The National School of Artificial Intelligence
Computer Architecture
Computer Components

Lab 01: Introduction To Logisim Evolution

Objectives: Introduction To Logisim Evolution

In this lab, you will:
Install Logisim Evolution and read the Lab sheet (30 min);
Follow the example with your teacher (20 min);
Complete the assignment and submit it (40 min).

Installation

Logisim-evolution is an educational tool for designing and simulating digital logic circuits. With its simple toolbar interface and simulation of circuits as they are built, it is simple enough to facilitate learning the most basic concepts related to logic circuits. With the capacity to build larger circuits from smaller subcircuits, and to draw bundles of wires with a single mouse drag, Logisim can be used (and is used) to design and simulate entire CPUs for educational purposes.

Logisim-Evolution is a Java application, so a Java runtime environment must be installed before using the application. Students may already have a Java runtime on their computer, thus they can skip this step, but those who do not will need to install the Java runtime. That process is not covered in this manual but information about installing the Java runtime environment is available at here. It can be confusing to know which version of Java to download but students working on these labs only need the runtime, called *JRE* on the website.

Logisim-Evolution is available as a free download here. Visit the website and download one of the 3.9.0 releases that correspond to your operating system. for instance, a .rpm for Linux or .msi for Windows. The package *logisim-evolution-3.9.0-all.jar* should work for all the operating systems. If this version does not work on your system, try the proper version for your system. It is also OK to download an older release.

Since the Logisim-Evolution file is a Java application, it does not need to be installed like most software. To start Logisim-Evolution, double-click on it. It is good practice to put Logisim-Evolution in a specific folder and create a shortcut on your desktop. That will start Java and then run the Logisim-Evolution application. Also, Logisim-Evolution will not need to be uninstalled when it is no longer needed since it is not actually installed, the Logisim-Evolution file can simply be deleted.

Logisim evolution Workspace

Start Logisim-Evolution by double-clicking its icon. The initial Logisim-Evolution window will be similar to Figure 1.13.

The Logisim-Evolution space is divided into several areas. Along the top is a text menu that includes the types of selections found in most programs. For example, the “File” menu includes items like “Save” and “Exit.” The “Edit” menu includes an “Undo” option that is useful. In later labs, the various options under “Project” and “Simulate” will be described and used. Items in the “FPGAMenu” are beyond the scope of this class and will not be used. Of particular importance at this point is “Library Reference” in the “Help” menu. It contains information about every logical device available in Logisim-Evolution and is very useful while using those components in new circuits.

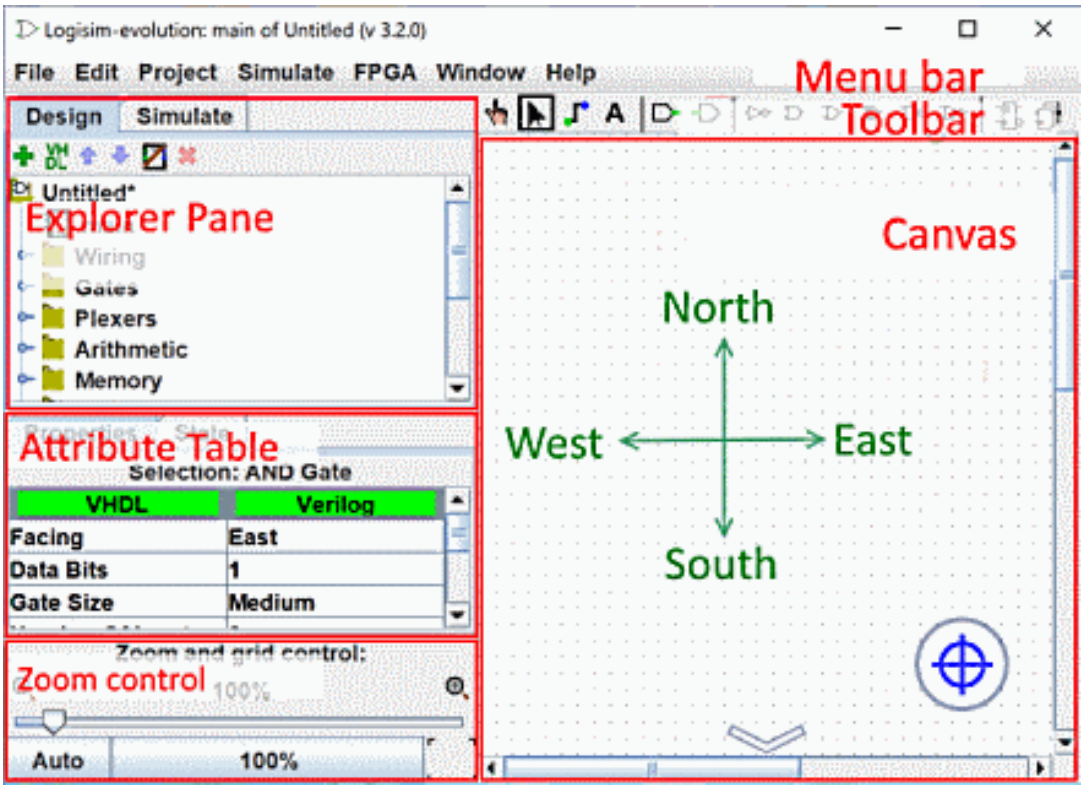

Figure 1.13: Logisim-evolution Initial Screen

Under the menu bar is the Toolbar, which is a row of buttons that are the most commonly used tools in Logisim-Evolution:

- **Pointing Finger**: Used to “poke” and change input values while the simulator is running.
- **Arrow**: Used to select components or wires in order to modify, move, or delete them.
- **A**: Activates the Text tool so text information can be added to the circuit.
- **Input Port**: Creates an input port for a circuit.
- **Output Port**: Creates an output port for a circuit.
- **NOT Gate**: Creates a NOT gate.
- **AND Gate**: Creates an AND gate.
- **OR Gate**: Creates an OR gate. . . etc.

The Explorer Pane is on the left side of the workspace and contains a folder list. The folders contain “libraries” of components organized in a logical manner. For example, the “Gates” folder contains various gates (AND, OR, XOR, etc.) that can be used in a circuit. The icons across the top of the Explorer Pane are used for advanced operations and will be covered as they are needed.

The Properties panel on the lower left side of the screen is where the properties for any selected component can be read and set. For example, the number of inputs for an AND gate can be set to a

specific number.

The drawing canvas is the largest part of the screen. It is where circuits are constructed and simulated. Its background is provided with aligned points to help you draw straight lines and align components.

The zoom factor is controlled at the bottom left. You can change it by dragging the cursor, using one of the two buttons to the left and right of the rate, or using the Ctrl-mouse wheel in the work area.

Beginner's Tutorial

Logisim-Evolution comes with a beginner's tutorial available in HELP -> TUTORIAL. That tutorial only takes a few minutes and introduces students to the major components of the application. Students who have difficulties with Logisim-Evolution should take a look at this tutorial.

The HELP menu contains also a LIBRARY REFERENCE item where you find all the details about any component. You enter the name of the component you are looking for (or any keyword) It will display all the details about it (Figure 1.14). For instance, the library tells you in which folder you can find this component. The behavior tells what this component does. Pins show you all the connections (in and out) to this component. Attributes are all the customization you can apply on this component.

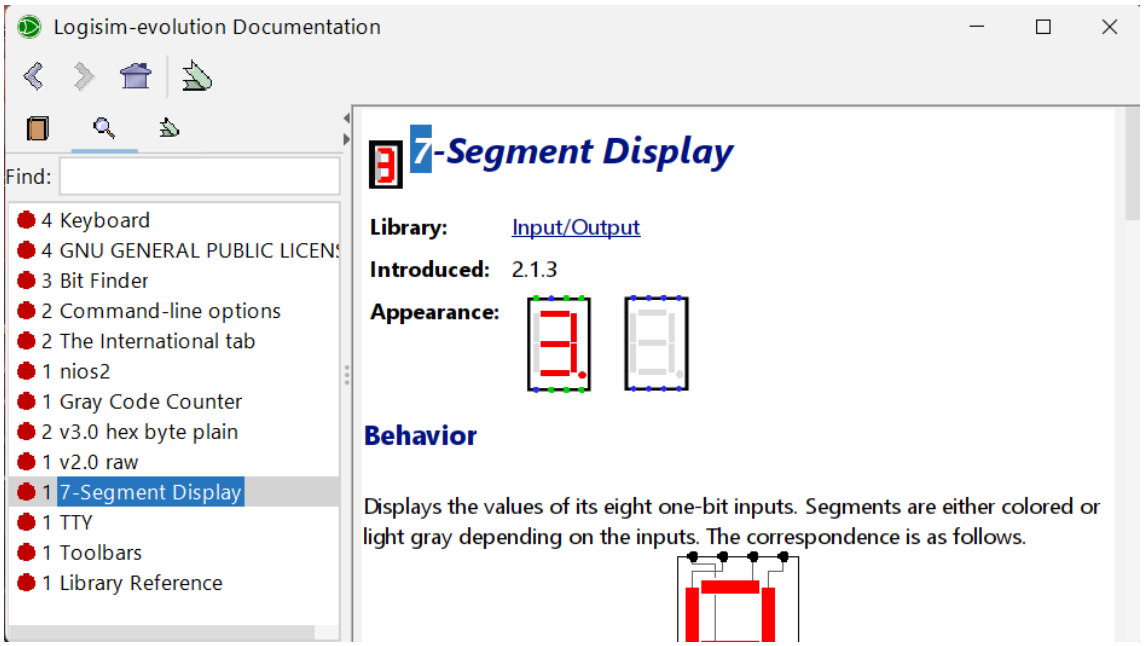

Figure 1.14: Library Reference

With your teacher

Build a simple adder

First, start by adding an input as shown in figure 1.15. Change its properties: Data Bits to 8 and Label to "Input1". Add another input with the same size and "Input2" as a label. After that, go to the Explorer Pane, expand the Arithmetic folder, and add an Adder to your circuit. Finally, add an output with the same size as the inputs (it should be), and "Output1" as a label.

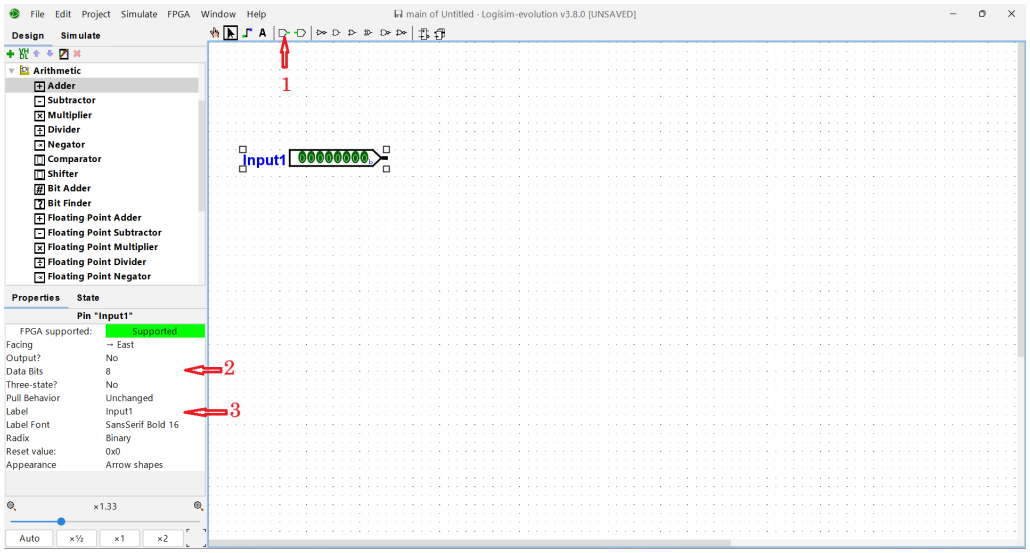

Figure 1.15: Adding an input

Connect all the components, then click on the pointy brown hand to test the circuit. Your circuit should look as in figure 1.16. Click on a bit with the pointy hand to change its value. The values will toggle between 0 and 1 each time you click on them.

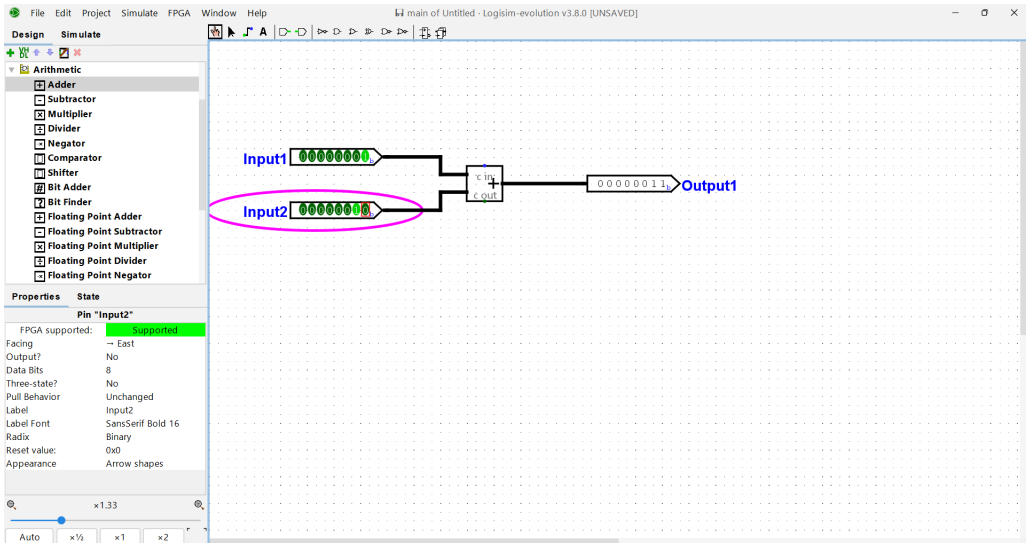

Figure 1.16: Simple Adder.

Build a simple adder from scratch

Now, we will build the same circuit from scratch, without using pre-built components. To do that, we will follow the basic steps that all designers use:

1. Describe the behavior of the circuit (the idea of a circuit). In our case, the idea is simple (a small adder);
2. Identify the inputs and the outputs: We have two inputs and one output;
3. Describe the circuit's behavior with the truth table: Specify the output of the circuit according to each input.
4. Use software like Logisim Evolution to transform this truth table into a circuit built with logic gates.

Designers used to do the last step by hand. They used to simplify the truth table using boolean logic, K-maps...etc. Then build the physical circuit. However, this method is prone to failure and defects.

To work in an organized and modular way, we create a sub-circuit for each component. Add a new circuit and name it Addition (Adder is not allowed) see Figure 1.17.

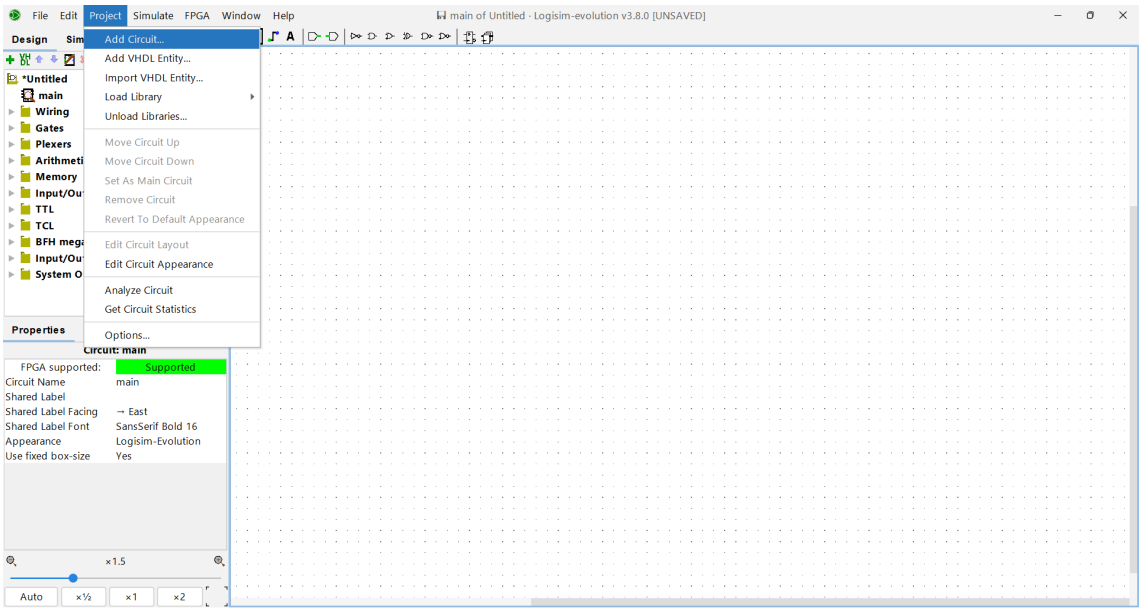

Figure 1.17: Add Circuit

To build the truth table, go to Project->Analyse Circuit as follows:

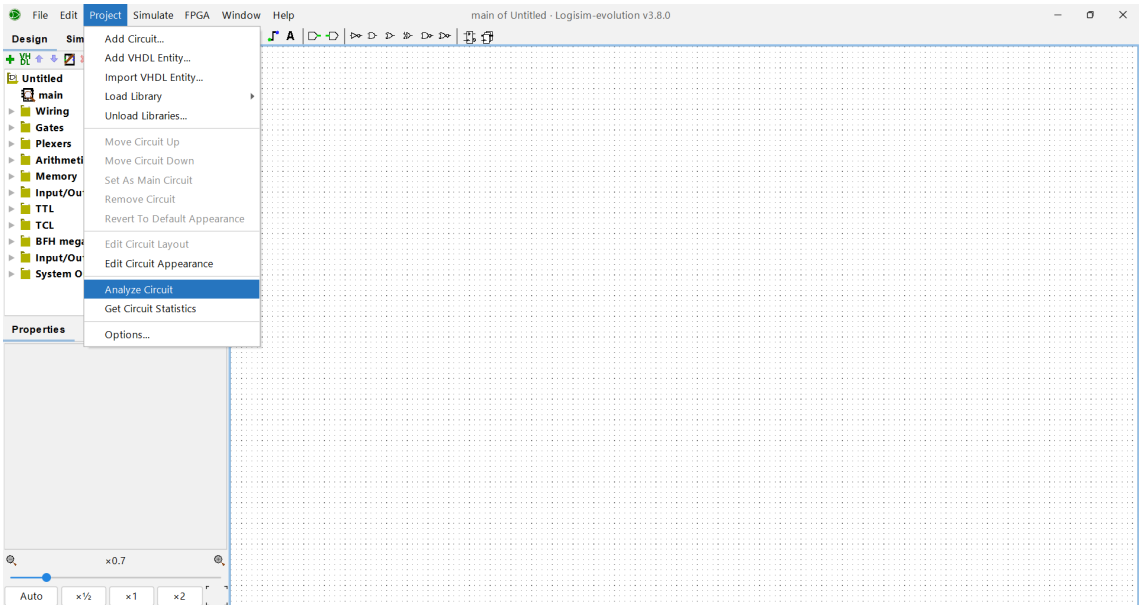

Figure 1.18: Lunch Project Analyser

A window for building the Truth table will appear. Enter two input variables and one output variable.

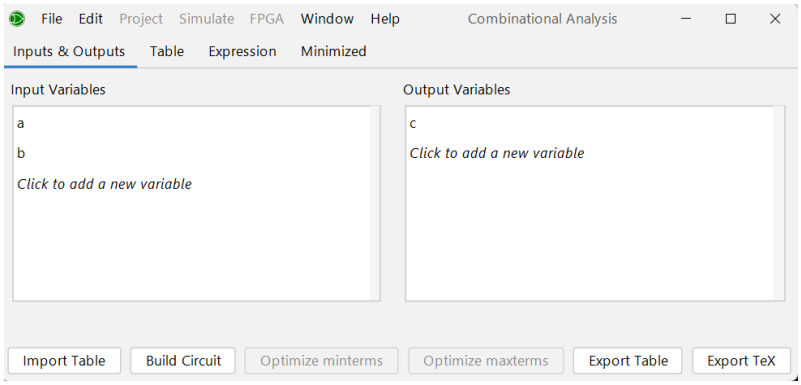

Figure 1.19: Truth Table Building

In the same window, go to the Table tab. You will find an incomplete table. Fill it out according to your configuration.

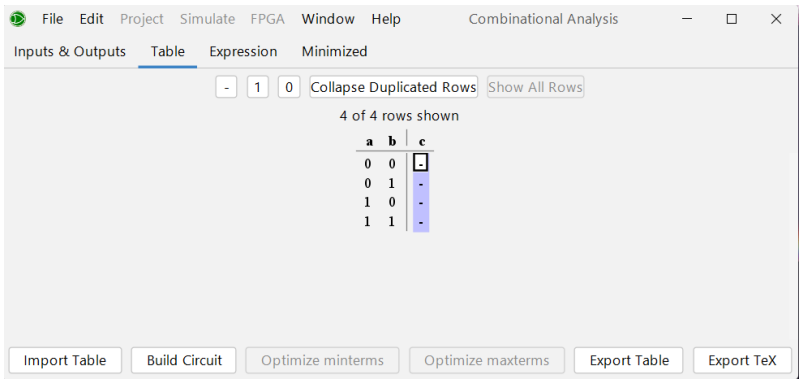

Figure 1.20: Input/Output Mapping

When you finish, click the Build Circuit button. It should build the circuit for you. If a message box pops up, click OK. Now you can use the circuit as a block. First, double-click on the “main” circuit. Then click only once on the “Addition” circuit. After that, click on the “Canvas” area of the “main” circuit, your “addition” circuit should be added as a black box (Figure)

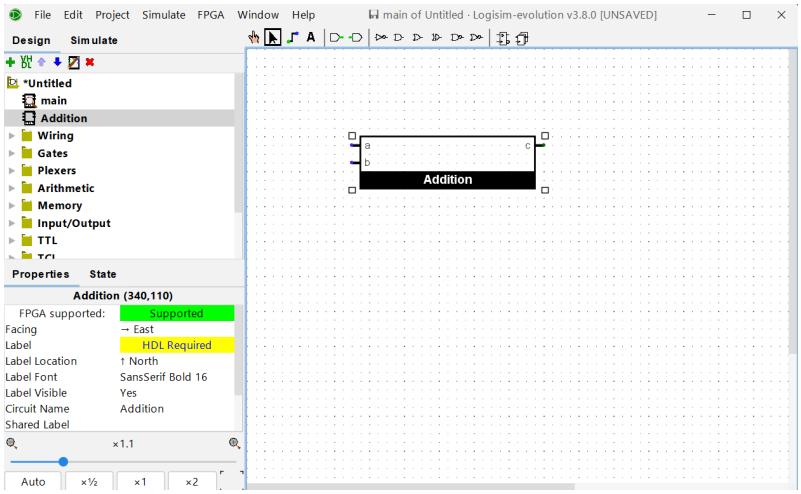

Figure 1.21: Black box circuit

Assignment

Build a sub-circuit for a seven-segment display. This component has seven segments that can be enabled separately. We will use it to display digits from 0 to 9 as follows:

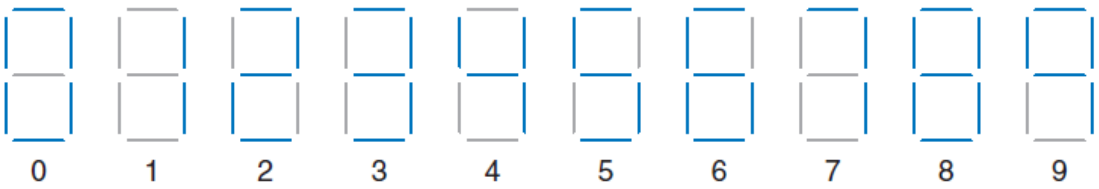

Figure 1.22: Ten Digits representation

To test your circuit, connect input pins to its inputs, and change their values to check if your displayer is working. The final result should look like Figure 1.23.

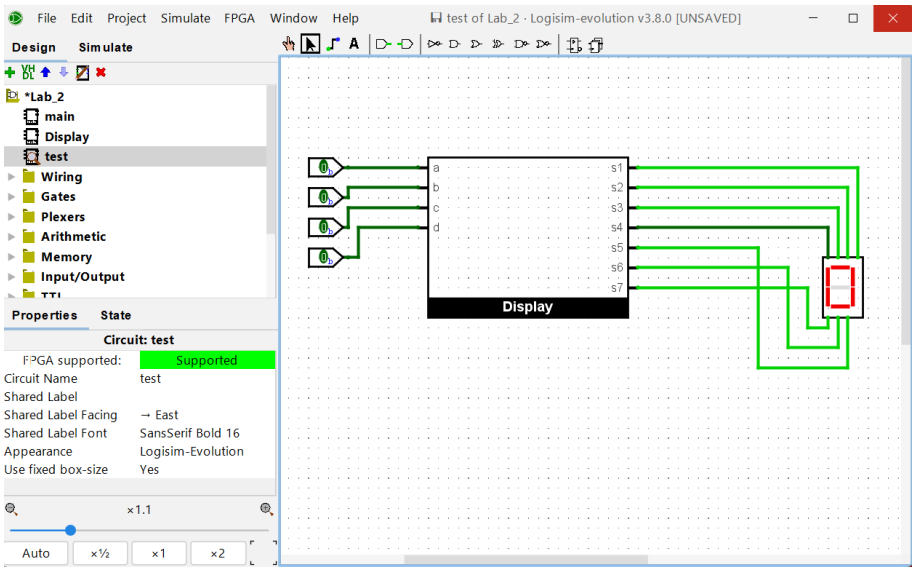

Figure 1.23: Test 7-Segments Display

Save all your work in a folder, we will use it in later labs. Submit your work.