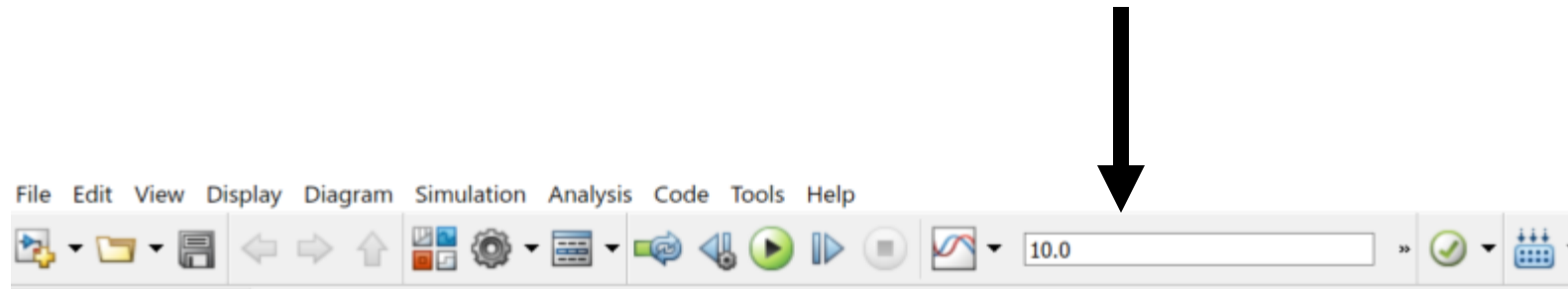
Taking Time into Account

1. Open **"timeBasedSources.slx"**
2. Run the model
3. Double-click on the "Scope" block
4. Change parameters and stop time
5. Re-run model

End of Unit 2: Basic Robot Movements

- Congrats !

- Here are some learning outcomes from this unit
  - How to browse Simulink libraries
  - How to connect Simulink blocks
  - How to run Simulink models
  - How to create Simulink Subsystems

- For a video tutorial, check out our [Simulink Quick Start Video](https://www.mathworks.com/videos/simulink-quick-start-78774.html)
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