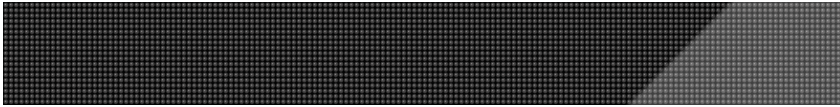
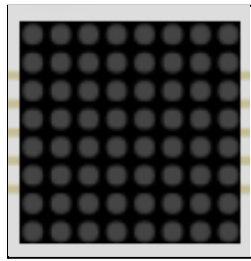


Topic	DOT MATRIX DISPLAY	
Class Description	Students will learn about the Led Dot Matrix unit. Students will also learn how LED Dot Matrix units work. Using this knowledge, students will create a project to display data on a display board and use the MD_Parola library to add animations.	
Class	PRO C269	
Class time	45 mins	
Goal	<ul style="list-style-type: none"> • Learning about the LED Dot Matrix unit. • Understanding how LED Dot Matrix unit works with MAX7219 controller. • Learning to light up a single dot on the LED display. • Learning to display text on the LED display. 	
Resources Required	<ul style="list-style-type: none"> • Teacher Resources: <ul style="list-style-type: none"> ○ Laptop with internet connectivity ○ Earphones with mic ○ Notebook and pen ○ Smartphone • Student Resources: <ul style="list-style-type: none"> ○ Laptop with internet connectivity ○ Earphones with mic ○ Notebook and pen 	
Class structure	Warm-Up Teacher-Led Activity Student-Led Activity Wrap-Up	10 mins 15 mins 15 mins 05 mins
WARM-UP SESSION - 10 mins		
Teacher Action		Student Action

<p>Hey <student's name>. How are you? It's great to see you! Are you excited to learn something new today?</p> <p>Following are the WARM-UP session deliverables:</p> <ul style="list-style-type: none"> • Greet the student. • Revision of previous class activities. • Quizzes. 	<p>ESR: Hi, thanks! Yes, I am excited about it!</p>
<p align="center">WARM-UP QUIZ Click on In-Class Quiz</p>	
<p>Activity Details</p> <p>Following are the session deliverables:</p> <ul style="list-style-type: none"> • Appreciate the student. • Narrate the story by using hand gestures and voice modulation methods to bring more interest in students. 	
<p align="center">TEACHER-LED ACTIVITY 15mins</p>	
<p align="center">Teacher Initiates Screen Share</p>	
<ul style="list-style-type: none"> • Understanding LED Dot Matrix display's working principle. • Lighting up a dot on the screen. 	
Teacher Action	Student Action
<p>Do you remember what we did in the previous class?</p> <p><i>If the student has any doubts, clarify the doubts.</i></p>	<p>ESR: We completed the smart clock project.</p>
<p>Today, we are going to learn about a new component named LED Dot Matrix display.</p>	

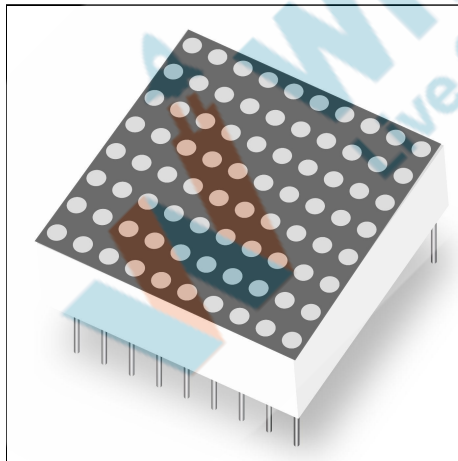
<p>Are you excited?</p> <p>We have actually seen this component many times in real life. When we ride the bus or metro, the information board is usually made up of an LED Dot Matrix display. Have you seen it?</p>  <p><i>Student can view the example video in Student Activity 1.</i></p> <p>Have you seen this component being used anywhere else?</p> <p>Great! You are very observant.</p> <p>The LED Dot Matrix display is used a lot because it is inexpensive, durable, and weather-proof.</p> <p>Let's try to understand how this LED Dot Matrix display works.</p> <p>An 8x8 LED Dot Matrix display looks something like this in the wokwi simulator-</p>	<p>ESR: Yes.</p> <p>ESR: Yes.</p> <p>ESR: Yes, they are used as scoreboards. Also, I have seen them in different shops too.</p>
---	--



Teacher adds a new LED Dot Matrix component in wokwi and shows it to the student. Student observes the component.

There are **8x8 LEDs** i.e. **64 LEDs** here. These LEDs can be lit up to form a character/ digit on the display.

A typical 8x8 Dot Matrix unit has 16 pins, 8 for each row and 8 for each column. The LEDs in each row and each column are wired together to reduce the number of pins. This technique of controlling a large number of LEDs with a smaller number of pins is called **multiplexing**.

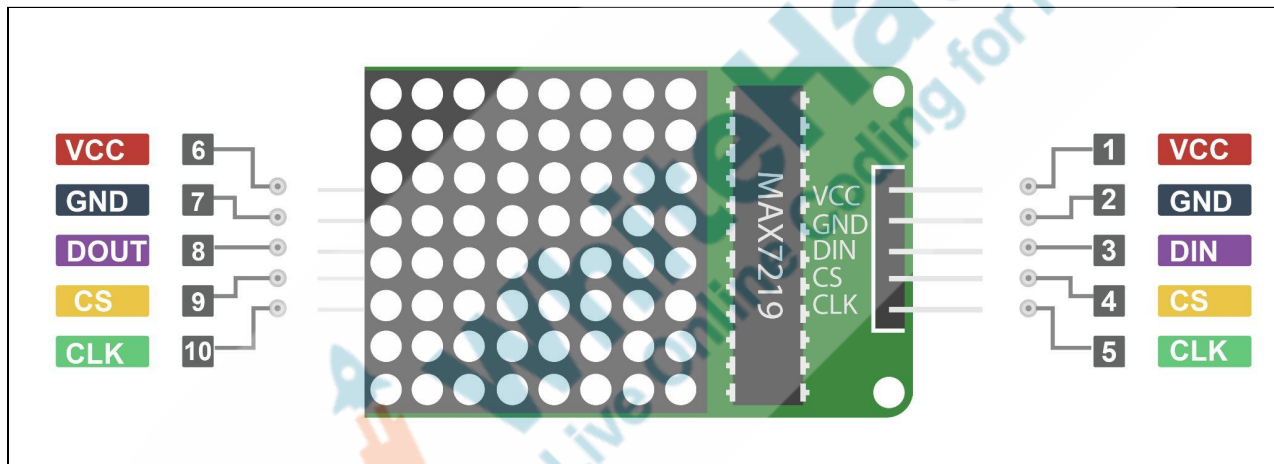


Student can view this image in [Student Activity 2](#).

But, 16 pins are a lot. We will need to connect a lot of pins to the Arduino board. Also, you have to constantly refresh the display to keep the image stable.

To save us from this, the **LED Dot Matrix** display comes with a **MAX7219 Controller**.

The **MAX7219 Controller** accepts data and can drive up to 64 LEDs.



Student can view this image in [Student Activity 3](#).

Let's observe the **LED Dot Matrix** display with **MAX7219 Controller**. Observe the pins on the **right-hand side** first.

Pin Name	Description
VCC	Voltage supply
GND	Ground
DIN	Data input

CS	Chip Select
CLK	Clock input

We have similar pins and a **DOUT** pin on the left-hand side to daisy-chain more LED Dot Matrix displays to make the display larger. Daisy-chaining is a way of connecting electronic components with each other.

Let's design the circuit first.

For our project, we are going to open wokwi.com and start a new Arduino Uno project.

1. Components:

- 1 x **Arduino Uno board**
- 1 x **LED Dot Matrix with MAX7219 Controller**

2. Let's do connections:

Arduino Uno board	LED Dot Matrix Pin Number
5V	VCC
Ground	GND
GPIO 11	DIN
GPIO 10	CS
GPIO 13	CLK

*Note: Wire color can be changed by **clicking over it** and selecting the color, or via **diagram.json** file. Go to the **diagram.json** wire and change the color of the wire. Any design changes or color changes can be done via the*

diagram.json file. Keep the track of the component and change the design settings.

Reference Circuit:



[Click here](#) to view the reference video.

Now it's time to write the code.

1. First, go to **sketch.ino**. Add the following header files-

- ```
#include <MD_MAX72xx.h>
```

**MD\_MAX72xx** library implements functions that allow the **MAX72xx** (eg, MAX7219) to be used for LED matrices (64 individual LEDs). It also allows

the programmer to use the LED matrix as a display where each LED pixel can be addressed. Pixel stands for picture element.

- `#include <SPI.h>`

**Serial Peripheral Interface (SPI)** is a set of communication rules that the electronic components must follow to communicate successfully.

**SPI** library allows you to communicate with other devices, with Arduino as the master device.

It is similar to when we communicate we have some rules which we refer to as grammar, which helps us communicate meaningfully so that others can understand us better.

2. Now, initiate variables to hold the pin numbers that connect the **Dot Matrix display** with the **Arduino Uno** board.

```
const byte clock_pin = 13;
const byte data_pin = 11;
const byte chip_select_pin = 10;
```

3. Initiate a variable named **max\_devices** which will hold the number of displays we will be using. We will keep this variable as 1 for now.

```
const byte max_devices = 1;
```

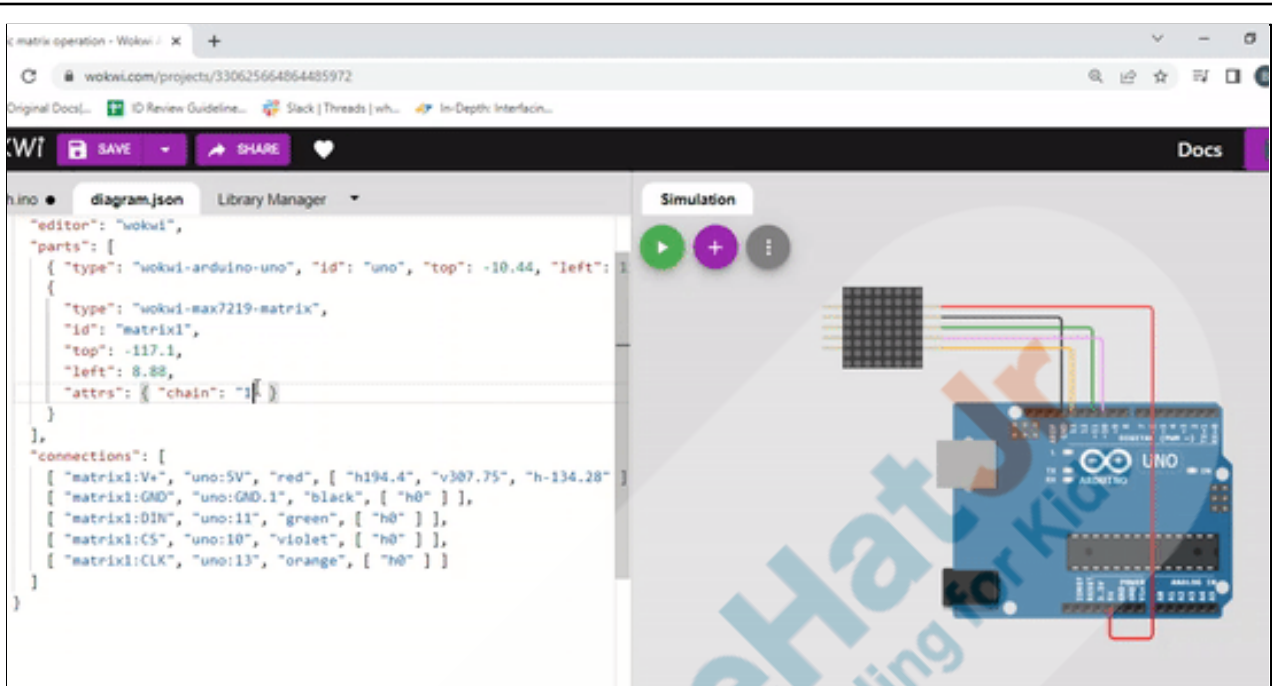
The number of LED devices chained together are 4 by default. The number of devices can be increased/decreased in the following manner-

Go to **diagram.json** → find **wokwi-max7219-matrix** under “**parts**” → find the **chain** attribute → change the value.

*Teacher tries different values for the chain attribute of the LED Dot Matrix display and shows it to the student.*

We will change it to 1 for now.





[Click here](#) to view the reference video.

4. Now, let's create an instance-

```
MD_MAX72XX matrix = MD_MAX72XX(MD_MAX72XX::PAROLA_HW, chip_select_pin, max_devices);
```

5. Now, let's write the following code inside the **setup()** function.

- Initiate the module.

```
matrix.begin();
```

- Clear the Dot Matrix display, if there is anything –

```
matrix.clear();
```

6. Now, we have 64 LEDs that we can light up. We will use the **setPoint()** function to

light up individual LEDs on display.

Syntax: **setPoint(row, column, status)**

The rows and columns are numbered in the following way for an **8x8 LED Dot Matrix** unit.

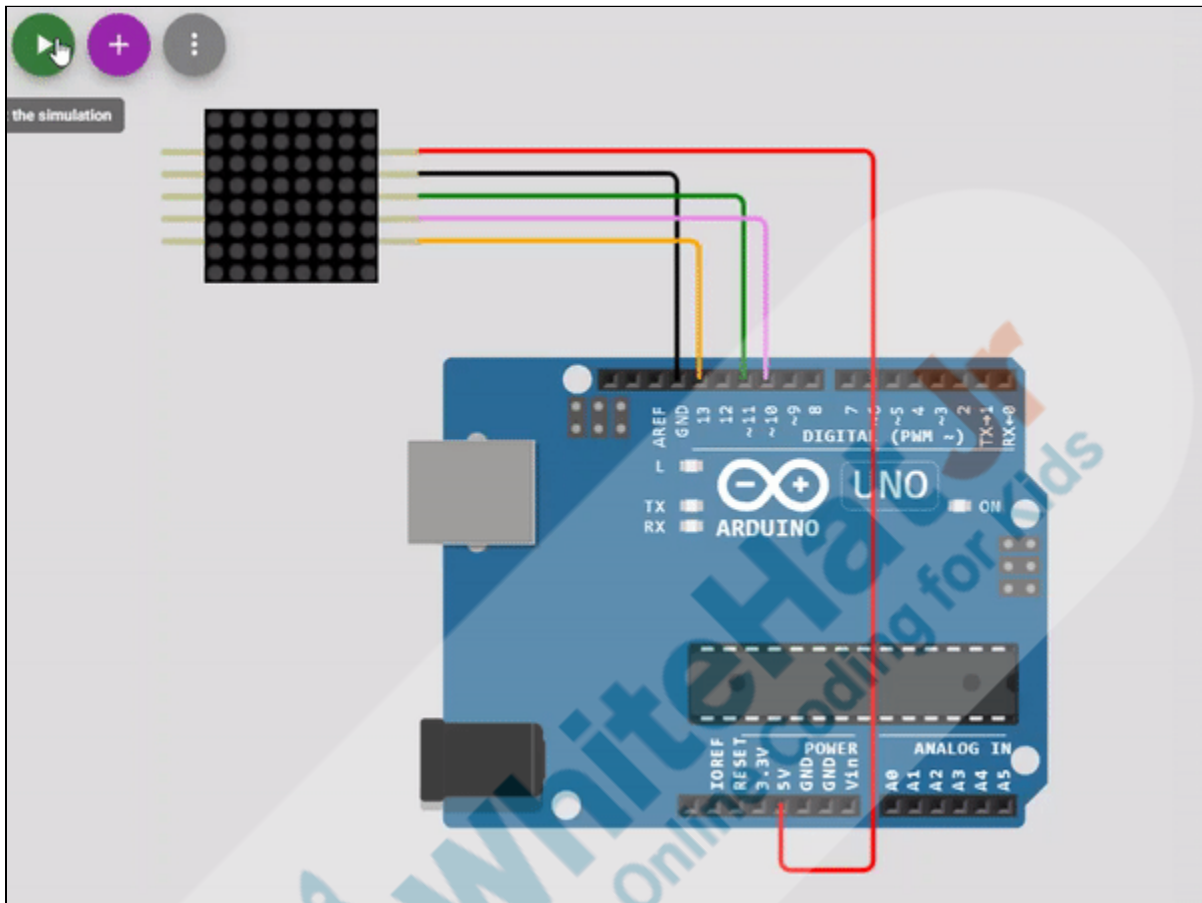
|    | c7    | c6    | c5    | c4    | c3    | c2    | c1    | c0    |
|----|-------|-------|-------|-------|-------|-------|-------|-------|
| r0 | (0,7) | (0,6) | (0,5) | (0,4) | (0,3) | (0,2) | (0,1) | (0,0) |
| r1 | (1,7) | (1,6) | (1,5) | (1,4) | (1,3) | (1,2) | (1,1) | (1,0) |
| r2 | (2,7) | (2,6) | (2,5) | (2,4) | (2,3) | (2,2) | (2,1) | (2,0) |
| r3 | (3,7) | (3,6) | (3,5) | (3,4) | (3,3) | (3,2) | (3,1) | (3,0) |
| r4 | (4,7) | (4,6) | (4,5) | (4,4) | (4,3) | (4,2) | (4,1) | (4,0) |
| r5 | (5,7) | (5,6) | (5,5) | (5,4) | (5,3) | (5,2) | (5,1) | (5,0) |
| r6 | (6,7) | (6,6) | (6,5) | (6,4) | (6,3) | (6,2) | (6,1) | (6,0) |
| r7 | (7,7) | (7,6) | (7,5) | (7,4) | (7,3) | (7,2) | (7,1) | (7,0) |

Student can view this image from [Student Activity 4](#)

Your code should look like this -

```
sketch.ino • diagram.json Library Manager ▼
1 // this module interacts with the hardware on lower level
2 #include <MD_MAX72xx.h>
3 #include <SPI.h>
4
5 const byte clock_pin = 13;
6 const byte data_pin = 11;
7 const byte chip_select_pin = 10;
8 const byte max_devices = 1;
9
10 MD_MAX72XX matrix = MD_MAX72XX(MD_MAX72XX::PAROLA_HW, chip_select_pin, max_devices);
11
12 void setup(){
13 matrix.begin();
14 matrix.clear();
15 }
16
17 void loop(){
18 matrix.setPoint(7,1,true);
19 delay(10);
20 }
```

Let's observe the output-



[Click here](#) to view the reference video.

*Teacher asks the student to guess the (row, column) of the LED she points to and checks if it is correct or not by lighting it up. It can be a fun activity to make the student understand how it works.*

Now, if we display each LED one by one, we will have to write a lot of complex code. Luckily, there is a library named [MD\\_Parola](#). This library helps to display patterns and animations efficiently. We will use functions from this library to display different information on the LED display.

As you understood the basics. You will build a project to display your name on the **LED Dot Matrix display**.

| Teacher Stops Screen Share                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                    |                           |    |     |        |     |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------------------|----|-----|--------|-----|--|
| Can you solve it?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>ESR:</b> Yes, sure!                                             |                           |    |     |        |     |  |
| Let's try. I will guide you through it.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                    |                           |    |     |        |     |  |
| STUDENT-LED ACTIVITY- 15 mins                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                    |                           |    |     |        |     |  |
| <ul style="list-style-type: none"> <li>Ask the student to press the ESC key to come back to the panel.</li> <li>Guide the student to start Screen Share.</li> <li>The teacher gets into Full Screen.</li> </ul>                                                                                                                                                                                                                                                                                         |                                                                    |                           |    |     |        |     |  |
| Student Initiates Screen Share                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                    |                           |    |     |        |     |  |
| <p style="text-align: center;"><u>ACTIVITY</u></p> <ul style="list-style-type: none"> <li>Build a program to print different characters and words on the LED Dot Matrix display using MD_Parola library.</li> </ul>                                                                                                                                                                                                                                                                                     |                                                                    |                           |    |     |        |     |  |
| Teacher Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Student Action                                                     |                           |    |     |        |     |  |
| <i>Teacher guides the student to open wokwi.com.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Student opens the <a href="https://wokwi.com">wokwi</a> simulator. |                           |    |     |        |     |  |
| <p>Let's try to create the circuit diagram first.</p> <p>1. Add the following components-</p> <ul style="list-style-type: none"> <li>1x <b>Arduino Uno board</b></li> <li>1x <b>LED Dot Matrix with MAX7219 Controller</b></li> </ul> <p>2. Connections-</p> <table border="1"> <thead> <tr> <th>Arduino Uno board</th><th>LED Dot Matrix Pin Number</th></tr> </thead> <tbody> <tr> <td>5V</td><td>VCC</td></tr> <tr> <td>Ground</td><td>GND</td></tr> </tbody> </table> | Arduino Uno board                                                  | LED Dot Matrix Pin Number | 5V | VCC | Ground | GND |  |
| Arduino Uno board                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | LED Dot Matrix Pin Number                                          |                           |    |     |        |     |  |
| 5V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | VCC                                                                |                           |    |     |        |     |  |
| Ground                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | GND                                                                |                           |    |     |        |     |  |

|         |     |
|---------|-----|
| GPIO 11 | DIN |
| GPIO 10 | CS  |
| GPIO 13 | CLK |

3. The number of devices can be increased in the following manner-

Go to **diagram.json** → find **wokwi-max7219-matrix** under “**parts**” → find the **chain** attribute → change the value.

*Teacher tries different values for the chain attribute of the LED Dot Matrix display and shows it to the student.*

We will keep it as 4 for now. This will make the display large enough to show an entire name.

**Reference circuit:**



[Click here](#) to view the reference video.

Let's work on the code now.

**Activity 1:** Using **print()** method from **MD\_Parola** library.

1. First, go to **sketch.ino**. We need to add the header file here.

```
#include <MD_MAX72xx.h>
```

```
// this module helps to display patterns and animations easily
#include <MD_Parola.h>
#include <SPI.h>
```

**MD\_Parola** library is implemented using the **MD\_MAX72xx** library for hardware control. It provides functions to simplify the implementation of text special effects on the LED matrix.

2. Now, initiate variables that hold the pin numbers that connect the Dot Matrix display with the **Arduino Uno** board.

```
const byte clock_pin = 13;
const byte data_pin = 11;
const byte chip_select_pin = 10;
```

3. Initiate a variable named **max\_devices** which will hold the number of displays we will be using. We will keep it as **4**.

```
const byte max_devices = 4;
```

4. Now, let's create an instance-

```
MD_Parola matrix = MD_Parola(MD_MAX72XX::PAROLA_HW, chip_select_pin, max_devices);
```

5. Now, let's write the following code inside the **setup()** function.

- Initiate the module.

```
matrix.begin();
```

- Clear the Dot Matrix display, if there is anything –

```
matrix.displayClear();
```

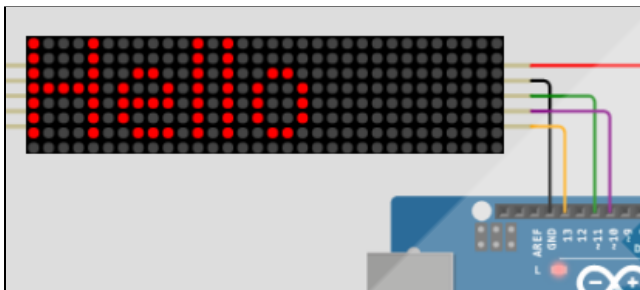


6. Let's try to print "hello" on the display now.

We can use the function **print()** for it. Write this function inside the **loop()** function.

```
matrix.print("Hello");
```

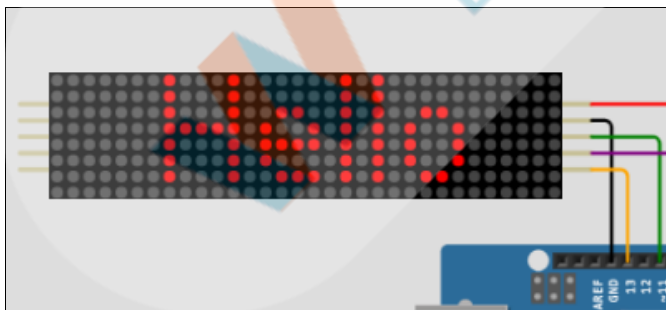
Run the code and observe the output.



7. We can change the alignment as well by using the **setTextAlignment()** function.

```
matrix.setTextAlignment(PA_CENTER);
matrix.print("Hello");
```

Run and check the output.



8. Let's say we want to show hello for a 1 second and after that your name for 1 second. We can use the **delay()** function and pass 1000 milliseconds (= 1 second) through the function.

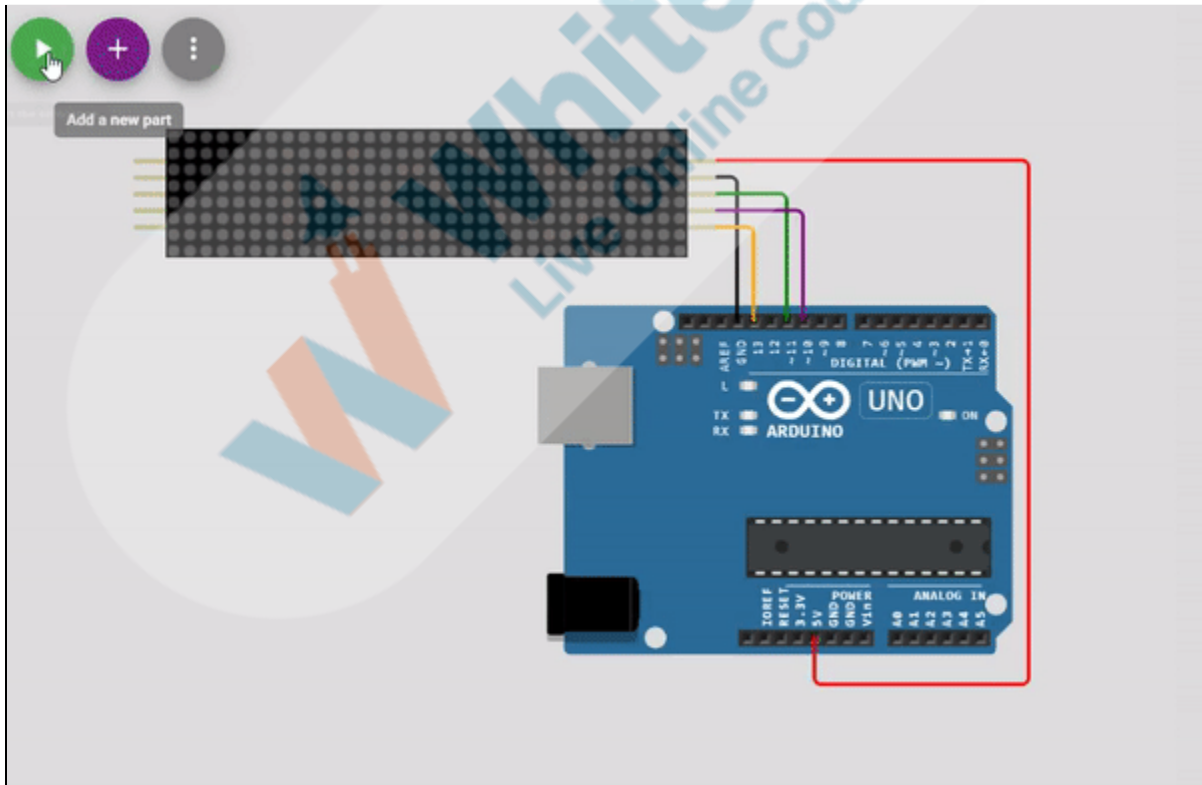
```
void loop(){

 matrix.setTextAlignment(PA_CENTER);
 matrix.print("Hello");
 delay(1000);
 matrix.setTextAlignment(PA_CENTER);
 matrix.print("Daisy");
 delay(1000);

}
```

The reference code for this can be found in [Teacher Reference 1](#)

### Reference Output 1:



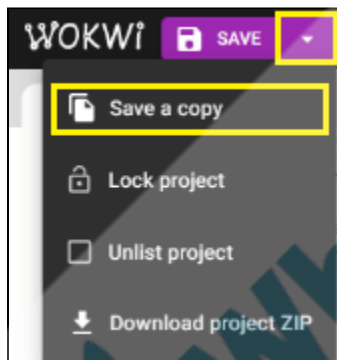
[Click here](#) to view the reference output.

**Activity 2:** Using **displayText()** method from **MD\_Parola** library.

Let's save the code till now. By clicking on the save button at the top.



Once, you have saved it. Make a copy of this file to do further experiments without losing the current code.



1. Now, we will also use the **displayText()** method from the **MD\_Parola** library.

This method is a convenient way to set up a text display. All the data necessary for setup is passed through as parameters. We can add display animation too.

It has 6 parameters. The 6 parameters of the **displayText()** function are :

1. text to be displayed
2. alignment
3. time interval between frames (scrolling speed). If you increase this number the speed will decrease.
4. pause between animation in and out

5. effect in
6. effect out

You can view the list of suitable effects for **effect in** and **effect out** parameter in [student activity 6](#)

```
void setup(){

 Serial.begin(9600);
 Serial.print("What to display?");

 matrix.begin(); // initialise the module

 matrix.displayClear(); // clear, if there is anything

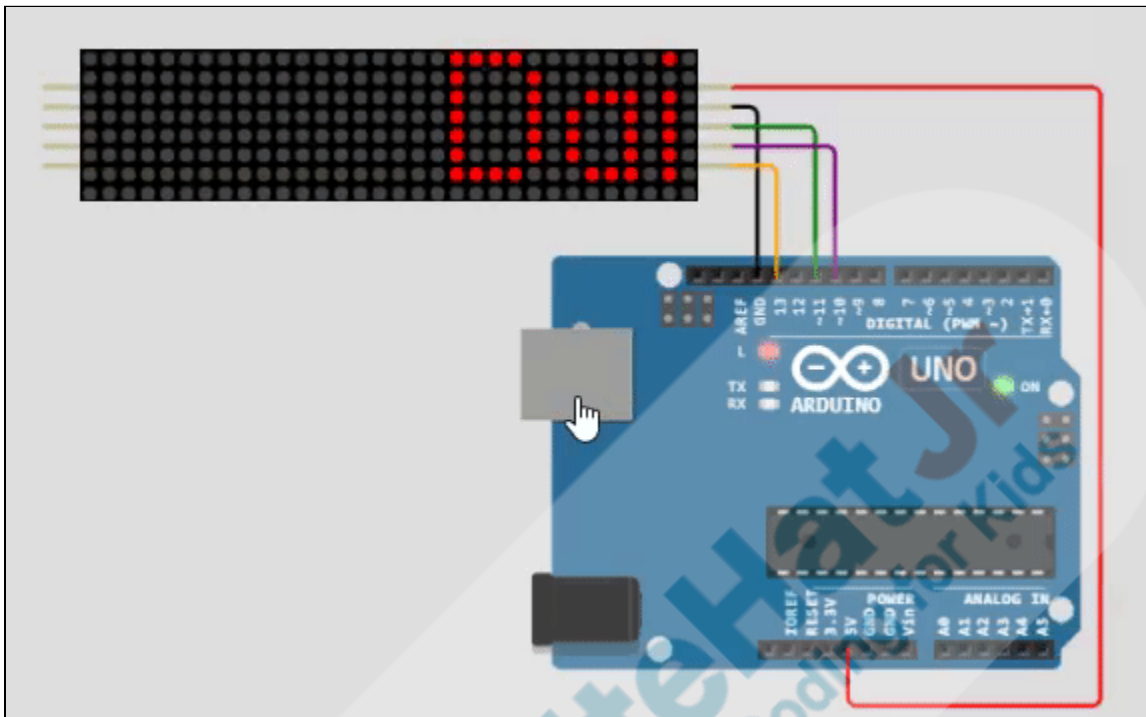
 matrix.displayText("Daisy", PA_CENTER, 50, 2000,
 | | | | | | | | PA_SCROLL_LEFT, PA_WIPE_CURSOR);
}

void loop(){

 // displayAnimate returns true when animation is finished
 // we then reset the animation
 if (matrix.displayAnimate()){
 | matrix.displayReset();
 }
}
```

Find the reference code for this activity in [Teacher Reference 2](#)

### Reference Output 2:



[Click here](#) to view the reference video.

**Activity 3:** Using **displayText()** method from **MD\_Parola** library to generate random animation.

You can add random effects too. For that, we need to change the **displayReset()** function with the following line.

```
matrix.displayText("Bijoya", PA_CENTER, 50,
2000, PA_RANDOM, PA_RANDOM);
```

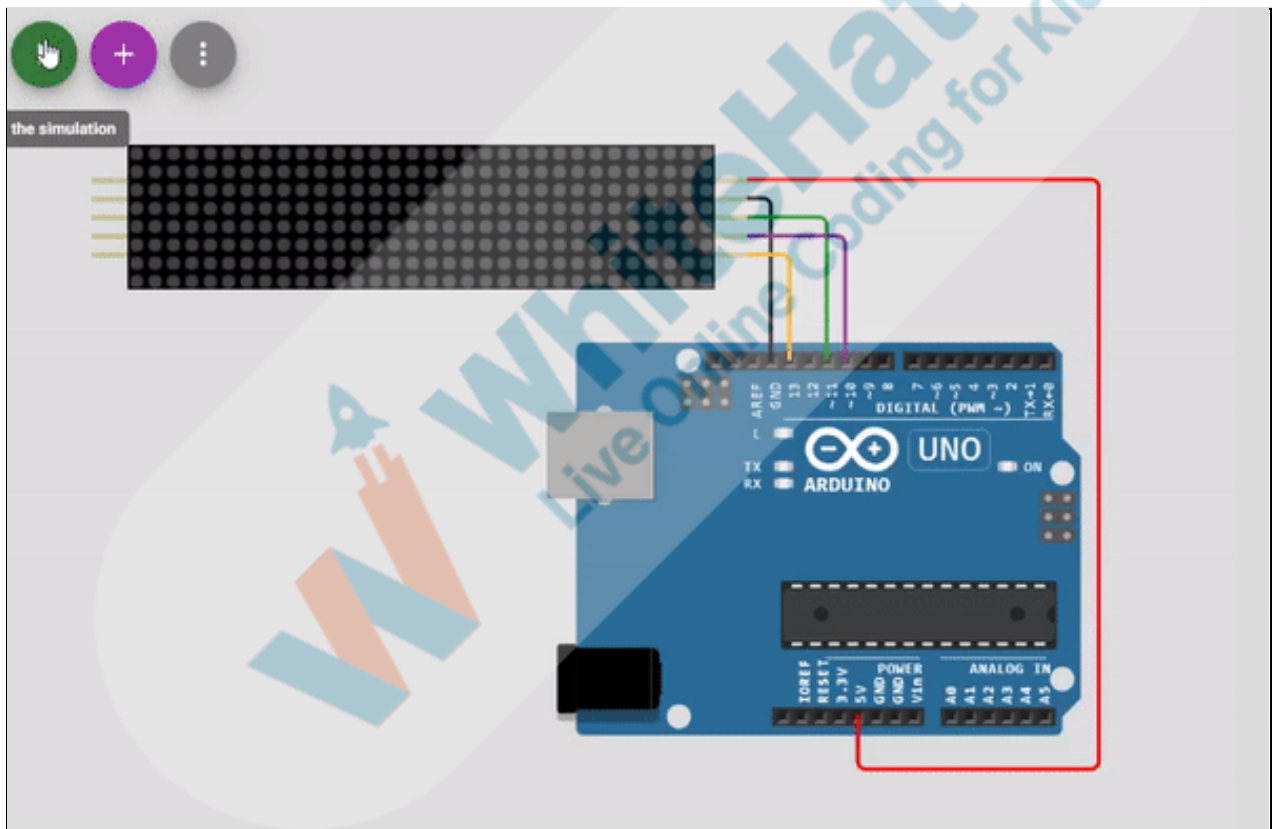
Find the reference code for this activity in [Teacher Reference 3](#)

The code should look like this-

```
void loop(){


 // displayAnimate returns true when animation is finished
 // we then reset the animation
 if (matrix.displayAnimate()){
 matrix.displayText("Daisy", PA_CENTER, 50, 2000, PA_RANDOM, PA_RANDOM);
 }
}
```

### Reference Output 3:



[Click here](#) to view the reference video.

| Teacher Guides Student to Stop Screen Share                                                                                                                                                                                                                             |                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WRAP-UP SESSION - 05 mins                                                                                                                                                                                                                                               |                                                                                                                                                                         |
| <b>Activity details</b><br><br><b>Following are the WRAP-UP session deliverables:</b> <ul style="list-style-type: none"> <li>• Appreciate the student.</li> <li>• Revise the current class activities.</li> <li>• Discuss the quizzes.</li> </ul>                       |                                                                                                                                                                         |
| WRAP-UP QUIZ<br>Click on In-Class Quiz                                                                                                                                                                                                                                  |                                                                                                                                                                         |
| <b>Activity Details</b><br><br><b>Following are the session deliverables:</b> <ul style="list-style-type: none"> <li>• Explain the facts and trivia</li> <li>• Next class challenge</li> <li>• Project for the day</li> <li>• Additional Activity (Optional)</li> </ul> |                                                                                                                                                                         |
| FEEDBACK                                                                                                                                                                                                                                                                |                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• <b>Appreciate and compliment the student for trying to learn a difficult concept.</b></li> <li>• <b>Get to know how they are feeling after the session.</b></li> <li>• <b>Review and check their understanding.</b></li> </ul> |                                                                                                                                                                         |
| Teacher Action                                                                                                                                                                                                                                                          | Student Action                                                                                                                                                          |
| <p>You get “hats-off” for your excellent work!</p> <p>In the next class, we learn about joysticks.</p>                                                                                                                                                                  | <p><i>Make sure you have given at least 2 hats-off during the class for:</i></p> <div> <div>Creatively Solved Activities +10</div> <div>Great Question +10</div> </div> |

|                                                                                           |                                                                                                                         |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
|                                                                                           | <div>Strong Concentration  +10</div> |
| <b>PROJECT OVERVIEW DISCUSSION</b><br>Refer the document below in Activity Links Sections |                                                                                                                         |
| Teacher Clicks                                                                            | <div>✕ End Class</div>                                                                                                  |
| <b>ADDITIONAL ACTIVITIES</b><br>(Optional)                                                |                                                                                                                         |
| Additional Activities                                                                     |                                                                                                                         |

| ACTIVITY LINKS      |                                             |                                                                                                                                                                                                                                                                                   |
|---------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Activity Name       | Description                                 | Links                                                                                                                                                                                                                                                                             |
| Teacher Activity 1  | Simulator                                   | <a href="https://wokwi.com/">https://wokwi.com/</a>                                                                                                                                                                                                                               |
| Teacher Activity 2  | Documentation of MD_Parola library          | <a href="https://www.arduino.cc/reference/en/libraries/md_parola/">https://www.arduino.cc/reference/en/libraries/md_parola/</a>                                                                                                                                                   |
| Teacher Activity 3  | Suitable effects for displayText() function | <a href="https://majicdesigns.github.io/MD_Parola/_m_d__parola_8h.html#acf3b849a996dbbe48ca173d2b0b82e daa65db4b21517eaca3a0011552dda00a86">https://majicdesigns.github.io/MD_Parola/_m_d__parola_8h.html#acf3b849a996dbbe48ca173d2b0b82e daa65db4b21517eaca3a0011552dda00a86</a> |
| Teacher Reference 1 | Reference Code 1                            | <a href="https://github.com/procodingclass/P-RO-C269-Reference-Code-1">https://github.com/procodingclass/P-RO-C269-Reference-Code-1</a>                                                                                                                                           |
| Teacher Reference 2 | Reference Code 2                            | <a href="https://github.com/procodingclass/P-RO-C269-Reference-Code-2">https://github.com/procodingclass/P-RO-C269-Reference-Code-2</a>                                                                                                                                           |
| Teacher Reference 3 | Reference Code 3                            | <a href="https://github.com/procodingclass/P-RO-C269-Reference-Code-3">https://github.com/procodingclass/P-RO-C269-Reference-Code-3</a>                                                                                                                                           |



|                     |                                                     |                                                                                                                                                                                                                                                                                     |
|---------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Teacher Reference 2 | Project                                             | <a href="https://s3-whjr-curriculum-uploads.whjr.online/296cd6e0-7d2b-4501-891b-731bbdcb3334.pdf">https://s3-whjr-curriculum-uploads.whjr.online/296cd6e0-7d2b-4501-891b-731bbdcb3334.pdf</a>                                                                                       |
| Teacher Reference 3 | Project Solution                                    | <a href="https://github.com/procodingclass/P-RO-C269-Project-Solution">https://github.com/procodingclass/P-RO-C269-Project-Solution</a>                                                                                                                                             |
| Teacher Reference 4 | In-Class Quiz                                       | <a href="https://s3-whjr-curriculum-uploads.whjr.online/0b5c6a6f-bf2b-4c59-a33a-c235aa1b55d9.pdf">https://s3-whjr-curriculum-uploads.whjr.online/0b5c6a6f-bf2b-4c59-a33a-c235aa1b55d9.pdf</a>                                                                                       |
| Student Activity 1  | LED Dot Matrix display example                      | <a href="https://s3-whjr-curriculum-uploads.whjr.online/dc19137b-dda8-4335-9f93-c2335d7c7e87.gif">https://s3-whjr-curriculum-uploads.whjr.online/dc19137b-dda8-4335-9f93-c2335d7c7e87.gif</a>                                                                                       |
| Student Activity 2  | LED Dot Matrix display unit with 16 pins            | <a href="https://s3-whjr-curriculum-uploads.whjr.online/dd4b8408-1668-42a1-8b88-b86ee7667590.jpg">https://s3-whjr-curriculum-uploads.whjr.online/dd4b8408-1668-42a1-8b88-b86ee7667590.jpg</a>                                                                                       |
| Student Activity 3  | LED Dot Matrix display unit with MAX7219 controller | <a href="https://s3-whjr-curriculum-uploads.whjr.online/b964d330-b165-4a8a-a9ff-b4d7436bd625.jpg">https://s3-whjr-curriculum-uploads.whjr.online/b964d330-b165-4a8a-a9ff-b4d7436bd625.jpg</a>                                                                                       |
| Student Activity 4  | LED Dot matrix row-column reference image           | <a href="https://s3-whjr-curriculum-uploads.whjr.online/d8e9f641-831c-4444-ae-f0-e11ea8fba3a5.png">https://s3-whjr-curriculum-uploads.whjr.online/d8e9f641-831c-4444-ae-f0-e11ea8fba3a5.png</a>                                                                                     |
| Student Activity 5  | Simulator                                           | <a href="https://wokwi.com/">https://wokwi.com/</a>                                                                                                                                                                                                                                 |
| Student Activity 6  | Documentation of MD_Parola library                  | <a href="https://www.arduino.cc/reference/en/libraries/md_parola/">https://www.arduino.cc/reference/en/libraries/md_parola/</a>                                                                                                                                                     |
| Student Activity 7  | Suitable effects for displayText() function         | <a href="https://majicdesigns.github.io/MD_Parola/_m_d__parola_8h.html#acf3b849a996dbbe48ca173d2b0b82e daa65db4b21517eaca3a0011552d da00a86">https://majicdesigns.github.io/MD_Parola/_m_d__parola_8h.html#acf3b849a996dbbe48ca173d2b0b82e daa65db4b21517eaca3a0011552d da00a86</a> |