DIGITAL EDUCATION PROGRAMME

Hands-on activities for developing essential 21st-century skills: critical thinking, creativity, collaboration, and problem-solving through the exciting world of football, robotics, and programming.

A PROJECT BY

FIFA Foundation

Project Direction: FIFA Foundation
Pedagogical Design: Matías Scovotti & Anabela Cathcarth
Cover & Editorial Design: Florencia Redondo & Carolina Saharian
Illustrations: Tony Ganem
Technical Drawing for Assemblies: Paulina Lera & Guillermo Piana

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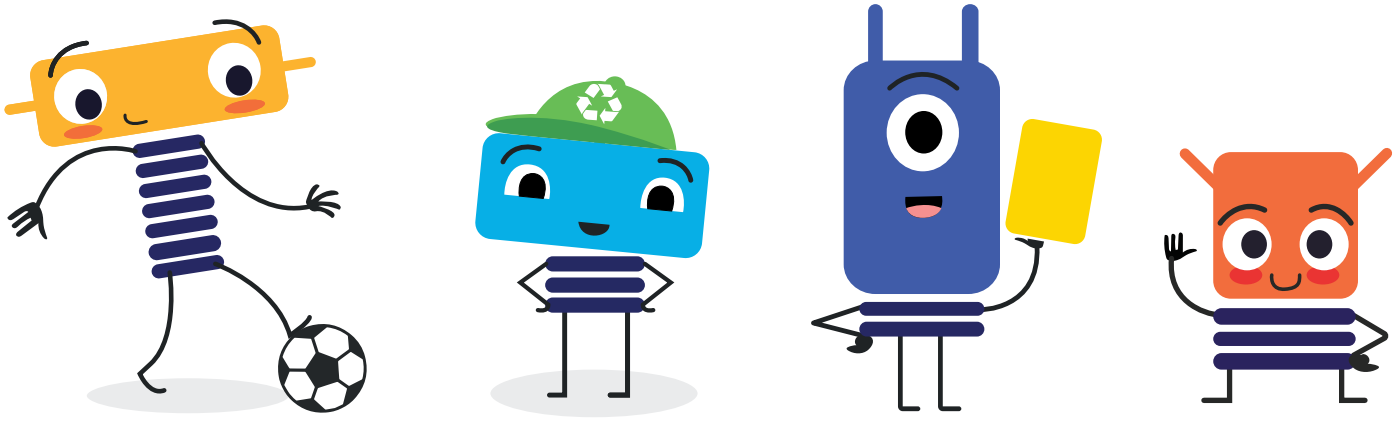
FIFA Foundation

DIGITAL EDUCATION PROGRAMME

FOOTBALL, ROBOTICS, PROGRAMMING &
COMPUTATIONAL THINKING



FIFA Foundation
Digital Education Programme

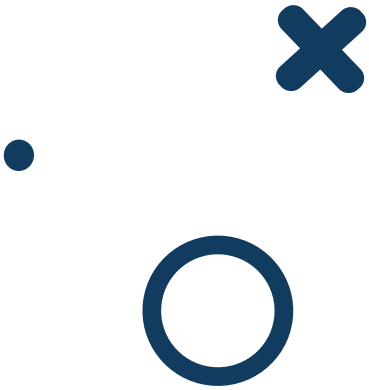
The FIFA Foundation implements an educational initiative named “Digital Education Programme”, a twofold programme of play-based learning for primary school students in vulnerable contexts that combines football and education, using the power of the beautiful game on and off the pitch to promote physical activity and digital education.

The Programme equally promotes football and digital skills to enable students to be active and engage in a fun way with a hands-on football-based approach applying technology to football whilst developing abilities such as computational thinking, creativity, collaborative work and problem-solving. Football is present throughout the programme with the expansion of football activities in the participating schools, and the proactive integration inside the digital classroom as the underlying element in the learning experience.

In this context, the FIFA Foundation Digital Education Programme will be rolled out in Belize in partnership with the **Ministry of Education, Culture, Science and Technology (MoECST) and the Football Federation of Belize (FFB)** as per the Memorandum of Understanding signed on 7 July 2023, reaching a total of 40 schools, 10,000 primary school students, and over 150 teachers for 3 years.

As part of its commitment within the MoU, and in line with FIFA’s Vision 2020-2023 to positively impact society through the power of football, the FIFA Foundation will regularly train teachers, provide a customised teaching material and educational platform, and equip the participating schools with:

- **40 Projectors**
- **680 Netbooks**
- **10’200 Pen Drives**
- **80 Storage Cabinets**
- **800 Robotics and programming kits**



This manual, as well as the customised programming platform, is part of the pedagogical and didactic educational content provided by the FIFA Foundation. It is designed to use the power and reach of the beautiful game to help empower the next generation of young people in Belize.

The above will be accompanied by awareness sessions for families including activities for families at school, meeting up with teachers, workshops, and special classes for families, to promote:

- the importance of being active, highlighting the transformational role of football inspiring children to learn life skills on and off the pitch, and

- the benefits of learning through play, particularly the importance of new technologies and robotics in education and the quantitative evidence indicating positive outcomes on the learning and development of new skills in students.

The Programme aims at making a positive social impact providing access to football, on the one hand, and to digital education in an entertained way, on the other hand, helping children improve physical and mental health and well-being, build life skills, learn to think creatively, reason systematically, and work collaboratively as essential skills in today’s society and the future of work.

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Know your book

The book has 3 categories of projects differentiated by color. Each project has 4 sections to work on.

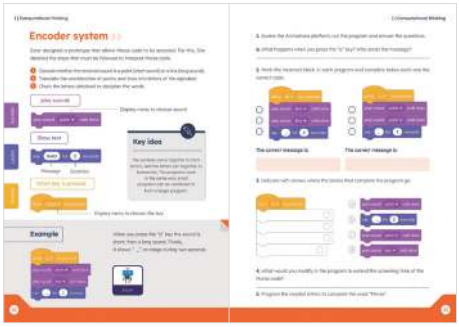
Let’s get to know them!

Introduction



This section presents the theme and works based on the curricular contents and the SDGs associated.

Computational thinking



This section presents the animation project to work on computational thinking.

Project



This section presents the robotics project with two challenges to program.

Self-assessment



This section reviews the concepts worked on and shares them.

SDGs

The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The 17 SDGs are integrated—they recognize that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

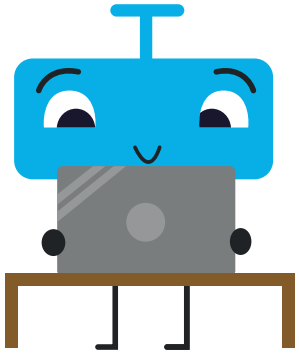
Countries have committed to prioritize progress for those who're furthest behind. The SDGs are designed to end poverty, hunger, AIDS, and discrimination against women and girls. The creativity, know-how, technology, and financial resources from all of society are necessary to achieve the SDGs in every context.

In line with the objectives outlined in Goal 4 Targets, the "Digital Education Programme" aims to ensure equal and quality primary education, eradicate gender and wealth disparities, and attain universal access to digital education. Furthermore, to facilitate the exploration of additional SDGs, each of the different chapters has been contextualized to establish connections with the remaining SDGs.



Introduction

In this book, we will work alongside the Bot family to find creative and technological solutions to various everyday challenges. Each chapter involves working with a robotics kit and different programming platforms.

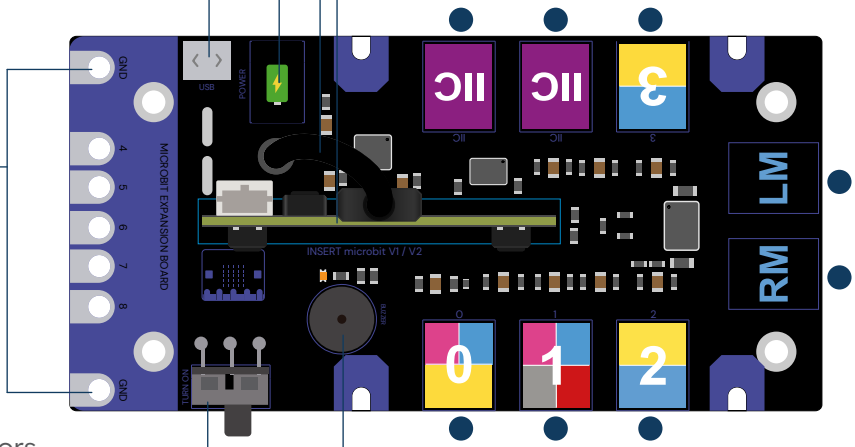


Let's get to know them!

What does the KIT contain?

Controller board

It is one of the most important components since it allows us to connect the microbit board and connect all the external components. These are its parts:



Battery connector

The battery provides power to the board through this connector.

Connection to the PC

The board connects to the PC through a USB cable.

Sensitive pads

It allows us to create touch buttons by connecting alligator cables.

Pins

These are the connection ports for sensors and actuators.
Each pin is identified by one or more colors, which indicate which components can be connected there. Each component can be connected to a pin that includes its color.

USB Cable

Micro USB cable to power the microbit board.

Microbit slot

Slot to insert the microbit board.

Buzzer

It is an integrated actuator capable of producing sounds.

Switch

Allows you to turn the board's external power on and off.

External components

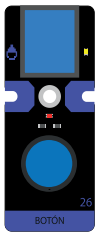
In the kit, there are some components that connect to the board using connection cables (one cable is needed for each component). They can be classified into sensors and actuators.

Sensors

These are components that read information from the environment (input information) and send it to the board for processing. In the kit, you can find two types: digital and analog sensors. They differ in how they process information and deliver it to the board.

Digital sensors

Many digital sensors can only provide two values: 0 (off) and 1 (on).



Push button sensor

Detects the pressure of a finger.

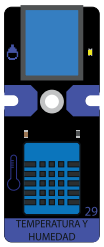
It connects to a blue pin.



Ultrasonic sensor

Measures the distance to an object in a range from 0 to 200 centimeters.

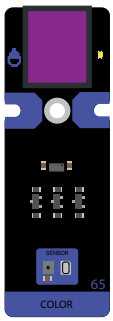
It connects to a red pin.



Temperature & humidity sensor

Reads the temperature and humidity of the environment.

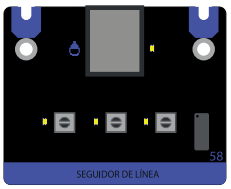
It connects to a blue pin.



Color sensor

It is used to detect the color of a light source or of an object. You can get the intensity levels of each color of the RGB model in a range from 0 to 255.

It connects to a purple pin.



Line follower

It is made up of three infrared sensors that are capable of detect color values: black and white. This allows you to identify a black line on the floor to follow.

It connects to a grey pin.



Touch button

Detects touch pressure. Also called “tactile button”.

It connects to a blue pin.



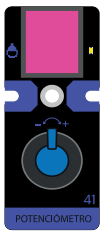
Obstacle

It uses an infrared light emitter and receiver to detect objects that are in front.

It connects to a blue pin.

Analog sensors

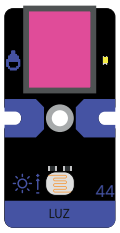
Analog sensors can provide a value within a range.



Potentiometer

Detects the rotation angle of a knob in a range between 0 and 1023.

It connects to a pink pin.



Light sensor

Capable of detecting the presence of light in the environment in a range between 0 and 1023.

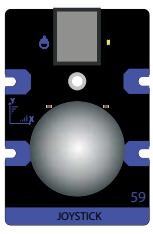
It connects to a pink pin.



Soil moisture sensor

Measures the soil moisture level in a range between 0 and 1023.

It connects to a pink pin.



Joystick

It consists of a stick that pivots on a base and reports the horizontal and vertical angle.

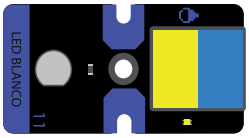
It connects to a grey pin.

Actuators

Actuators are output components. This means they are responsible for carrying out the actions indicated by the board. In the programming platform, they are typically categorized into three groups: “Outputs,” “Displays,” and “Motors.”

Outputs

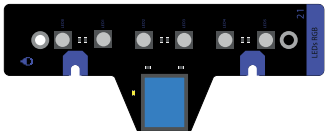
Many digital sensors can only provide two values: 0 (off) and 1 (on).



White LED

It is an actuator that allows control of turning on and off as well as adjusting the brightness of the light.

It connects to a blue or yellow pin.



RGB LEDs

It is composed of six RGB LED lights that allow you to get a wide variety of tones by combining the three primary colors of light: green, red and blue.

It connects to a blue pin.

Displays

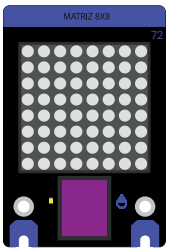
LCD display

It is an actuator that allows the display of text.

It connects to a purple pin.



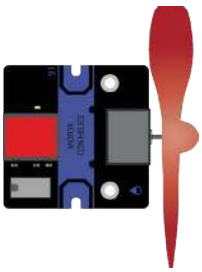
LED matrix



It is an actuator whose function is to display drawings or text.

It connects to a purple pin.

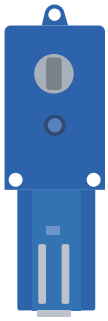
Motors



Fan motor

Generates an air current through the motorized movement of the propellers.

It connects to a red pin.



DC motor

It is able to generate a rotary movement to the left or to the right in different speeds.

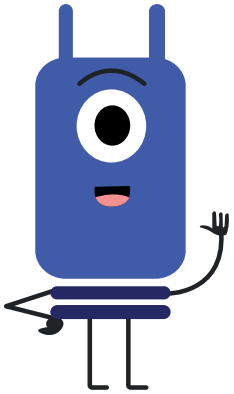
It connects to a black pin.



Servo motor

It is able to produce a rotary movement and take a stable position at a specific angle. It has a range opening that goes from 0 to 180 degrees.

It connects to a blue pin.



Know the project

Access all the digital material available to work with each one of the projects, the programming platforms and technical information of the kit.

https://steamBelize.fifafoundation.org/QR/00

Assembly parts

In the kit you will find plastic pieces to develop the assembly of the devices. Within each chapter there is a step by step guidance to carry them out.

Inserts

Small parts that allow the boards to be attached to each other or the components to the plastic boards.


Board Bracket


90° Bracket


L-Shaped Bracket

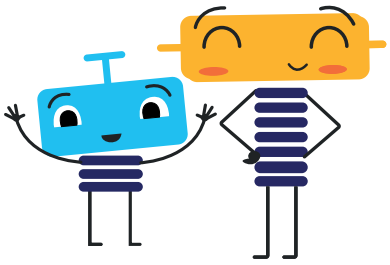

45° Bracket


Pivot Plug


Pivot Sockect


Servo Support


Fastener Bracket



Plastic boards

Perforated boards of different sizes to place components and assemble structures.


Nx30 Beam


Nx40 Beam


Nx50 Beam


Nx60 Beam


Nx80 Beam


Nx100 Beam


Nx150 Beam


N2x100 Beam


P10 Plate


P11 Plate


P12 Plate


P13 Plate


P14 Baseplate

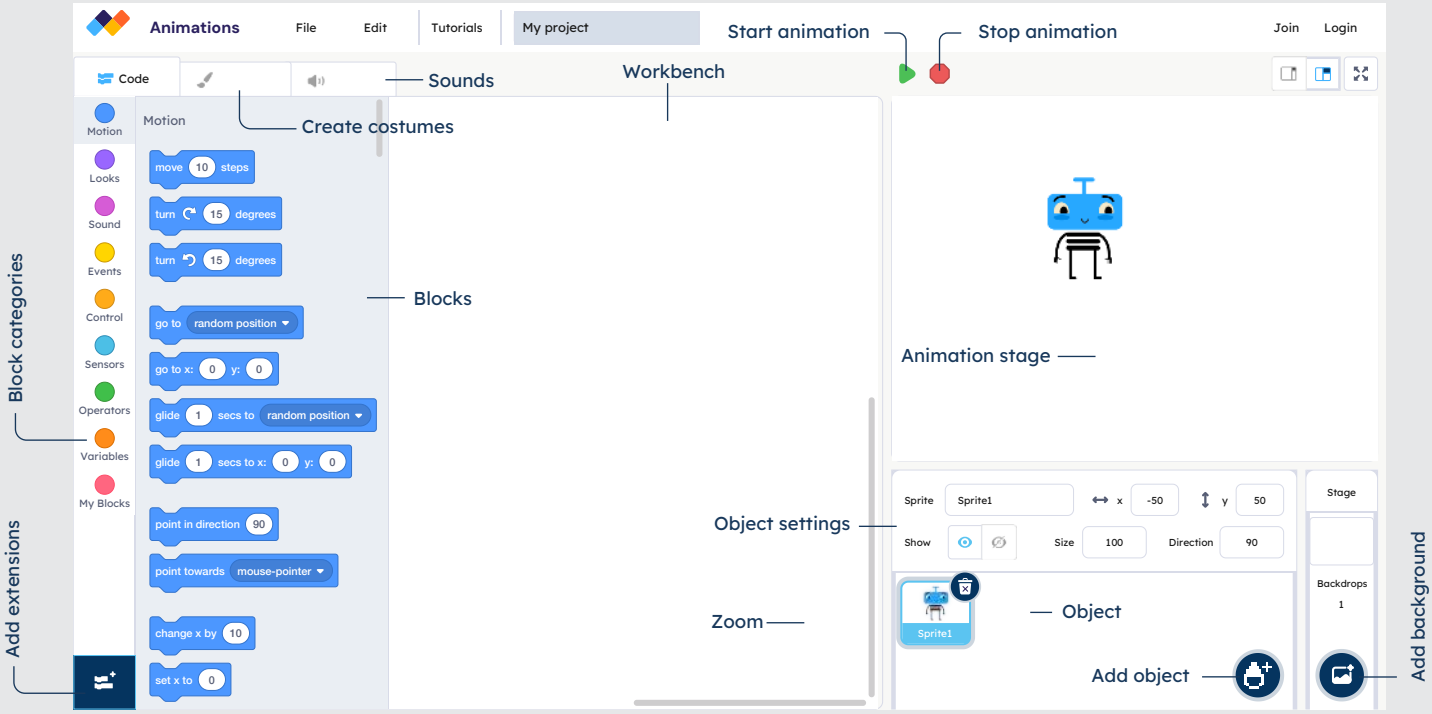

Motor Plate

Animations platform

Animations is a digital platform that we will use to complement computational thinking activities. Through pre-designed projects, we will learn how to program the movement of objects in a scene using various tools.

https://animations.fifafoundation.org

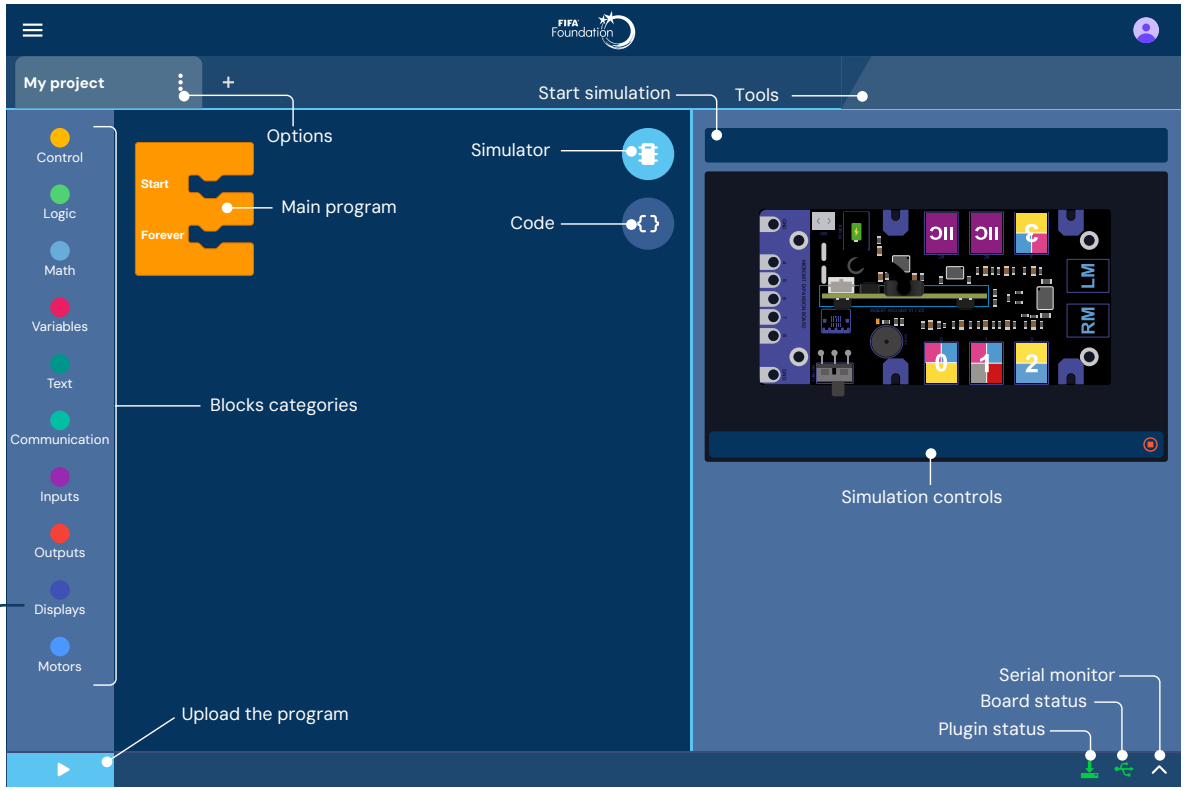
Structure of Animations



Maker Platform

The kit components are programmed in a programming environment called Blocks, which is located within the Maker platform. This space has the following tools:

https://maker.fifafoundation.org



Categories Group of blocks that have different functions. We can identify them by their colors.

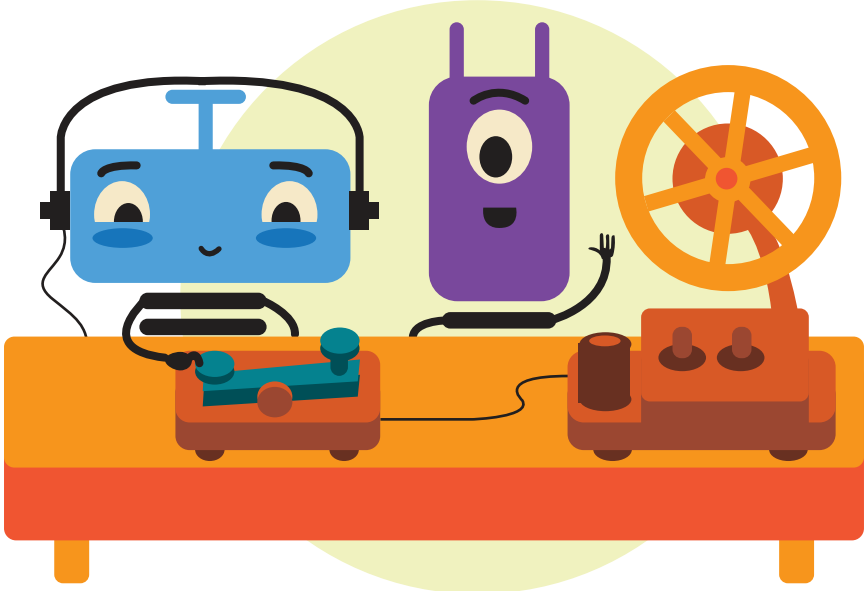
Control	Control of times and decisions in programs (for example, conditionals).
Logic	Performing operations to evaluate conditionals and compare values.
Math	Performing mathematical operations (for example, adding, subtracting, dividing).
Variables	Creation, declaration and modification of variables.
Text	Creation, modification and combination of texts.
Communication	Communication between the board and other devices to send or receive data.
Inputs	Reading the status of the sensors. They are classified as analog and digital.
Outputs	Activation of robot components (for example, LED lights and buzzer).
Displays	Activation of screens (LED matrix or LCD display).
Motors	Activation and control of the operation of motors and wheels.





Encrypted messages

1



Encrypted messages



Cloe and Ester wanted to send secret messages to each other that no one else could decipher. Before inventing a new language, they decided to do some research on communication systems that have been used by societies throughout time.

When they discovered the Morse code, they became interested in knowing the system of symbols that make up the alphabet.

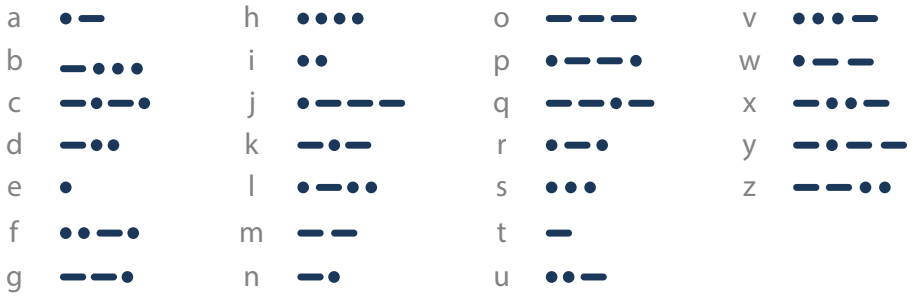
Excited to implement this form of communication, they started thinking of a machine that would allow them to send coded messages.

Let's think...

What machine could be used to send encrypted messages?
What other ways of non-verbal communication do you know?
How can they help the inclusion of people with different abilities?

Morse code is a system of dots and dashes that, through different combinations, allows you to represent the letters of the alphabet. With this code, ancient telegraphs could send messages from the combination of short and long electrical impulses. The duration of each pulse in Morse code communication is essential to interpret whether it is a “dot” or a “dash”. Combining these two symbols will allow you to form and interpret words.

1. Decode the words taking the Morse code table as a reference; then, complete the sentence using the decoded words.



A is a machine used to transmit

encoded by electrical impulses.

Investigate

1. Research the history of Morse code and answer the following questions:

a. In what year was Morse code invented? Who created it?

b. In what year was the electric telegraph built? What differences did it have with the ones used later?

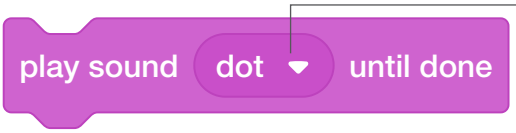
Encoder system

Ester designed a prototype that allows Morse code to be encoded. For this, she detailed the steps that must be followed to interpret Morse code.

1. Decode whether the received sound is a dot (short sound) or a dash (long sound).
2. Translate the combination of dots and dashes into letters of the alphabet.
3. Chain the letters obtained to decipher the words.

Sounds

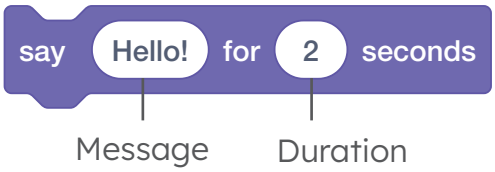
play sounds



Choose the sound

Looks

Show text

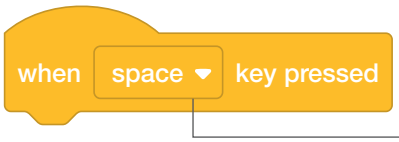


Message

Duration

Events

When key is pressed

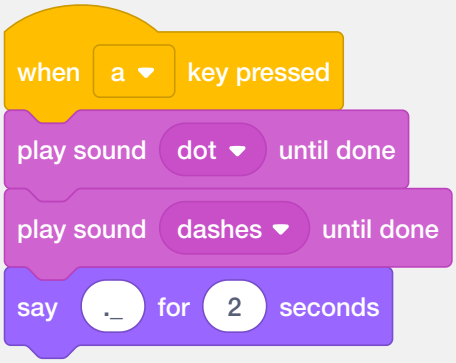


Display menu to choose the key

Key idea

The symbols come together to form letters, and the letters join together to form words. The programs work in the same way: small programs can be combined to form a larger program.

Example



When you press the “a” key the sound is short; then a long sound. Finally, it shows “. _” on stage during two seconds.

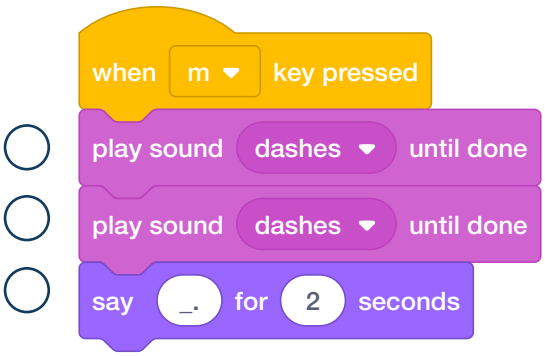


1. Access the Animations platform, run the program and answer the questions.

a. What happens when you press the “a” key? Who sends the message?

.....

2. Mark the incorrect block in each program and complete below each one with the correct code.

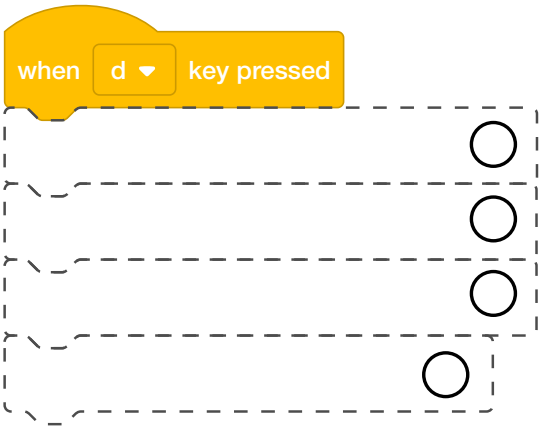


The correct message is:



The correct message is:

3. Indicate with arrows where the blocks that complete the program go.





4. What would you modify in the program to extend the screening time of the Morse code?

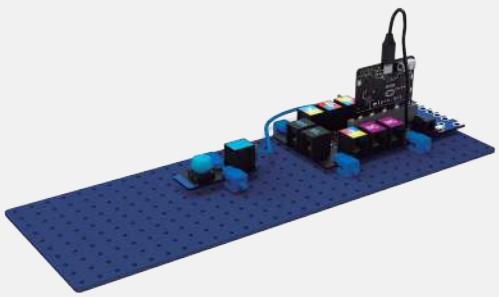
.....

5. Program the needed letters to complete the word “Morse”.

Telegraph

It's time to create our own telegraph! With the push button and the buzzer, we can create a device that plays a sound when the push button is pressed.

1. **Scan the QR code** and follow the assembly step by step.

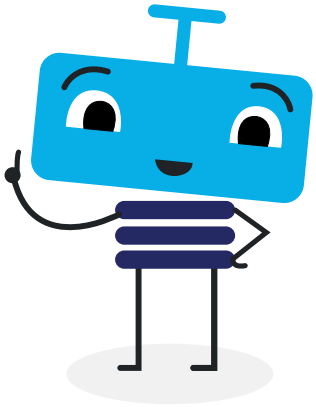


https://steamBelize.fifafoundation.org/QR/01

Components

- [ ] PC with Maker software
- [ ] USB Cable
- [ ] Control board
- [ ] Microbit board
- [ ] Push button
- [ ] Connection cables

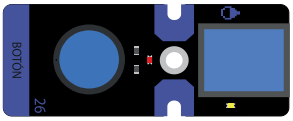
The duration of pressing the push button will determine whether it's a dot or a dash.



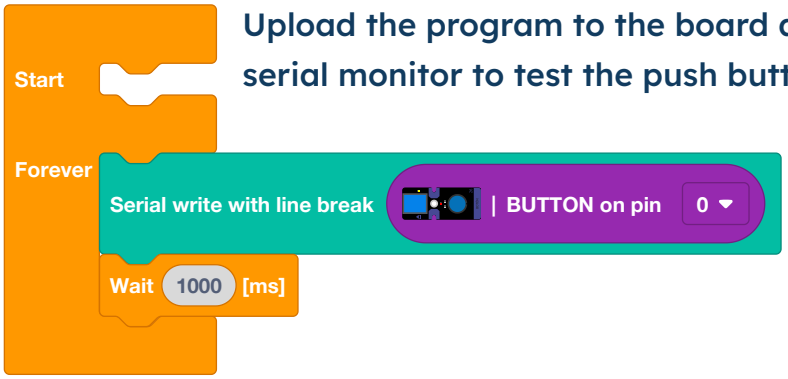
Push button

Pin 0 | Sensor

The push button is a digital sensor capable of detecting finger pressure and triggering programmed actions. The push button only has two possible states: 1 (pressed) and 0 (not pressed).



Upload the program to the board and open the serial monitor to test the push button.



Buzzer

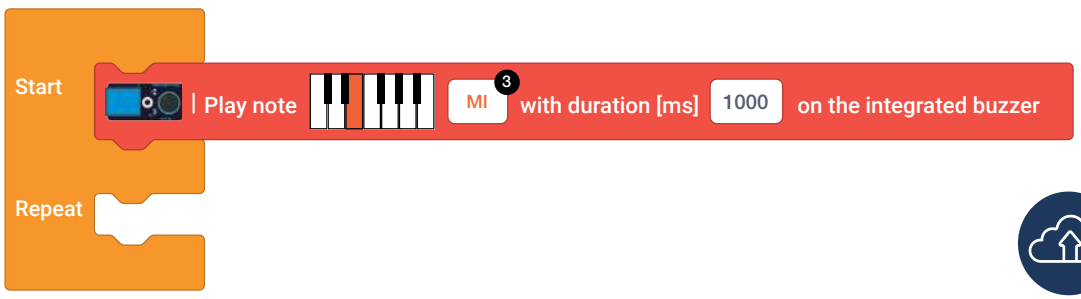
Built-in | Actuator

It is integrated into the board and allows generating a square wave sound with variable frequency. Low frequencies generate bass sounds and the most High frequencies generate high-pitched sounds. Frequency range audible by humans 20 Hz and 20,000 Hz.



It is integrated into the board

Upload the program to the board to test the buzzer.



Sound messages

In order for the telegraph to generate messages, it is necessary to program the built-in buzzer with different durations.

Control

Outputs

Wait block

The time the board waits before executing a new action. The time is expressed in milliseconds (ms).



— Wait time

play sound

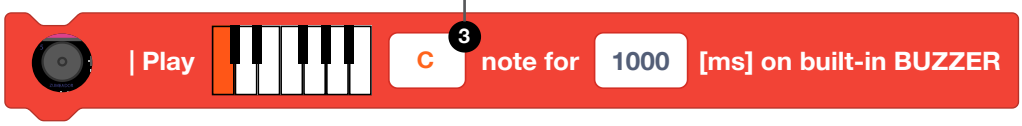
This block will activate the built-in buzzer for a specified time in milliseconds.

Key idea

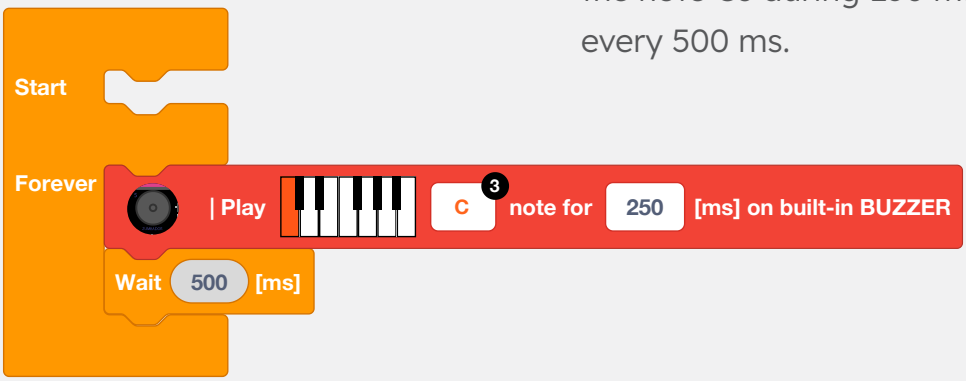
To make a sequence of sounds, it is necessary to place a waiting time between each action.



Click to open the panel



Example



In this program, the built-in buzzer plays the note C3 during 250 ms and repeats every 500 ms.

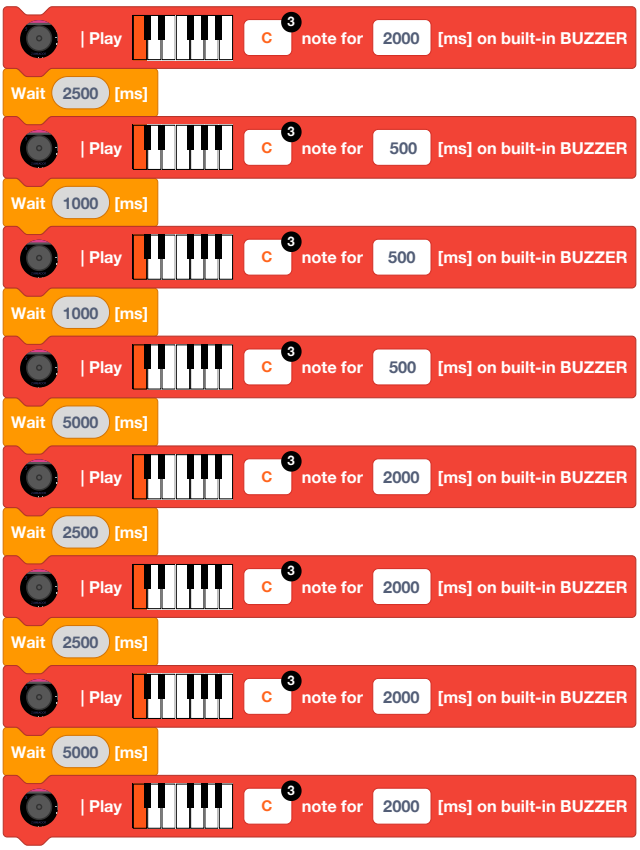
Program the message > >

1. The length of time each note is held will determine whether it is a dot or a dash. Complete the table with the required information.

a. If the dot lasts 1/4 the length of the dash, and the dash lasts 1 second, what is the duration in milliseconds of each one?

Message	Dot	Dash
Duration	_____ ms	_____ ms

2. Analyze the following program and write down the word that is formed.



Message:

_____

_____

With the kit > >

3. Assemble the program in Maker with the durations specified in point 1. Then, upload it onto the board. Where should it be placed in the structure for it to play only once?

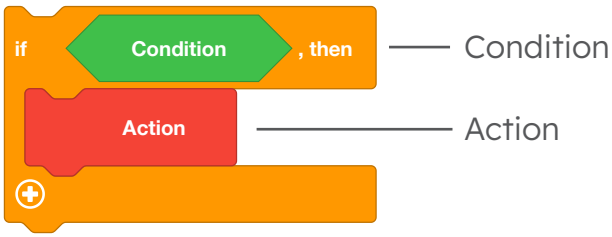
4. Program the device to send the word “hello.”

Only if I press it

In order for the telegraph to produce sounds with the push button, it is necessary to know if it is pressed. To do this, we will use conditional statements if... then.

Conditional block

Structure that allows executing one or more actions if the condition is true.



Control

Digital inputs

Reading the push button

Get the state of the push button.

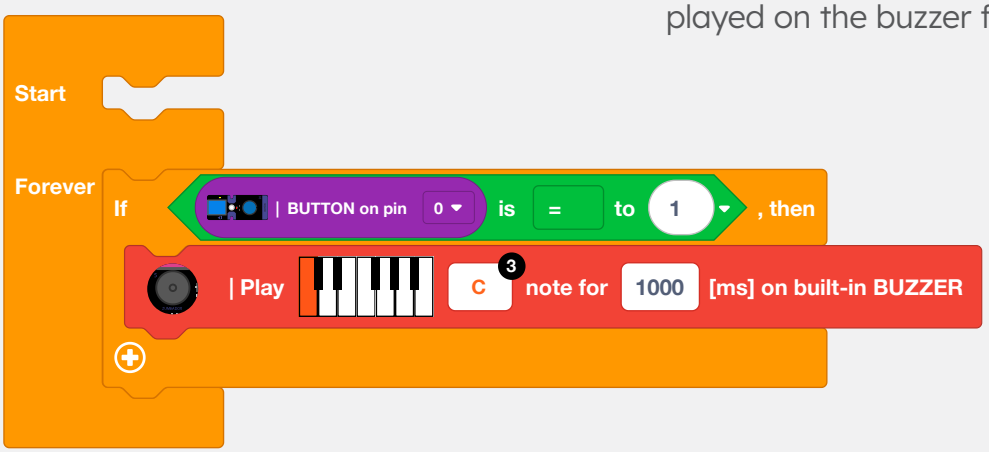


Key idea

The push button can be used with the conditional to know if it's pressed, perform a specific action.

Example

If the push button is pressed, a sound is played on the buzzer for 1 second.



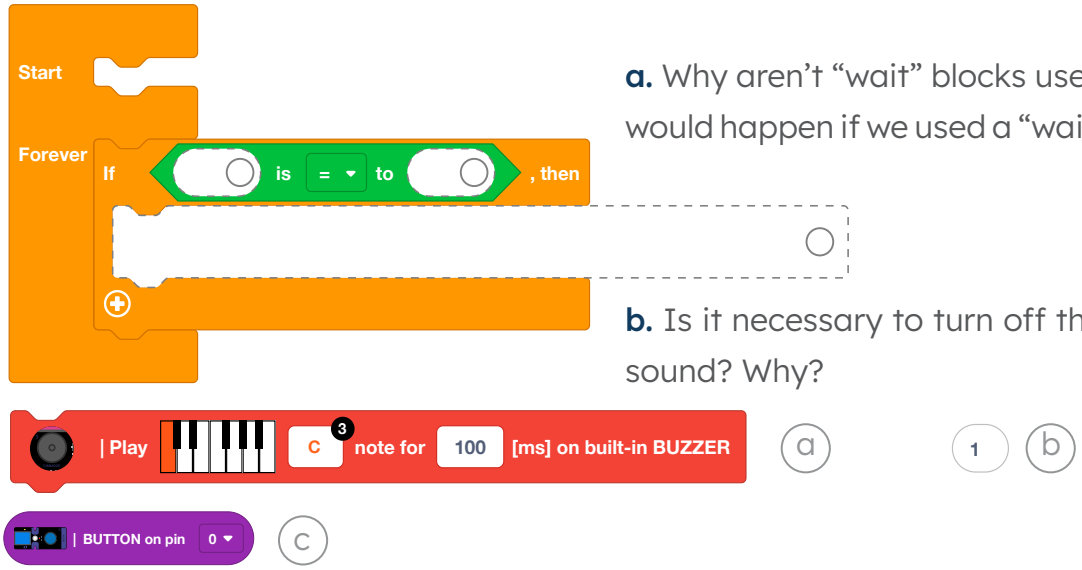
Program the telegraph > >

1. The time the button is held down will determine whether it's a dot or a dash. What should be the duration of the 'play note' block? Why?

.....

.....

2. Arrange the blocks to assemble the program correctly, then answer the following questions in the folder.



a. Why aren't "wait" blocks used? What would happen if we used a "wait" block?

b. Is it necessary to turn off the buzzer sound? Why?

With the kit > >

3. Assemble the program in Maker based on the previous exercises. Then, upload it onto the board and press the push button. What happens?

4. Change the frequency of the note to D. Is the sound lower or higher in pitch?

To think and discuss > >

The telegraph produces sounds when the push button is pressed, but what would happen if we wanted to send messages to a person with hearing impairment? How could we solve this problem? What components would be necessary?

Let's review

1. Organize the tasks involved in decoding a message in Morse code.

- ☐ String together the obtained letters to decipher the words.
- ☐ Translate the combination of dots and dashes using the Morse code table.
- ☐ Decode whether the received sound is a dot (short sound) or a dash (long sound).

2. Circle the correct options.

Which of these actions can alter the behavior of a program?

- ☐ Modifying the main program by replacing the buzzer with lights.
- ☐ Turning the board on and off several times.
- ☐ Changing the pin within the block without changing the connection to the board.

3. Indicate true or false.

a. The buzzer allows playing only one note at a time.

- ☐ True
- ☐ False, because .....

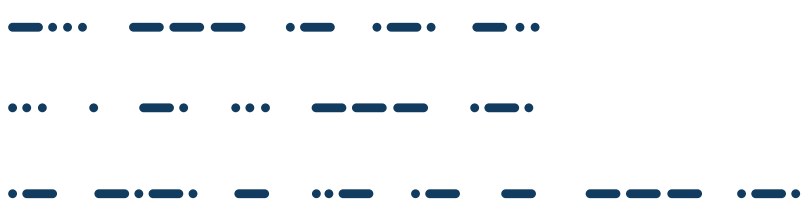
b. The telegraph can only be programmed using sounds.

- ☐ True
- ☐ False, because .....

c. The conditional allows executing one or more actions if the condition is true

- ☐ True
- ☐ False, because .....

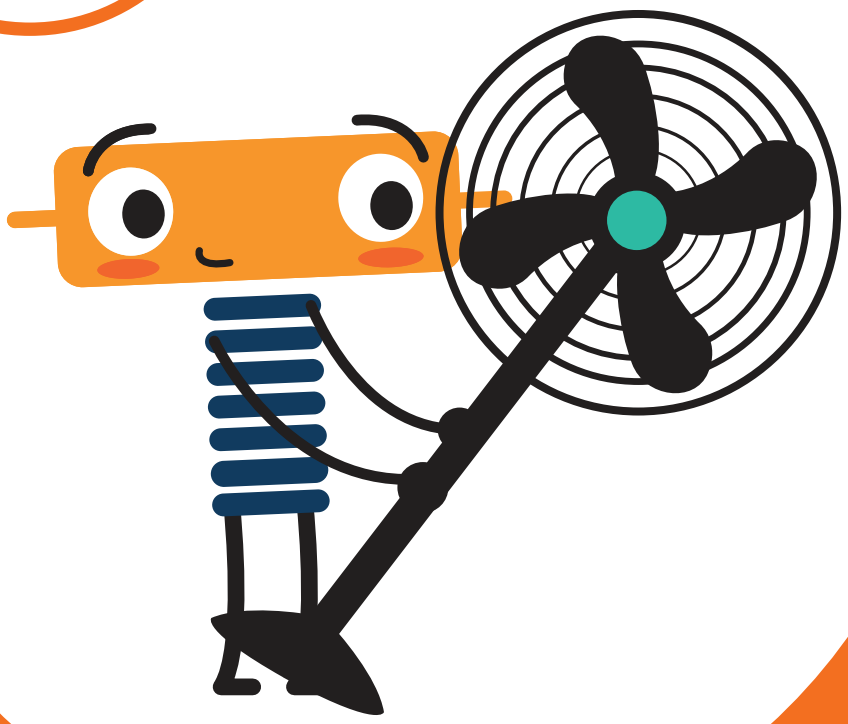
4. Connect the word with the corresponding Morse code using arrows.



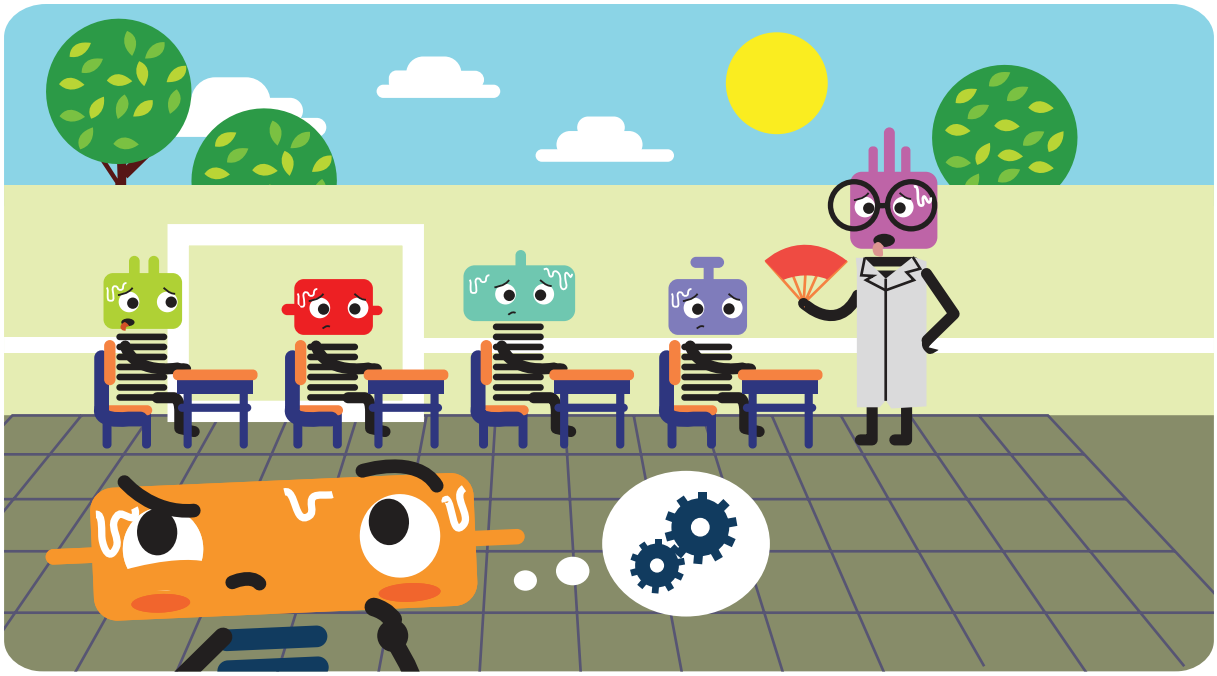
- ◯ **Actuator**
- ◯ **Board**
- ◯ **Sensor**

Weather station

2



Weather station



When Daniel arrived at class, he noticed that it was too hot in the classroom, the fan was on, and the windows were open. Nevertheless, the temperature inside the classroom kept rising throughout the day. Daniel was sure that it was hotter inside than outside, which is why when he suggested to the teacher to have the class in the schoolyard, everyone thought it was a great idea.

Once in the yard, everyone felt relief from the heat. Daniel wondered if the temperature had really changed and asked the teacher how they could check it.

Let's think...

What device would be used to measure temperature?
What are the consequences of global warming on ecosystems?
What measures can be taken to avoid global warming?

1. Read the following article and answer.

In the year 1886, an American inventor named Schuyler Skaats Wheeler worked at the Curtis Electric Motor Company, creating the first fan that operated exclusively with electricity and even commercialized the so-called Wheeler fan, which could be placed on a table. One year later (in 1887), another American inventor named Philip Diehl patented the ceiling fan.

While there were some ventilation methods in existence before, such as using leaves to create a breeze, the first fan is considered to be a handheld fan created in China, around 2697 BC.

Starting from 1820, some inefficient fans were used in mines to attempt to improve ventilation. Although they were too large and had limited efficiency, they were called volumigenic fans.

In 1849, William Brunto invented a steam-powered fan with a 6-meter radius, which was exhibited at the 1851 Universal Exhibition. Based on this model, in 1856, the Frenchman Theophile Guibal solved the problems with other fans used in mines. He invented a dynamic fan equipped with blades enclosed in an airtight chamber that captured air from the mines and expelled it outside, renewing the interior air.

a. What inventions were used before the electric fan?

.....

b. What benefits does the electric fan have compared to previous inventions?

.....



Investigate

1. Research different fan models and answer the following questions.

a. How have various fan models evolved and improved over time?

b. What other inventions have been used to combat heat? What are the differences and benefits of each of them?

Running Fan

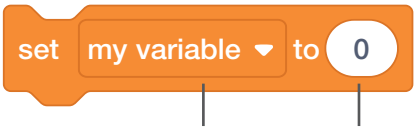
Daniel designed a prototype of a fan that allows configuring different speed levels. Additionally, he created an animated simulation to demonstrate how it would work. To program it, he used a variable.

Variables

Motion

Events

Associate value to the variable

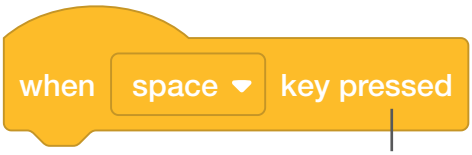


Choose variable Variable value

Access the value of the variable

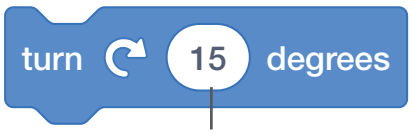


When key is pressed



Display menu to choose the key

Rotate object



Number of degrees

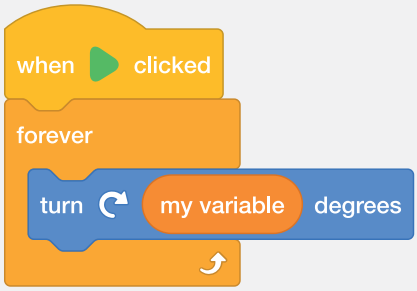
Key Idea

A variable is used to store values within a program. This value can be compared to a reference value during the program's execution to determine what action to take.

Example

The "right arrow" and "left arrow" keys allow you to change Daniel's rotation direction. When you start the program and press one of these two keys, Daniel will begin rotating clockwise or counterclockwise.







1. Access the Animations platform, run the program, and answer the questions.

a. What happens when you start the program? And when you press the “1” key?

.....

.....

b. What is the function of the “Velocity” variable?

.....

.....

2. Analyze the following blocks and describe how the fan blades behave in each case.

a



When you press the “2” key, the fan blades

.....

.....

b



When you press the “0” key, the fan blades

.....

.....

3. What would you change in the program to make the fan blades spin faster when you press the “3” key?

.....

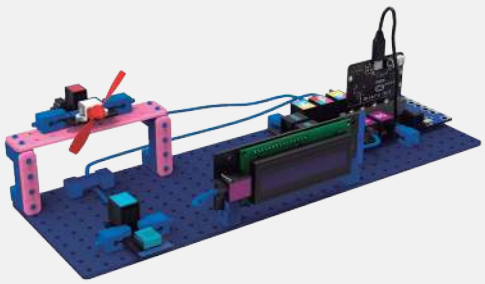
.....

4. Program the event to make the fan blades spin faster when you press the “4” key.

Smart Fan

It's time to create our own smart fan! For this, we will use the Temperature & humidity sensor, the fan motor, and the LCD display.

1. **Scan the QR code** and follow the step-by-step assembly instructions.



https://steamBelize.fifafoundation.org/QR/02

Components

- [ ] PC with Maker software
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] Temperature & humidity sensor
- [ ] LCD display
- [ ] Fan motor
- [ ] Connection cables

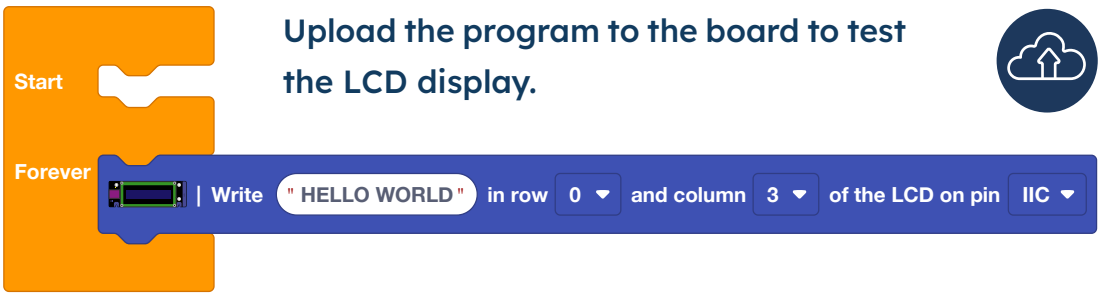
LCD display

Pin IIC | Actuator

This component allows displaying text messages with a maximum of 32 characters organized in 2 rows and 16 columns.



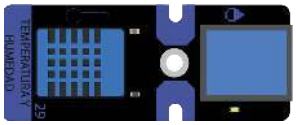
Upload the program to the board to test the LCD display.



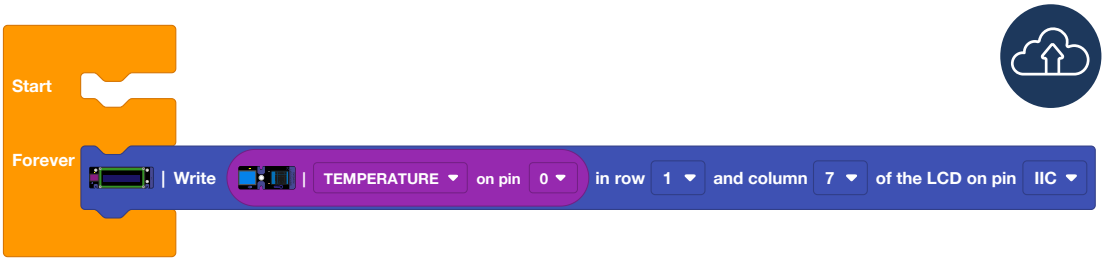
Temperature & humidity sensor

Pin 0 | Sensor

This sensor is capable of reading the ambient temperature and humidity. Unlike other digital sensors that only read two values, this one can read a range of values between 0 and 50 degrees.



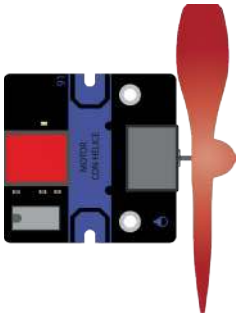
Upload the program to the board to test the temperature & humidity sensor.

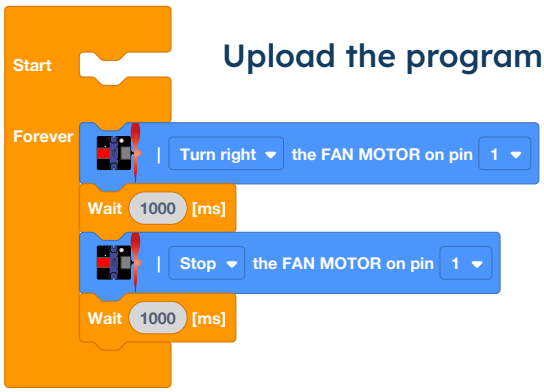


Fan motor

Pin 1 | Actuator

The fan motor is a component capable of generating an air current through the motorized movement of the propellers. The propellers can rotate to the left, to the right, or remain braked.





Upload the program to the board to test the fan motor.

Visualizing the Temperature

In a room, the temperature can vary at different times of the day and due to various circumstances. With these blocks, we can visualize those changes on the LCD display.

Temperature sensor block

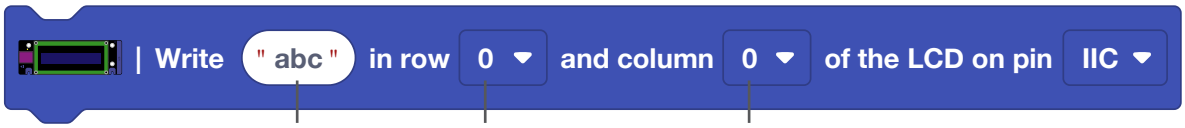
Gets the temperature in degrees Celsius or the humidity percentage of the environment.



Choose type

Write on the display

Write messages on the LCD display.



Message Row number Column number

Key Idea

Erasing texts before writing allows us to clean the LCD display and have a clear reading.

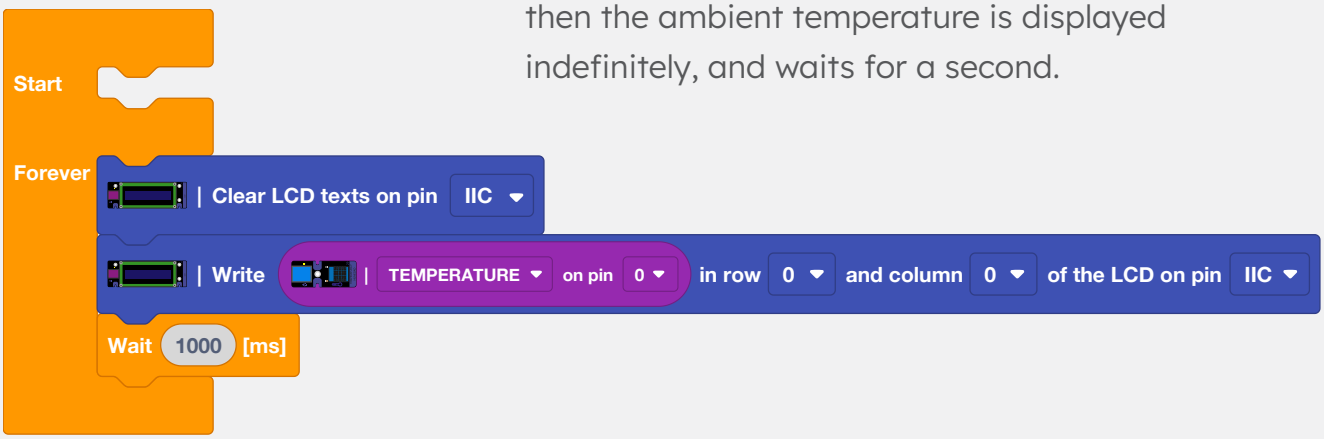
Clear display

Delete texts from the LCD display.



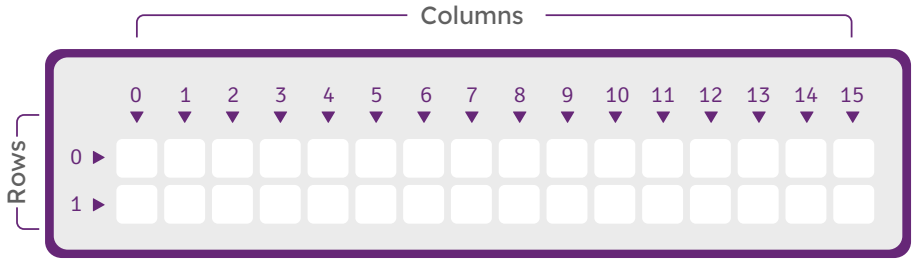
Example

In this program, the LCD display is cleared, then the ambient temperature is displayed indefinitely, and waits for a second.



Program the temperature > >

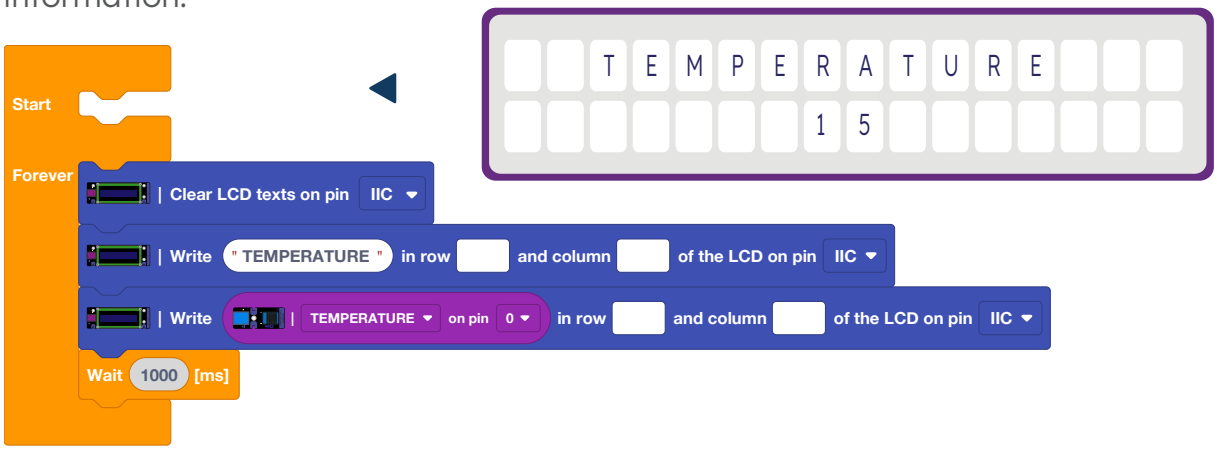
1. The LCD display is composed of 16 columns and 2 rows, with each character occupying one cell (including spaces). Analyze the following image and answer.



a. How many characters can be written in total?

☐ 16 ☐ 32 ☐ 64

2. Analyze the following message and complete the program with the missing information.



a. Why are two “write on the LCD” blocks needed?

b. What function does the “Wait” block serve in this program? What would happen if it’s not there?

With the kit > >

3. Assemble the program in Maker. Then, upload it onto the board. Do the characters appear as in the drawing in point 2?

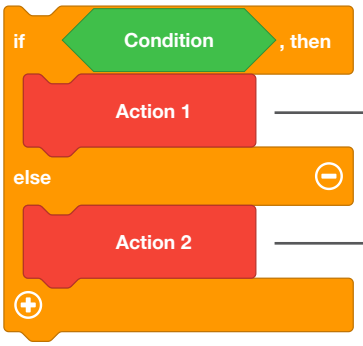
4. Program the device to write the word “C” after the temperature value.

Activate the fan

To turn the fan on or off based on the temperature, it is necessary to compare its value with a reference value. To do this, we will use the if... else conditionals.

Conditional block

Structure that allows executing different actions based on a condition.



Condition

Action 1

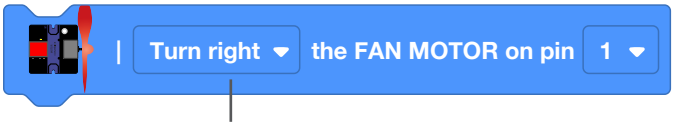
Action 2

Key Idea

The "if... else" conditionals allow executing one action if the condition is true and another action if the condition is false.

Fan motor block

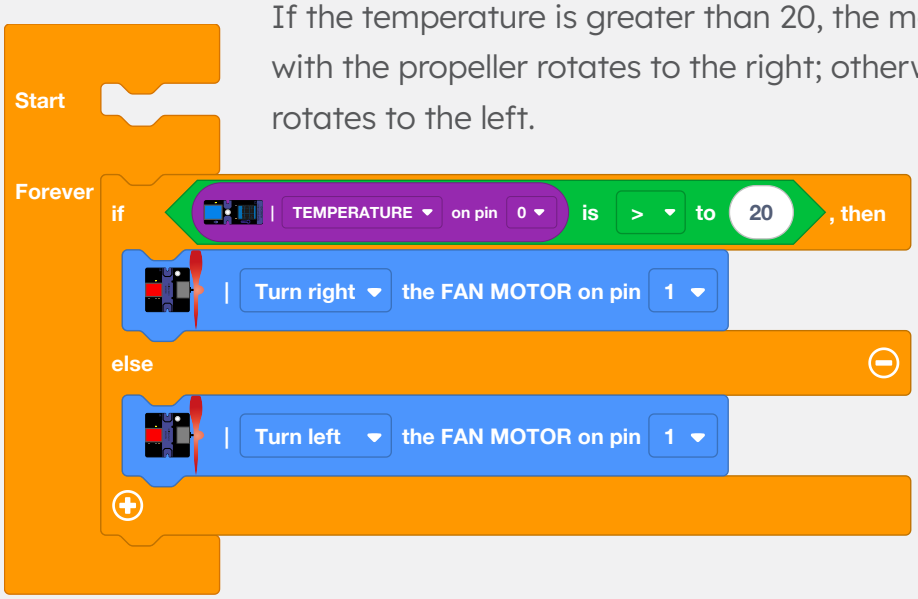
Rotate or brake the fan motor.



Display a menu to choose the rotation direction or to brake.

Example

If the temperature is greater than 20, the motor with the propeller rotates to the right; otherwise, it rotates to the left.

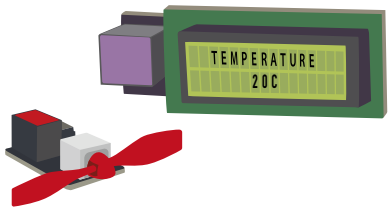


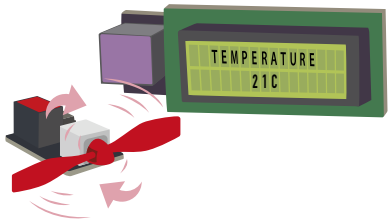
Control

Motion

Program the fan > >

1. Analyze the following illustrations.



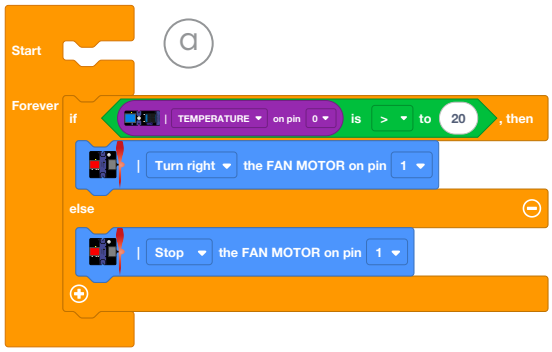


2. Complete the missing data with the information provided by the illustration.

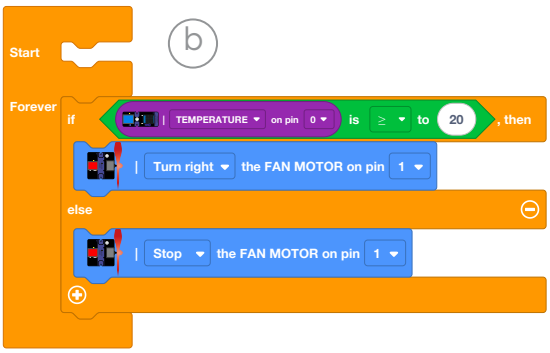
If the “Temperature” is greater than _____ , then _____ if not _____

3. According to the text from the previous point, which of these programs should they use? Justify your answer.

a



b



With the kit > >

3. Assemble the program in Maker using the programming from the previous challenge. Then upload it onto the board. What temperature is displayed, and what happens to the motor?

4. Modify the room temperature until the motor changes its state.

To think and debate > >

The weather station allows measuring the ambient temperature and activating or deactivating the motor based on it. What other climatic factor could be measured? What components would be necessary?

Review

1. Explain these concepts in your own words.

Electric Fan

Temperature Sensor

Conditional

LCD display

2. Indicate true or false.

a. The LCD display has 16 rows and 2 columns.

☐ True

☐ False, because .....

b. The electric fan has a motor that generates airflow when it rotates.

☐ True

☐ False, because .....

c. The temperature sensor is capable of reading the ambient temperature and providing a range of values from 0 to 1023.

☐ True

☐ False, because .....

d. It is not possible to adjust the fan motor rotation speed.

☐ True

☐ False, because .....

e. The comparison “a < 20” will be correct if “a” is between 0 and 20.

☐ True

☐ False, because .....

Smart parking

3



Smart Parking



Cloe went to a football match with her family. Once they arrived at the location, her dad had to drive around in circles to find a parking space. Cloe realized that the match was approaching and she was worried about not arriving on time.

Her dad told her that he had to go through all the spaces to find an available spot and that it would be very helpful to know which spaces are free and which are occupied.

Let's think...

How could we determine the available spaces?
How can technology improve traffic? What benefits does it have in the development of urbanization?

1. Read the following article and answer in your folders.

New technologies will allow vehicles to find the nearest available parking spaces using a smartphone. This would save the driver 60 hours per year.

The cumbersome task of finding a parking spot in today's vast metropolises could easily be considered one of the most exhausting challenges that millions of people face daily. Urban centers are clogged with cars, and there is inadequate infrastructure to accommodate the growing number of vehicles.

Technological advances in the field of autonomous driving have focused on addressing the parking situation. Associated with ubiquitous smartphones, the software works in conjunction with sensors placed in parking lots to inform the driver in the midst of the search process about the existence of a parking space. The system looks for the nearest spot, considering aspects such as the size of the vehicle and special needs, such as for people with disabilities or pregnant women, who are assigned specific spaces.
The driver only needs to select the most convenient space and head there, without wasting time or fuel in the process.

The parking of the future will be fast, personalized, and autonomous. This will save time for the driver and, at the same time, improve traffic flow in large cities.

a. What is the solution proposed in the article about the parking problem in big cities?

b. What benefits do smart parking systems have for the environment?



Research

1. Research smart parking systems in your country.

a. What did you find? Where are they installed? Describe their operation and components.
b. Analyze the different devices you found and answer: Which one could be implemented in your city? Why?

Available Spaces

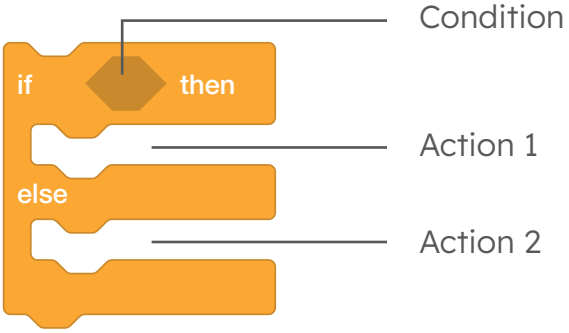
Cloe designed a parking prototype that allows detecting available and occupied spaces. Additionally, she created an animated simulation to demonstrate how it would work. To program it, she used conditionals, sensors, and costumes.

Control

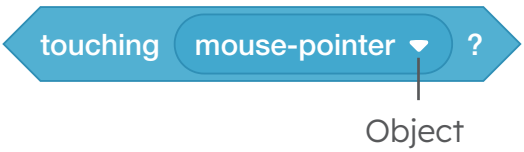
Sensors

Looks

Conditional if then else



Touching objects



Change costume

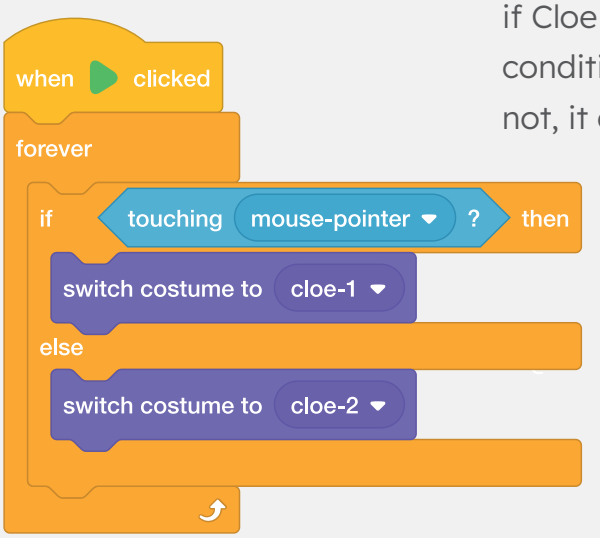


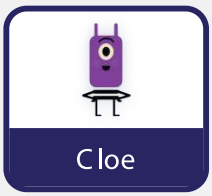
Key Idea

The blocks included in the "Sensors" category allow us to obtain specific data from the environment, the stage, or other objects. Hexagonal-shaped blocks are used to ask a question and transform into true or false based on the result.

Example

At the beginning of the program, it evaluates if Cloe is touching the mouse pointer. If the condition is correct, it changes to costume 1; if not, it changes to costume 2.





1. Access the Animations platform, run the program, and answer the questions.

a. What happens when the program starts? And when you press the arrow keys on the keyboard?

.....

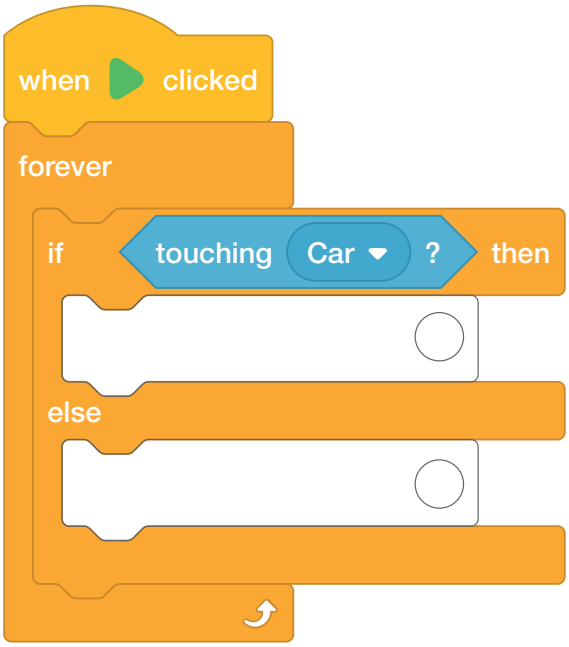
.....

b. Park the car in space "1A." What happens to the indicator?

.....

.....

2. The following blocks allow us to program a condition so that if a car touches the parking spot, it changes to "occupied." Arrange the blocks to program this behavior.



a switch costume to Busy

b switch costume to Free

3. Why does the condition ask if it's touching "Car"? What is the difference with the condition presented in the example?

.....

.....

4. Duplicate the "parking spot" object and program the behavior for the rest of the available spaces.

Smart Parking

It's time to create our own smart parking system! For this, we will use the ultrasonic sensor and the LED matrix.

1. **Scan the QR code** and follow the step-by-step assembly instructions.

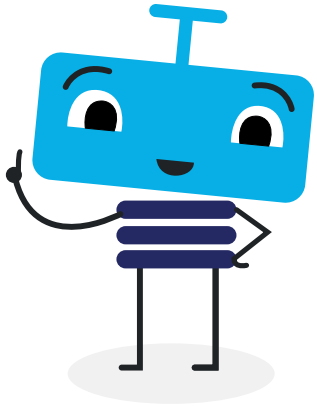


https://steamBelize.fifafoundation.org/QR/03

Components

- [ ] PC with Maker software
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] Ultrasonic sensor
- [ ] LED matrix
- [ ] Connection cables

When the sensor detects a vehicle, a cross is drawn on the LED matrix to indicate that the parking space is occupied.

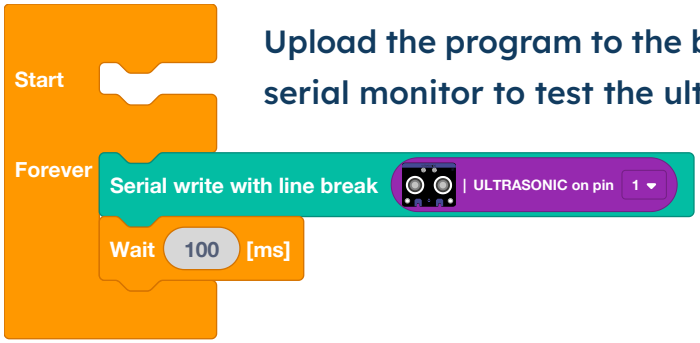


Ultrasonic sensor

Pin 1 | Sensor

This component allows measuring distances. It emits an ultrasonic pulse that bounces off an object. Taking into account the speed of the pulse and the time it takes to return, the sensor calculates the distance to the object. Its reading range is from 0 cm to 200 cm.



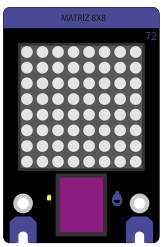


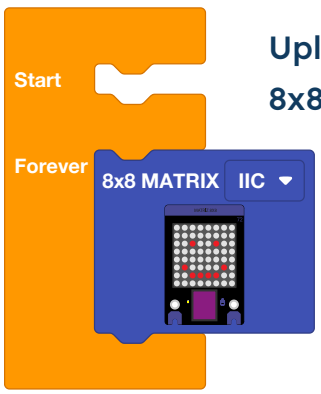
Upload the program to the board and open the serial monitor to test the ultrasonic sensor.

LED Matrix

Pin IIC | Actuator

It is a screen composed of a group of 64 individual red LEDs that can be turned on individually. It's possible to create letters and drawings by turning on some LEDs and leaving others off.





Upload the program to the board to test the 8x8 Matrix.

Know the distance

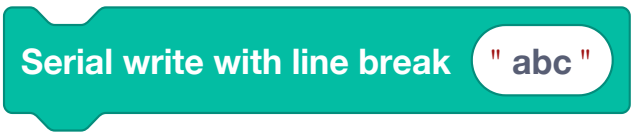
To know if the parking space is occupied or not, it's necessary to know the distance measured by the ultrasonic sensor. The serial monitor allows us to view data from the control board on the computer.

Key idea

The serial monitor allows us to view all kinds of data on the computer. It is very useful for understanding sensor values or identifying logic errors in our program.

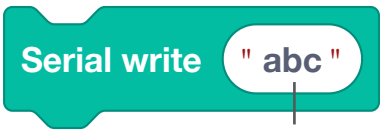
Write to serial port

Write messages to the serial port with line break.



— Message

Write messages to the serial port without line break.



Message

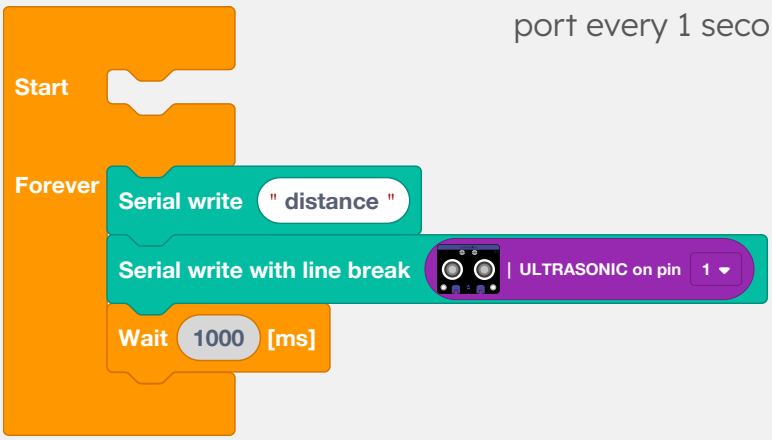
Ultrasonic block

Get the distance to an object in cm.



Example

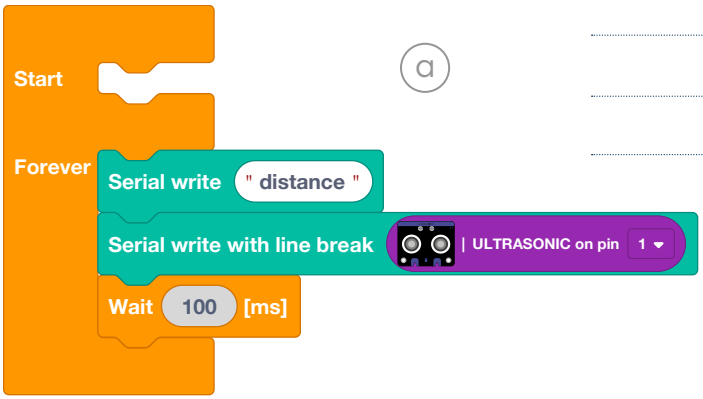
In this program, the word "distance" and the value obtained by the sensor are written to the serial port every 1 second.



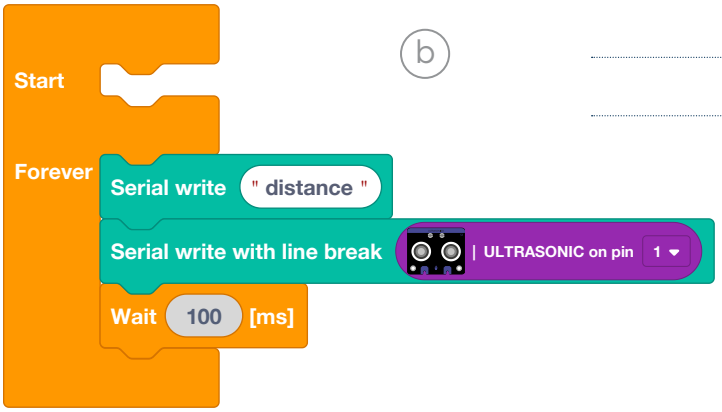
Program the distance > >

1. Analyze the following programs and explain their operation in each of them.

a



b



2. Taking the programs from the previous point, answer the following questions.

a. What is the function of the "Wait" block in these programs? What would happen if it is not there?

.....

b. What is the difference between the "Serial write" block and the "Serial write with line break" block?

.....

With the kit > >

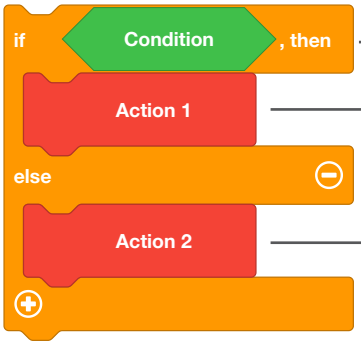
3. Create the program that allows you to have a clear reading in Maker. Then, upload it to the board and open the serial monitor. What values do you receive when placing an object close to the sensor?

Free and occupied spaces

To indicate whether the space is free or occupied, it is necessary to compare the distance value with a reference value. For this, we will use the if... else conditionals.

Conditional block

Structure that allows executing different actions based on a condition.



Condition

Action 1

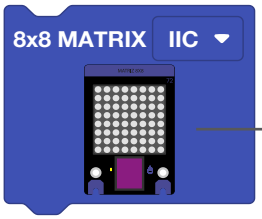
Action 2

Block to draw on the matrix

Turning individual LEDs on or off on the LED matrix.

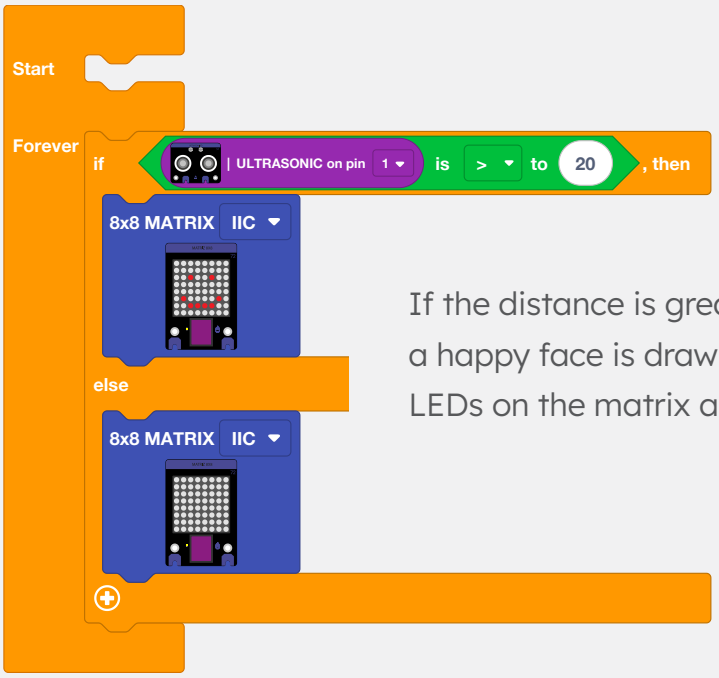
Key idea

The “draw on the LED matrix” block allows you to choose from different pre-designed drawings or create your own design by clicking on the LED you want to turn on or off.



Click to open the panel

Example



If the distance is greater than 20 cm, a happy face is drawn. Otherwise, all LEDs on the matrix are turned off.

Program the free and occupied spaces > >

1. Analyze the table and fill in when the space is free and when it is occupied.

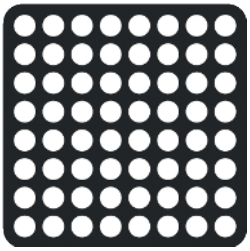
Distance	Place
7 or more cm	
4 or less cm	

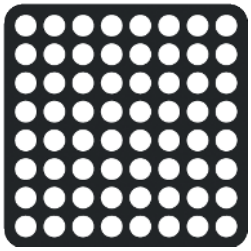
2. Based on the information from the previous table, which of these options allows you to program the first condition? Justify your answer.

a 

b 

The option that allows programming the first condition is the ..... because .....





3. Create a design to display on the LED matrix when the space is available and when it's occupied.

With the kit > >

3. Set up the program in Maker based on the previous exercises. Then, upload it to the board. What design is displayed on the matrix? And what happens when you place the vehicle?

4. Adjust the ambient temperature until the motor changes its state.

To think and debate > >

Smart parking allows us to indicate the available and occupied spaces.
How could we count the number of available spaces in a parking lot?
What programming structure would be necessary?

Review

1. Mark true or false.

a. To determine if a space is available or occupied, sensors are used.

☐ True

☐ False, because .....

b. The ultrasonic sensor allows obtaining the distance to an object in millimeters.

☐ True

☐ False, because .....

c. The comparison “a ≥ 10” will be correct if “a” is greater than 11.

☐ True

☐ False, because .....

d. To display data from the controller board on the computer, the serial port is used.

☐ True

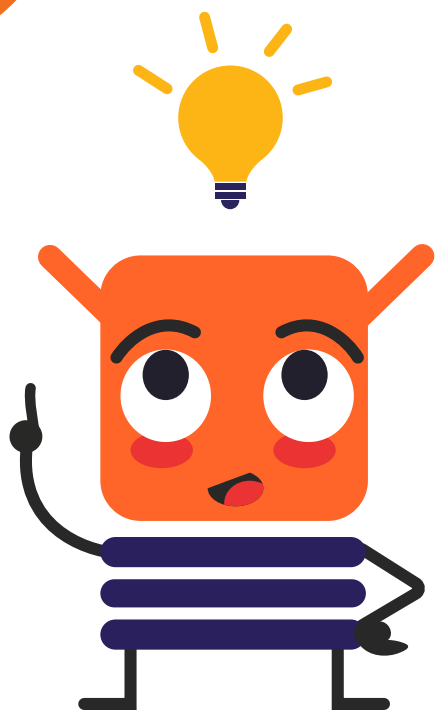
☐ False, because .....

2. Connect the parts of the phrases with arrows.

1. The LED matrix is...	A sensor that allows measuring the distance to an object.
2 . The ultrasonic sensor is...	A programming structure that allows sending data to the computer.
3. A conditional is...	An actuator that has 64 red LED lights that can be controlled individually.
4. The serial port is...	A programming structure that allows executing different actions depending on a condition.

Energy Saving

4



Energy Saving



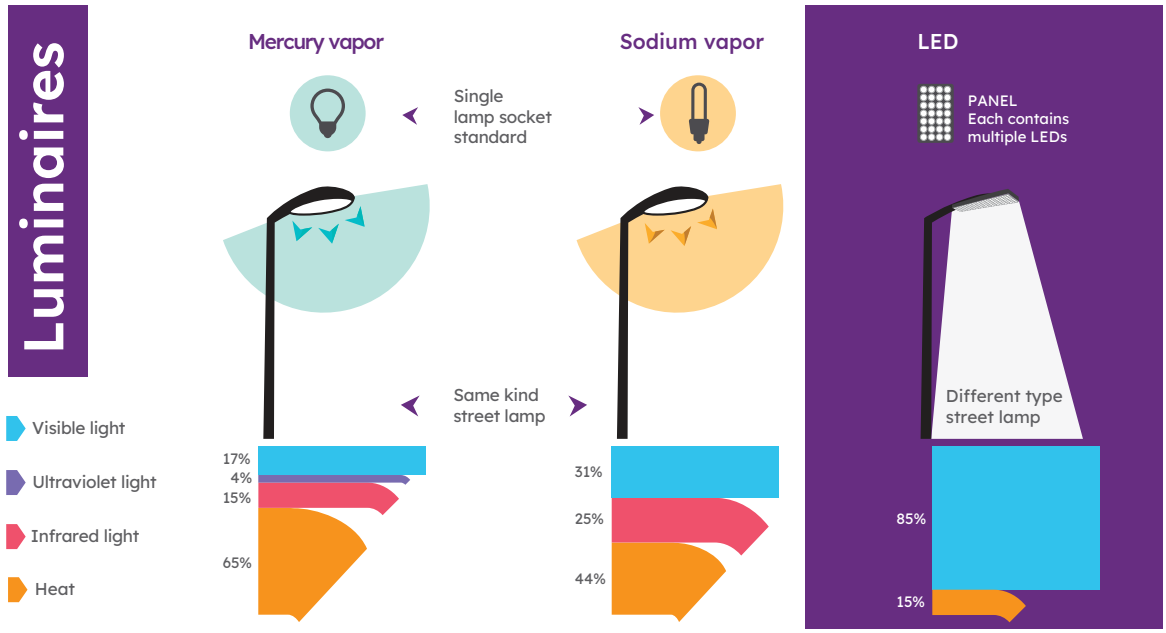
The building where Ubaldo lives has many common areas, and lately, he has noticed that the lights in these spaces remain on for many hours a day, even when they are not needed. Whenever he finds the lights on during the day, he turns them off, and he even put up a sign asking his neighbors to do the same, but he hasn't had much success. For this reason, he decided to discuss his problem with his friend Daniel, to find a solution together.

Let's think...

How can we solve the electricity consumption problem in the building?
How does energy conservation contribute to environmental preservation?

1. Analyze the following infographic and respond:

Technologies used in urban lighting



Source: https://grlum.dpe.upc.edu/manual/index2.php

a. What is the most efficient technology for lighting? .....

b. How many mercury vapor lamps are needed to obtain the same amount of light as one LED technology lamp?

c. If LED technology is used to achieve the same amount of light as a sodium vapor lamp, what will be the percentage of energy savings?

.....

Investigate

1. Make a research and answer the following questions.

a. What measures for saving electricity do you take at school or in your homes?

b. What everyday practices can you change to reduce electricity consumption?

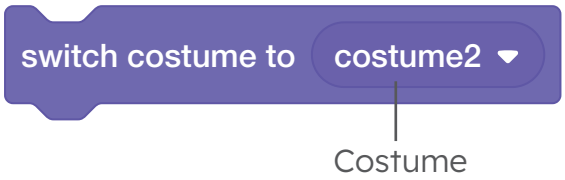
c. Do the streetlights stay on all day? How do they work?

Intelligent Lighting

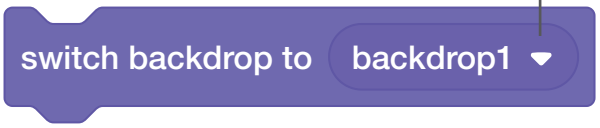
Ubaldo designed a prototype of intelligent lighting that allows lights to turn on only when there is a person in the area. Additionally, he created an animated simulation to demonstrate how it would work. To program it, he used events and costumes.

Looks

Change costume



Change background



Events

When receiving message

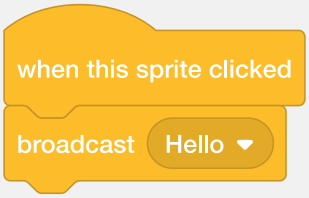


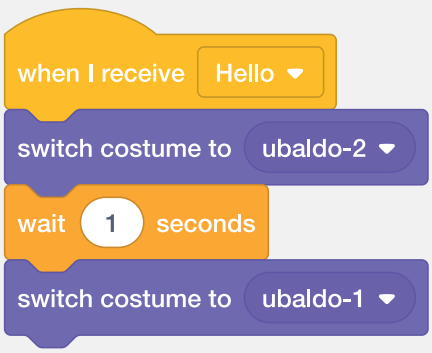
Key Idea

Messages are actions that are automatically executed upon receiving specific data, allowing us to communicate with one or more objects.

Example

In this program, we have two objects: “Daniel” and “Ubaldo.” “Daniel” sends the message “Hello” when it is pressed. When Ubaldo receives the message “Hello”, he changes his costume, waits for a second and changes his costume again.









1. Access the Animations platform, run the program, and answer the questions.

a. What happens when the program starts?

.....

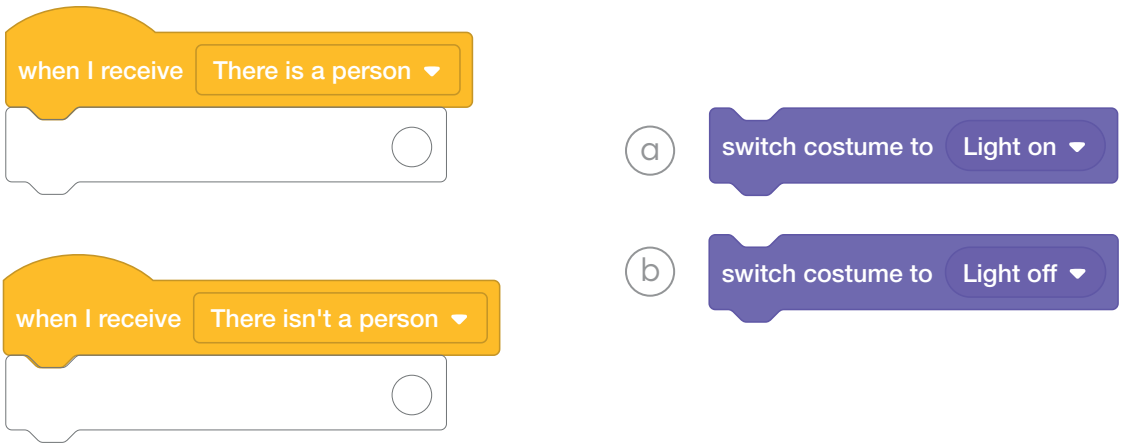
.....

b. What is the state of the hallway light when Ubaldo appears?

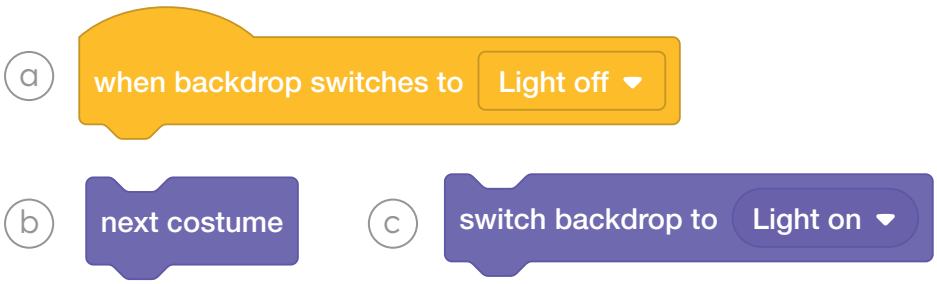
.....

.....

2. Ubaldo sends two messages, “There is a person” and “There isn’t a person”. The “Light” object should change to on or off when receiving these messages. Arrange the blocks to program this behavior.



3. Analyze the program and answer: Which of these blocks allows us to change the background costume when the light is on?

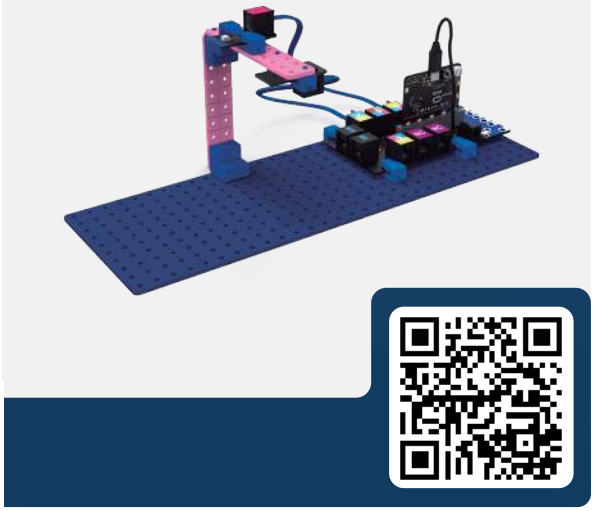


4. Add the block to change the background to “off” when there is no person.

Automatic Lighting

It's time to create our own automatic lighting system! To do this, we will use the light sensor and the white LED.

1. **Scan the QR code** and follow the step-by-step assembly instructions.



https://steamBelize.fifafoundation.org/QR/04

Components

- [ ] PC with Maker software
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] White LED
- [ ] Light sensor
- [ ] Connection cables

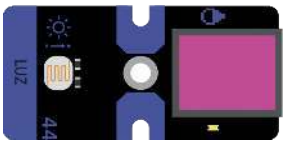
The LED will be controlled by the light sensor, turning it on and off.

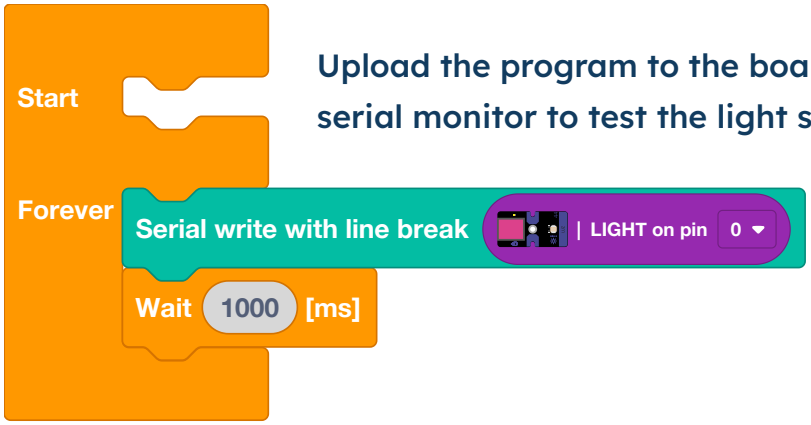


Light Sensor

Pin 0 | Sensor

This component has an LDR (Light Depending Resistor) that allows it to detect the presence of light in the environment. It provides a value within a reading range from 0 to 1023.



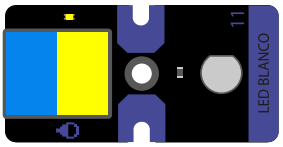


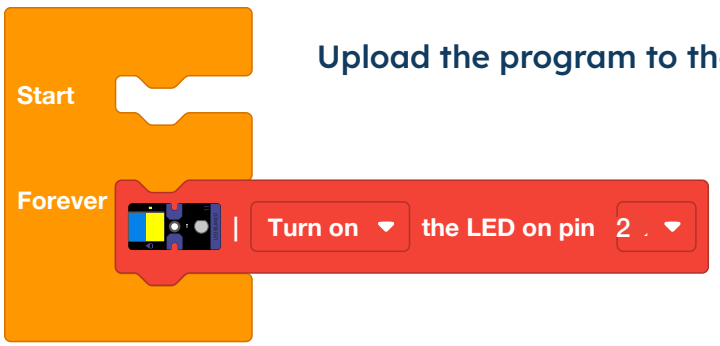
Upload the program to the board and open the serial monitor to test the light sensor.

White LED

Pin 2 | Actuator

The acronym LED stands for “light-emitting diode.” When turned on, it emits bright white light. This component allows you to control the on/off state as well as adjust the brightness of the light.





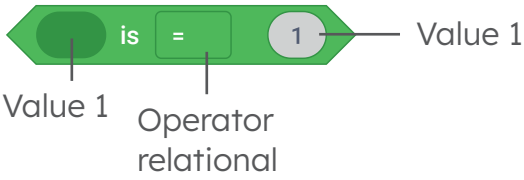
Upload the program to the board to test the LED.

Automating On/Off

To determine whether the LED should turn on or off, it is necessary to know the ambient light intensity.

Relational Operation Blocks

Relational operators are symbols that allow us to compare two values. If the comparison is true, the condition is considered true.



Key idea

When a system has analog sensors, such as the light sensor, it is common to use relational operators to determine if the sensor reading is greater or less than a threshold value. Compound conditionals can also be used to check if the value is within a range.

LED block

Turn the white LED module on or off



Click to turn on or off

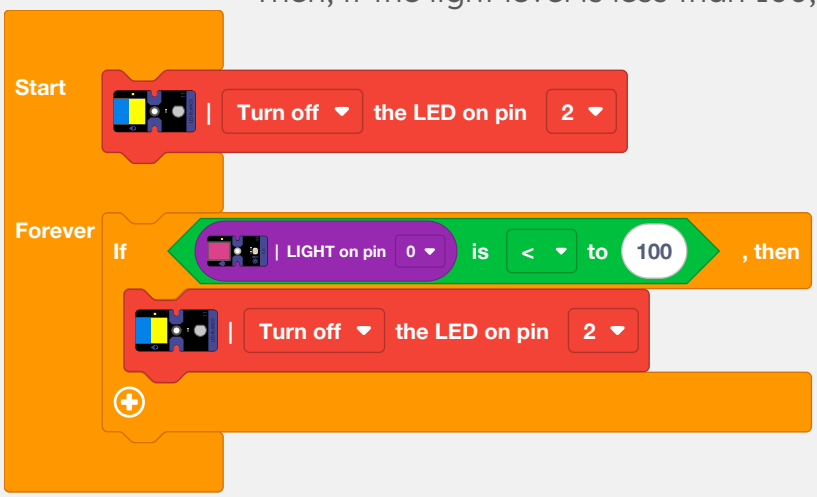
Light sensor block

Get the ambient light level



Example

At the beginning of the program, the LED turns off. Then, if the light level is less than 100, it turns on.

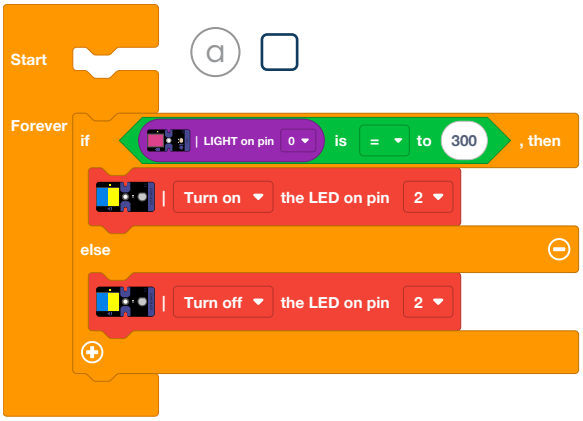


Programming the On/Off > >

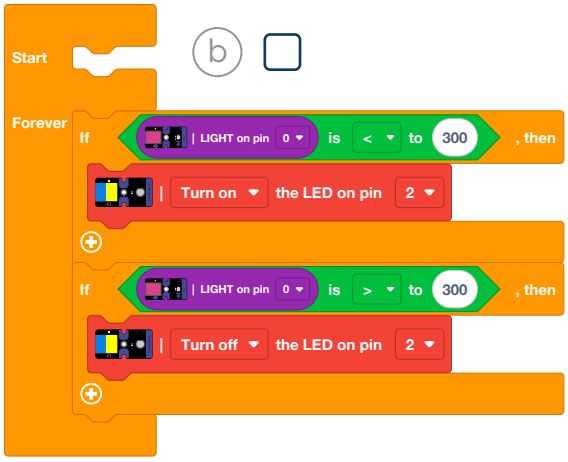
Our system will work as follows:
If the light intensity is less than 300, turn on the LED. If not, turn it off.

1. Indicate which of the following programs solve the challenge and which do not. For those that do not, justify why in your folders.

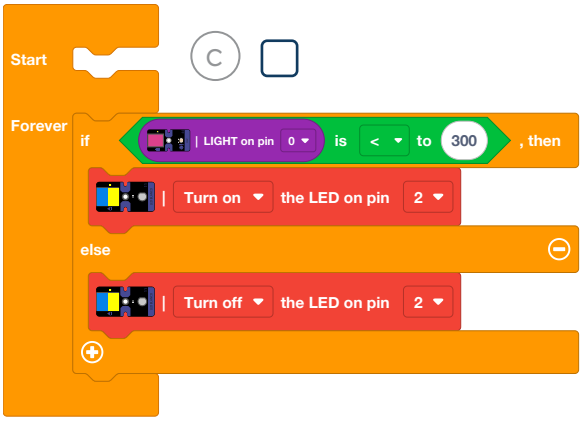
a ☐



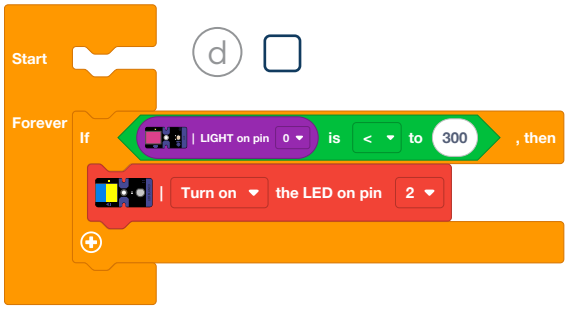
b ☐



c ☐



d ☐



2. Among the previous programs, is there more than one that solves the challenge? If so, answer which one you would use and why.

.....

With the kit > >

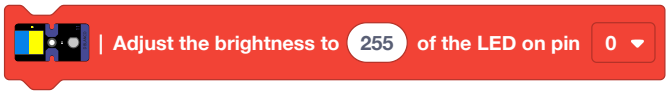
3. Create the program that best solves the challenge in Maker. Then, upload it to the board. What happens to the LED when you change the lighting in the room?

Adjusting the light intensity

The amount of light in the environment can vary throughout the day, and the intensity of artificial lighting doesn't necessarily have to be the same at all times. To do this, we will adjust the brightness of the LED to accommodate this change.

Adjust brightness block

Structure that allows executing different actions based on a condition.

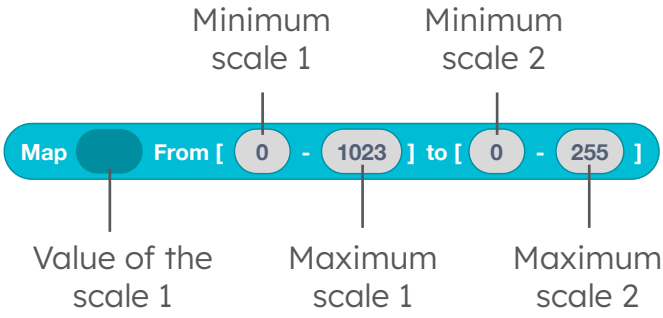


Key idea

To modify the brightness of the LED, the board uses a type of signal called PWM (pulse width modulation). By varying the on time, you can adjust the LED brightness level between 0 and 255.

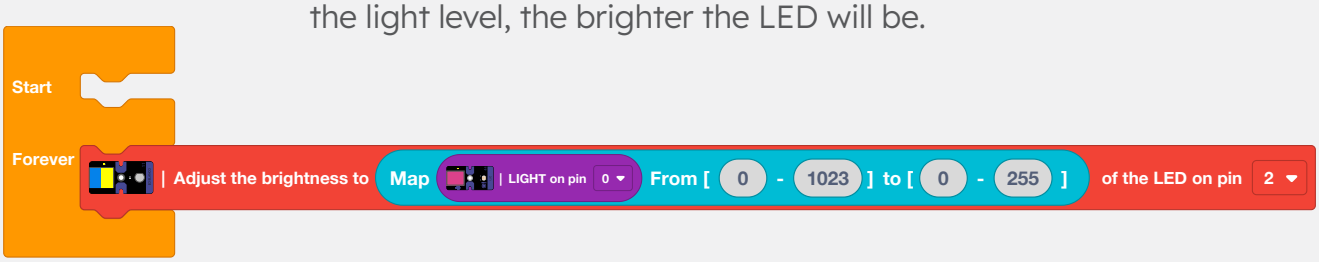
Map block

It allows us to transform a value from an origin range to its proportional value in a destination range.



Example

During the program's execution, depending on the light level, the brightness of the white LED will be adjusted. The higher the light level, the brighter the LED will be.

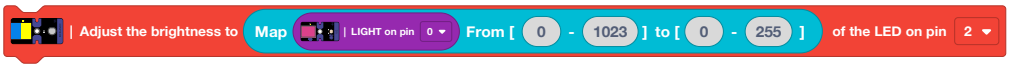


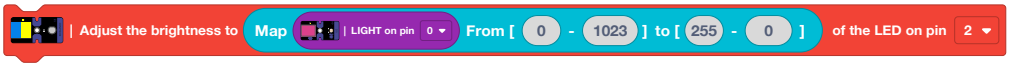
Program LED brightness > >

1. In the following table, the minimum and maximum levels of brightness detected by the sensor and the brightness level of the LED in each case are indicated. Please complete the table with the missing data.

Light level	Lighting condition	LED brightness	LED illumination percentage
0	Night (total darkness)		100%
	Day (total brightness)	0	0%

2. Taking the information from the previous table, mark which of the following blocks allows you to transform the brightness of the LED into the specified range. Justify your answer.

a ☐ 

b ☐ 

c ☐ 

With the kit > >

3. Build the program in Maker based on the previous exercises. Then, upload it onto the board. What happens to the LED when the ambient light level changes?

4. Use a flashlight to illuminate the light sensor at different distances. Can you see the brightness of the LED gradually changing?

To think and debate > >

The automatic lighting system adjusts the light intensity depending on the ambient light level. How could we control the lighting so that it only turns on when a person is detected? What components would be necessary?

Review

1. Indicate true or false.

a. The LED module can be lit in different colors.

☐ True

☐ False, because .....

b. The blocks to program the light sensor are located within the “digital inputs” category.

☐ True

☐ False, because .....

c. The range of values delivered by the light sensor ranges from 0 to 255.

☐ True

☐ False, because .....

d. The “map” block allows transforming a value from a source range to its proportional value in a target range.

☐ True

☐ False, because .....

2. Circle the correct option.

a. The white LED allows modifying the LED intensity with values ranging from...

☐ 0 to 102 ☐ 0 to 255 ☐ 0 to 1

b. The light sensor processes a/an...

☐ Digital signal ☐ PWM signal ☐ Analog signal

c. When the light sensor outputs 1023, it means that...

☐ There’s too much light ☐ There is little light ☐ There is no light at all









Penalty time



Penalty Shootout



Daniel and Ester were full of determination as they prepared for the upcoming football championship. For weeks, they trained hard and adopted a special diet. One early Saturday morning, the coach gathered them at the training field for a special lesson. He focused on the most intriguing part of the game: penalty shootouts. With meticulousness and patience, he showed them strategies to guess the direction of the ball and anticipate the opponent's movements in the crucial moments of penalty kicks.

Daniel and Ester were eager to put these valuable lessons into practice in the upcoming tournament, knowing that they were better prepared than ever.

Let's think,

How can we use technology to help players perfect their techniques during the game? How does proper nutrition benefit athlete's performance?

Scientists from the University of Berkeley, California, and the Georgia Institute of Technology used a machine learning system (reinforcement learning) to enable MIT's Mini Cheetah robots to act as real-world football goalkeepers. They use cameras to capture motion to determine where the ball will go and send signals to the Mini Cheetah robot so that it knows the proper maneuver to stop the goal.

1. Watch the following video and answer:

Scan the QR code to access the video:
https://steamBelize.fifafoundation.org/QR/15



a. What technology does it use to detect and determine the trajectory of the ball?

.....

b. What is the robot's success rate in stopping balls?

.....

c. In what situations does the robot fail?

.....

Investigate

1. Research on other devices designed to stop shots on goal and answer the questions.

a. What devices did you find?

.....

b. What technology do they use to anticipate the trajectory of the ball?

.....

c. What margin of effectiveness do they have?

.....

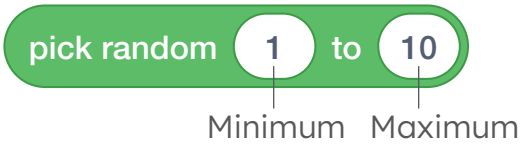
Goalkeeper

Ester designed a prototype of an automatic penalty stopper that keeps track of the goals scored. Additionally, she created an animated simulation to demonstrate how it would work. To do this, she programmed a character to stop shots on goal.

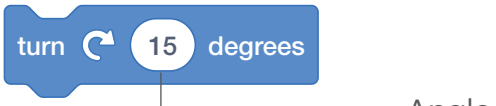
Operators

Motion

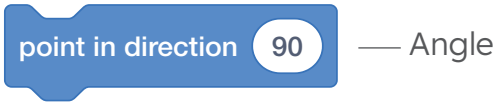
Random number



Rotate



Point



Key Idea

The “rotate” and “point” blocks allow you to modify the direction in which an object points. The angle is measured in degrees, where 0 degrees points to the right, 90 degrees points upward, 180 degrees points to the left, and 270 degrees points downward.

Example

At the start of the program, Ester positions herself at 90 degrees, waits for 1 second, rotates randomly, and moves a random number of steps.





1. Access the Animations platform, run the program, and answer the questions.

a. What happens when you start the program?

.....

b. Use the left or right arrow keys and press the space key. What happens to the ball?

.....

2. When kicking the ball, Ester must choose which way to throw herself and then move a few steps in that direction. Analyze the program and order the blocks to program the random values in each case.



(a) pick random -70 to 70

(b) pick random 1 to 10

3. Modify the program to play a sound every time a goal is scored. Which of these blocks would you add? Mark the option you consider correct.

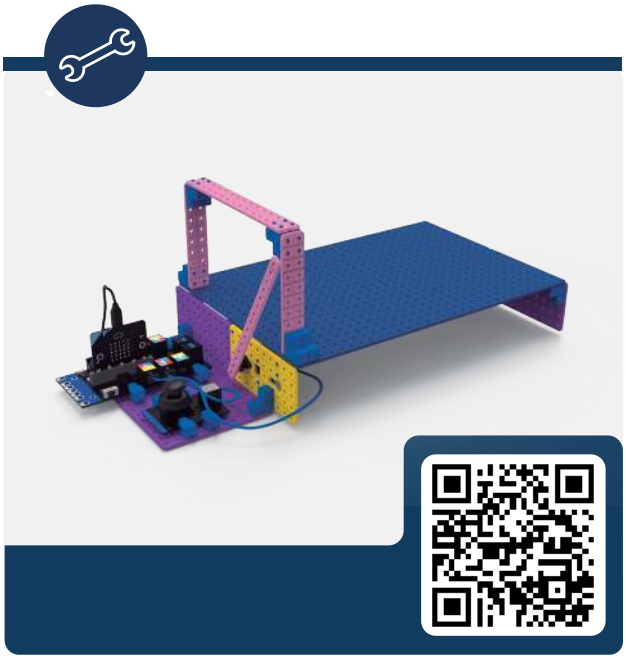
(a) play sound Goal Cheer until done

(b) start sound Goal Cheer

Penalty Stopper

It's time to create our own penalty stopper! To do this, we will use the joystick and the servo motor.

1. **Scan the QR code** and follow the step-by-step assembly instructions.



https://steamBelize.fifafoundation.org/QR/05

Components

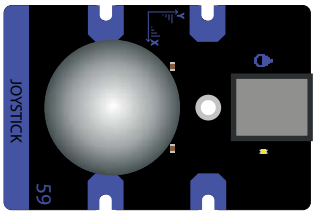
- [ ] PC with Maker software
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] Joystick module
- [ ] Servo motor
- [ ] Ball
- [ ] Connection cables

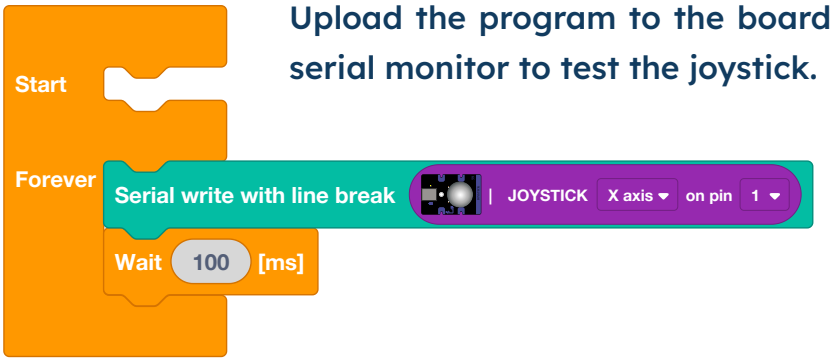


Joystick Module

Pin 1 | Sensor

It is an analog sensor that allows you to control movements based on the angle of inclination of a lever linked to two potentiometers, one for horizontal movement and another for vertical movement.



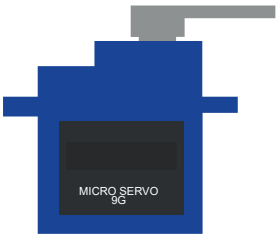


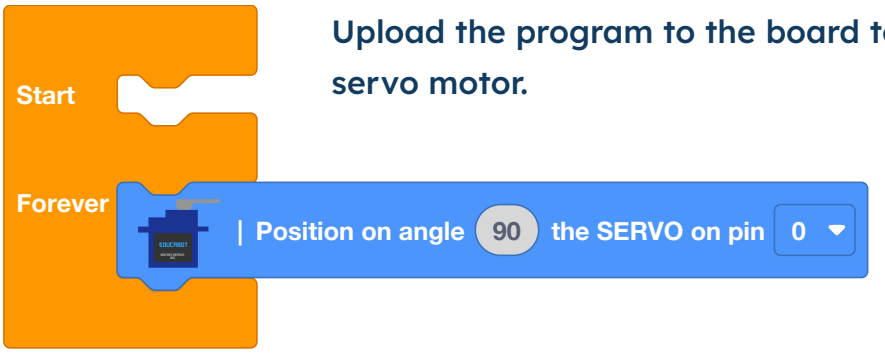
Upload the program to the board and open the serial monitor to test the joystick.

Servo motor

Pin 0 | Actuator

The servo motor is an actuator capable of generating a rotational movement and holding a stable position at a specific angle. Opening range: 0° to 180°.





Upload the program to the board to test the servo motor.

Moving the Goalkeeper

To make our goalkeeper effective, we need to know the angles of movement that will allow us to cover all areas of the goal.

Servo motor block

Move the servo motor to a specific angle



Angle

Wait block

Time the board waits before executing a new action. Time is expressed in milliseconds (ms).



Time of wait

Key Idea

The servo motor consists of a direct current motor, a gear case, and a control circuit. It has a built-in regulation system that can control the exact position it is in.

Example

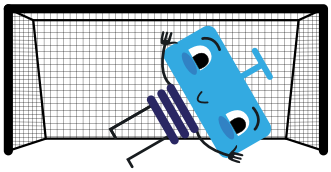
In this program, the servo motor is positioned at 0°, waits for 1 second, moves to 180°, and waits for another second.

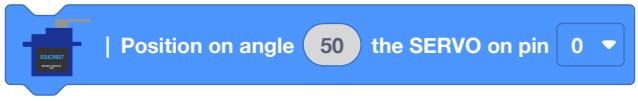


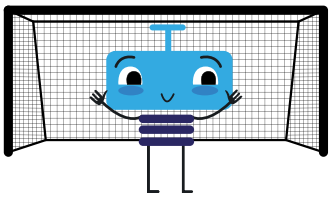
Programming the Movement > >

1. The goalkeeper will have 3 positions: center, left, and right. Analyze the table and match the angles with the corresponding goalkeeper's position.

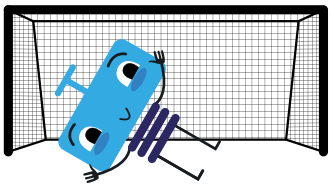












With the kit > >

2. Set up the program in Maker to move to each side. Then, upload it to the board. What happens with the goalkeeper?

3. Verify if the movement angles match the goalkeeper's positions. If they don't, what angles did you set?

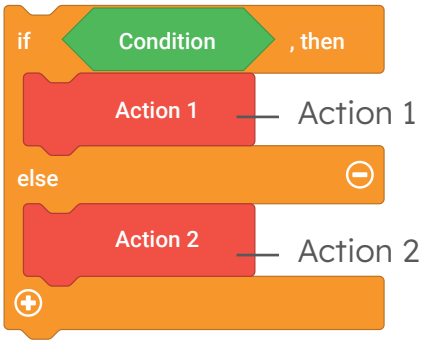
LEFT _____ CENTER _____ RIGHT _____

Control the Goalkeeper

With the established movement angles, we will use the joystick to control where the goalkeeper moves.

Conditional block

A structure that allows executing one or more actions if the condition is met.



Key Idea

Conditionals allow adding more conditions using the "+" button in the block. Each added condition is concatenated with the previous one.

Joystick block

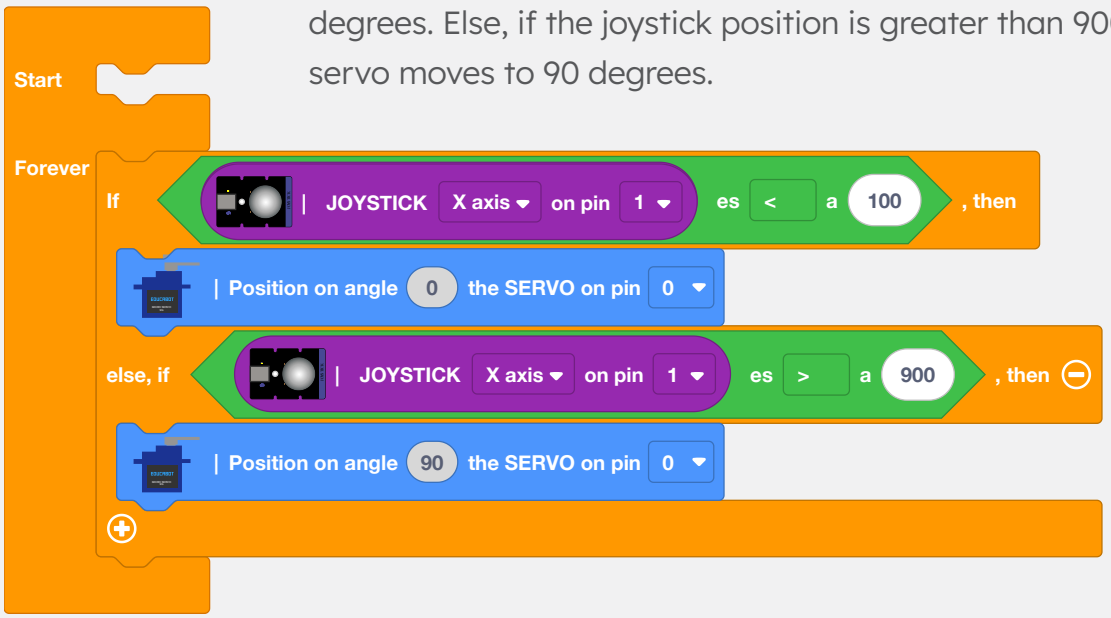
Allows you to read the position of the joystick in a certain axis.



Movement axis

Example

If the joystick position is less than 100, the servo moves to 0 degrees. Else, if the joystick position is greater than 900, the servo moves to 90 degrees.

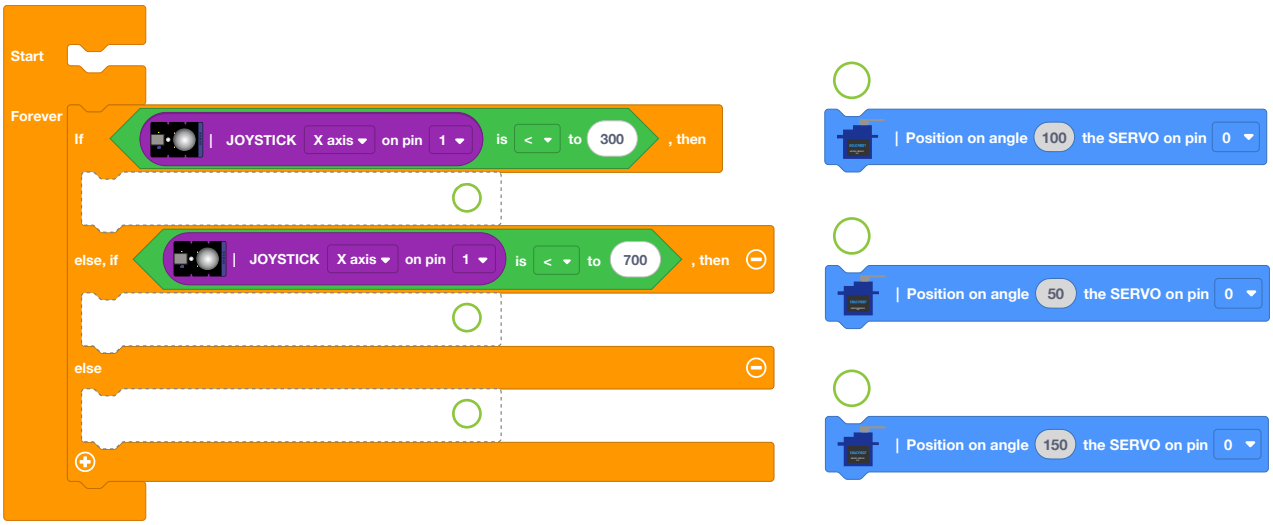


Program the goalkeeper > >

1. Analyze the following table that sets the movement ranges of the joystick's X-axis.

Right		Center		Left	
0	299	300	699	700	299

2. Analyze the following conditions and match them with the corresponding movement block using arrows.



With the kit > >

3. Create the program in Maker using the programming from the previous challenge. Then, upload it to the board. What is the initial position of the goalkeeper? What happens if you move the joystick?

To think and debate > >

The goalkeeper moves according to the position of the joystick's X-axis. What improvement could be made? What components would be necessary?

Review

1. Circle the correct option:

The joystick module allows...

a. measuring the tilt angle of the X-axis.
b. measuring the tilt angle of both X and Y axes.
c. controlling the movement of the X-axis.

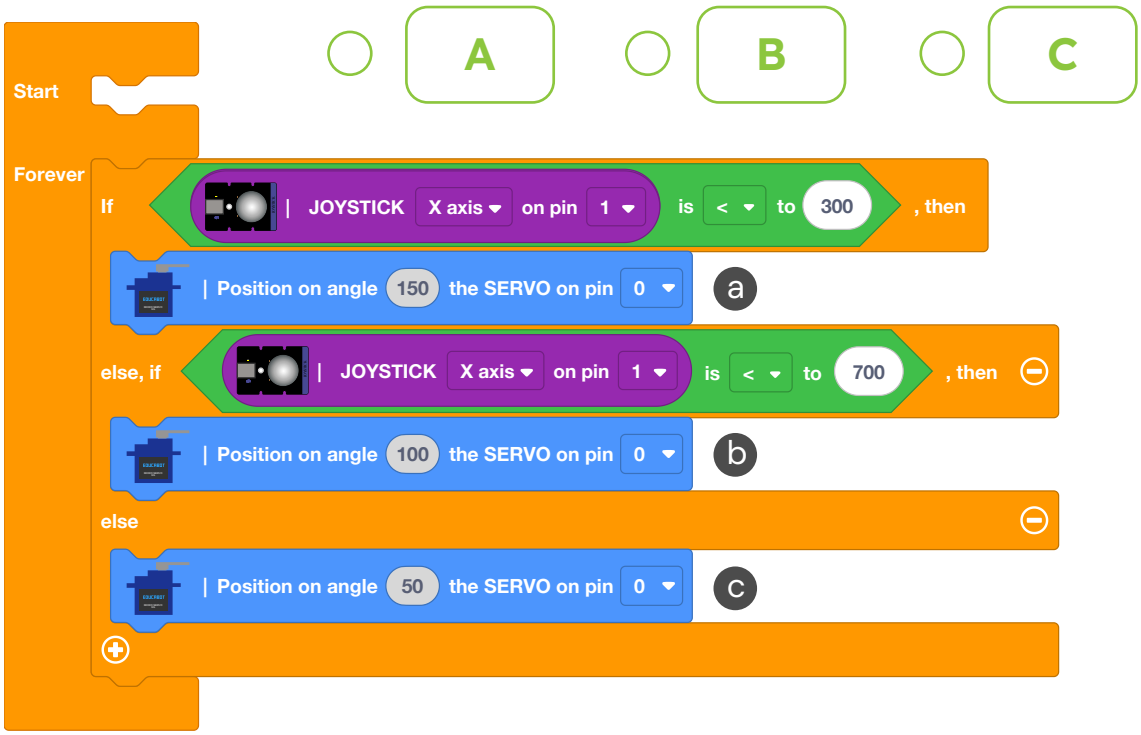
The joystick module is an...

a. analog sensor
b. digital sensor.
c. actuator

The servomotor is a sensor whose opening angle can be between 0° and 180°.

☐ True
☐ False, because .....

2. If the X-axis of the joystick measures 300, which condition is executed?



Football bots



Football bots



As Cloe walked back home after school, her eyes stumbled upon an intriguing announcement that read: “FootballBots Championship - Robotic Football League.” A shiver of excitement ran down her spine, as it combined two great passions in life: playing football and building robots. With a twinkle in her eyes, she couldn’t resist the temptation, and upon reaching home, she began to look for information about the rules and requirements to participate in that thrilling championship.

Let’s think...

How can such a popular sport like football help promote science and technology among young people? How could women be encouraged to participate in these activities?

1. Read the following article and answer:

WILL ROBOTS TRIUMPH OVER WORLD CUP WINNERS BY 2050?

The RoboCup dream has inspired generations of roboticists.

RoboCup is an annual international event where teams work on AI and robotics, addressing challenges like autonomous football playing, household chores, and disaster response. It drives advancements in machine learning, multiagent systems, and human-robot interaction.

RoboCup's original goal was to have autonomous humanoid robots beat human football teams by 2050. The competition, starting in 1997, has grown to include various robot football leagues. The 2023 edition took place in Bordeaux, France and hosted 2,500 humans and 2,000 robots from 45 countries.

In 1997, the first RoboCup had modest competition levels, but it encouraged integrated robotic systems. Achieving RoboCup's founding goal by 2050 remains uncertain, given the challenges of real-world perception and human-like agility for robots. Hardware and software improvements are needed.

RoboCup remains a significant challenge for AI and robotics, offering a rich training ground for the next generation of roboticists and fostering innovation in the field.

Source: https://spectrum.ieee.org/robocup-robot-soccer

a. What is RoboCup about?

.....

b. What was the initial goal of the competition?

.....

c. What are the major challenges mentioned in achieving that initial goal?

.....

Investigate

1. Research other competitions of this kind and answer the questions.

a. What is the main objective of these competitions?

.....

b. Are the robots autonomous or controlled by human players?

.....

c. Is there any similar proposal in the city where you live?

.....

Humans vs. Robots

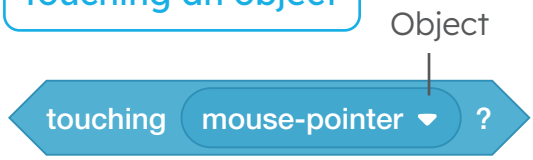
Cloe designed a football video game where a human competes against an intelligent robot. For this, she programmed the robot's behaviors and the control of the human player.

Sensing

Operators

Motion

Touching an object

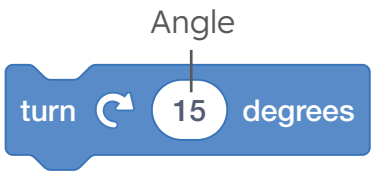


Mathematical functions



Pointing towards and Rotate



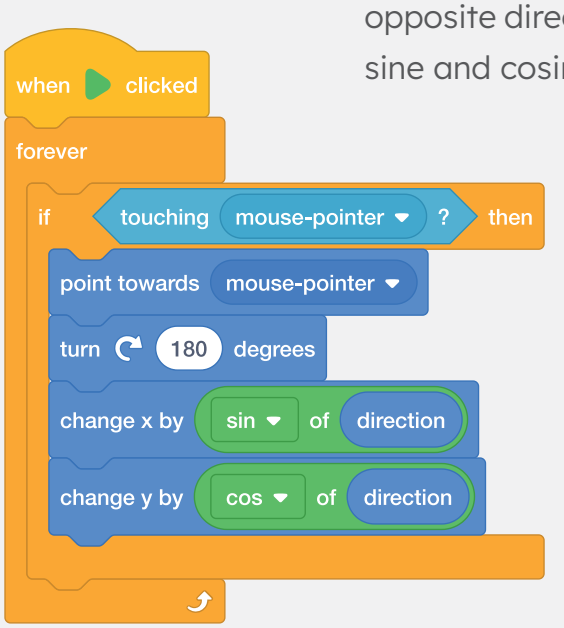


Key idea

The mathematical functions block allows you to perform complex operations like square root, sine or cosine of an angle, absolute value, logarithm, among others. Different functions can be chosen from the dropdown menu.

Example

If Cloe is touching the mouse pointer, she points in the opposite direction and moves in that direction using the sine and cosine functions.





1. Access the Animations platform, run the program, follow the game instructions, and answer the questions.

a. What happens when you start the program?

.....

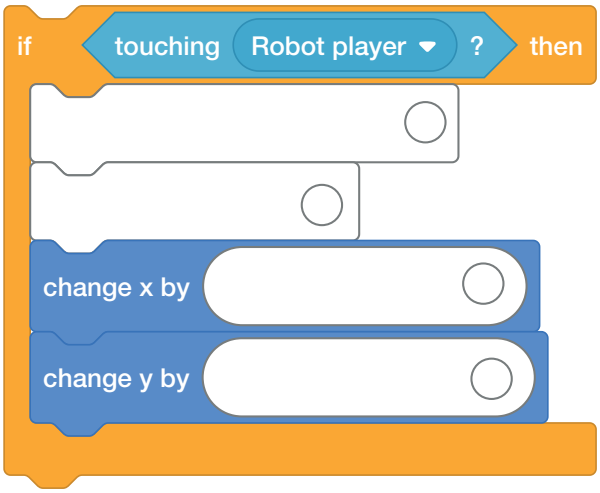
b. Use the keyboard arrows to move Cloe. Were you able to score a goal?

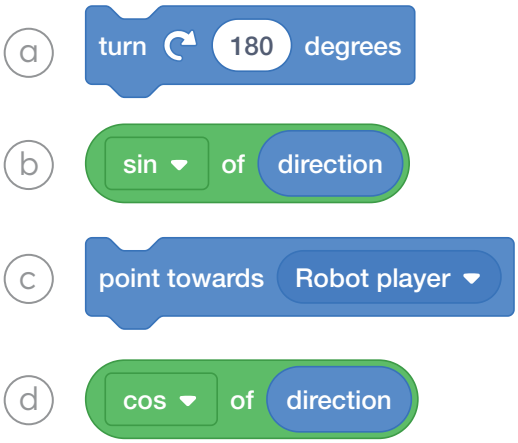
.....

c. What happens if you collide with the robot?

.....

2. When colliding with the robot, Cloe should move in the opposite direction. Analyze the program and arrange the blocks for it to work correctly.





3. Run the program with the modifications from the previous step. What happens when you collide with the robot?

.....

.....

4. Play a round of matches and then discuss among yourselves. Was it easy to defeat the robot player?

.....

Football-playing Robot

It's time to create our own football-playing robot! To do this, we will use the motors and the control app.

1. **Scan the QR code** and follow the step-by-step assembly instructions.



https://steamBelize.fifafoundation.org/QR/06

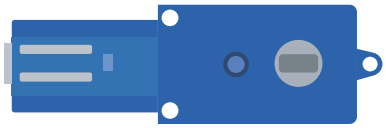
Components

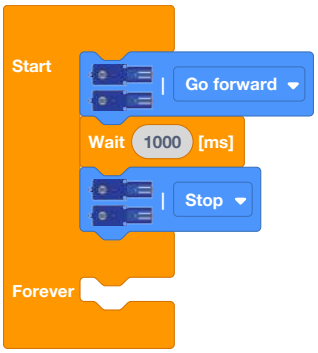
- ☐ PC with Maker software
- ☐ Device with Bluetooth connectivity and Control app
- ☐ USB cable
- ☐ Control board
- ☐ Microbit board
- ☐ Motors
- ☐ Football ball
- ☐ Connection cables

MR & ML pins | Actuator

DC Motor

It is an actuator that allows the wheels to move and turn left or right. You can also control the speed (0 to 255).



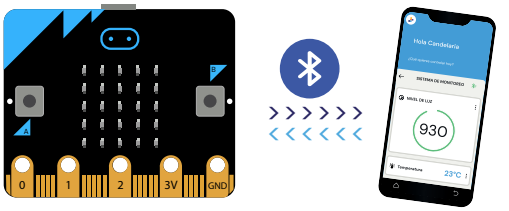


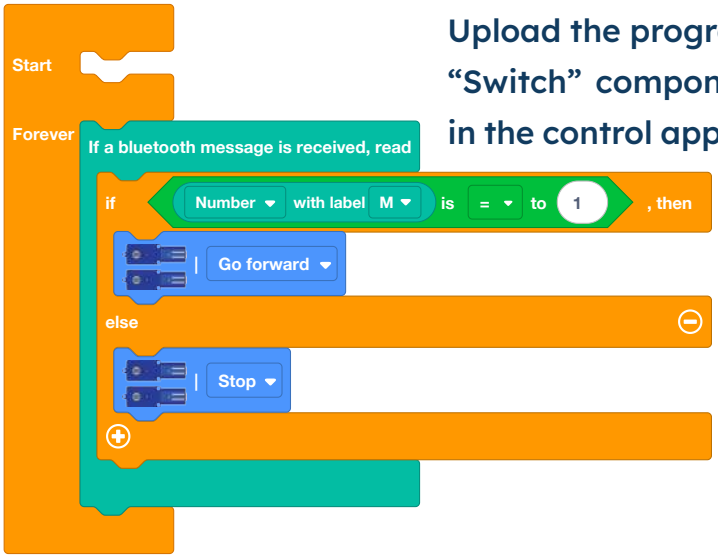
Upload the program to the board to test the motors.

Bluetooth Module

Integrated | Communication

The Bluetooth module allows us to communicate wirelessly between the board and the control app.



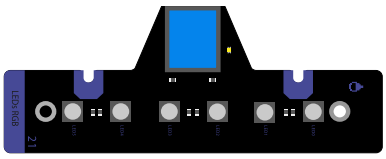


Upload the program to the board, add a "Switch" component with the label "M" in the control app, and test its operation.

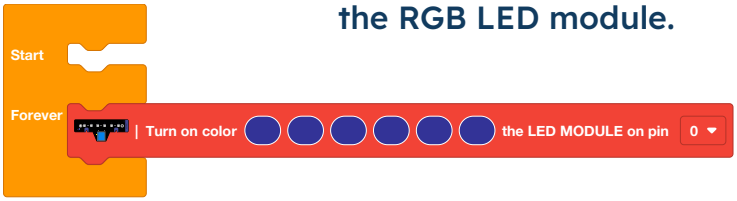
RGB LED module

Pin 0 | Actuator

This component has six RGB LED lights that can be individually controlled.



Upload the program to the board to test the RGB LED module.

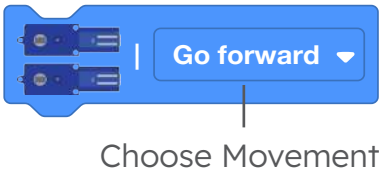


Moving the Robot

To be able to play, we need to program the robot's control using the control app.

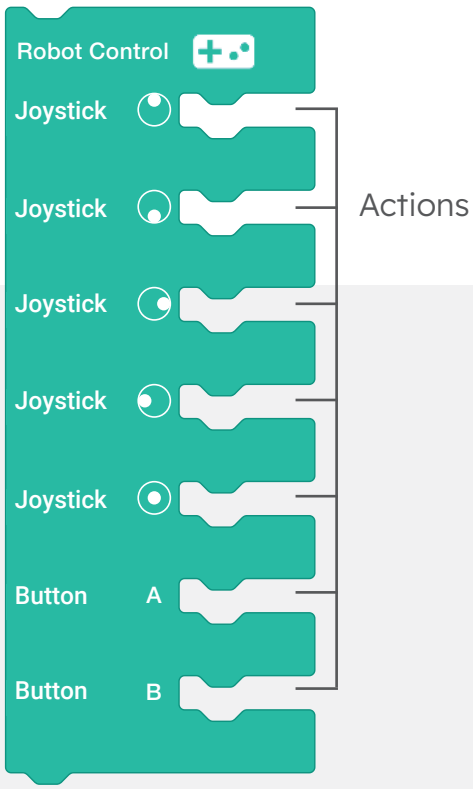
Motor Block

Moves motors MD and MI to move forward, turn, or stop.

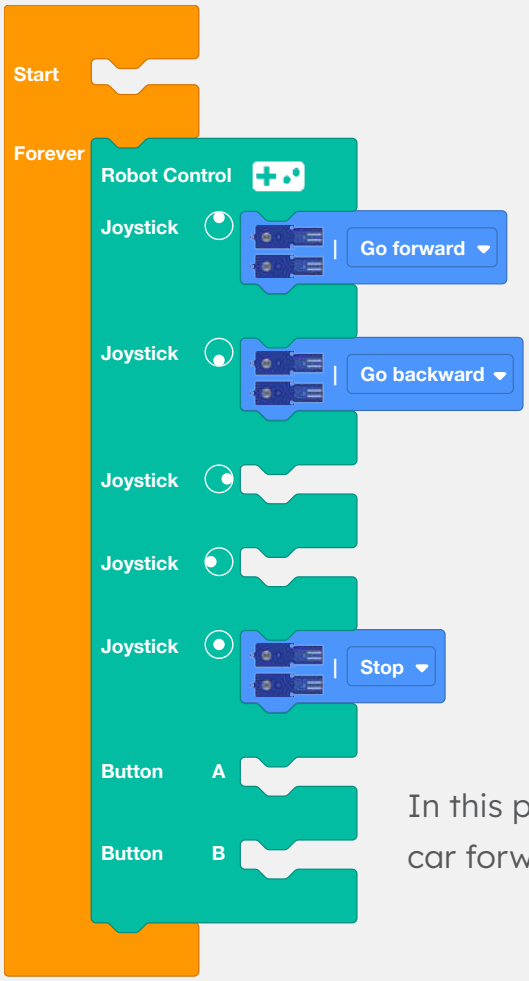


Control Block

Access the controls of the control app.



Example



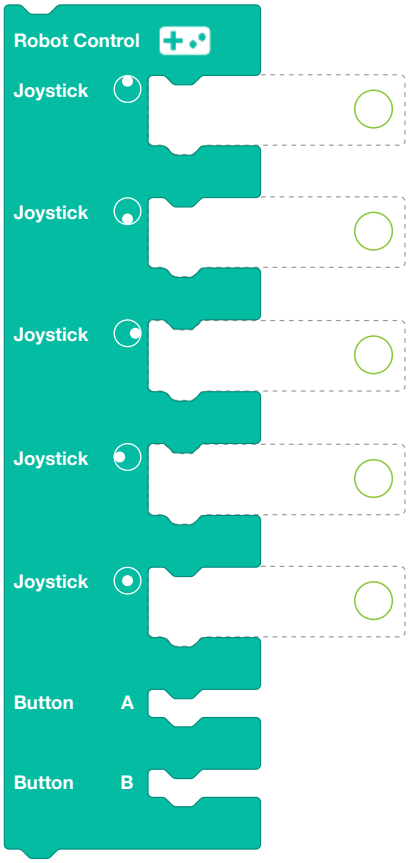
Key idea

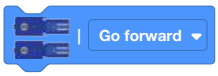
The control mode of the app has a joystick and 2 buttons that allow us to control the car.

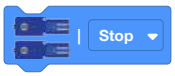
In this program, joystick controls are used to move the car forward, backward and stop.

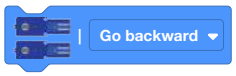
Bluetooth Control > >

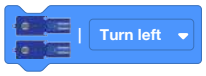
1. Using the app control's joystick, we should move the robot in all directions. Arrange the blocks according to the joystick's position.

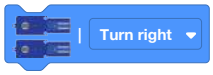


a 

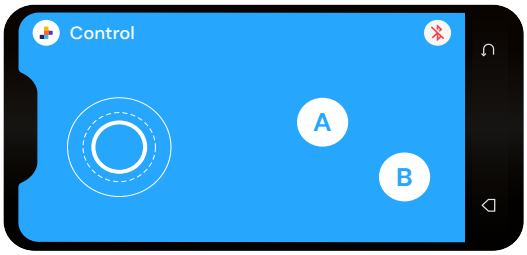
b 

c 

d 

e 

2. Open the app and select "Control mode".



With the kit > >

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to check its operation. What happens when you move the joystick?

.....

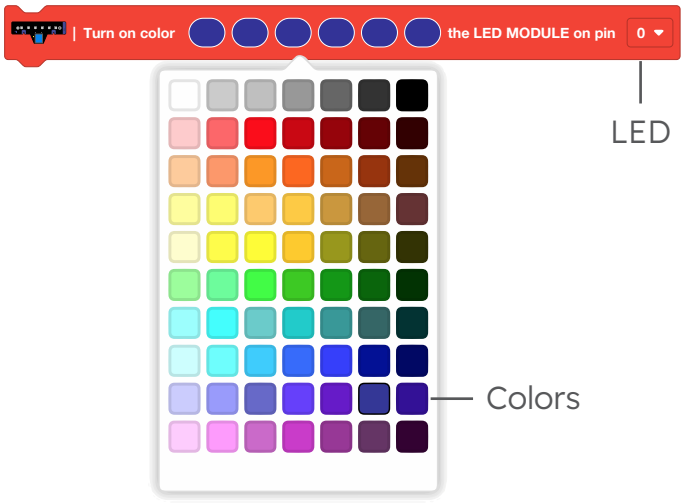
4. Set up a circuit around the classroom and try to drive the robot without deviating from the course.

Distinguishing Teams

With the robot control working, we need to set the colors for each team.

Turn on color block

Allows you to choose different colors for each LED of the module.

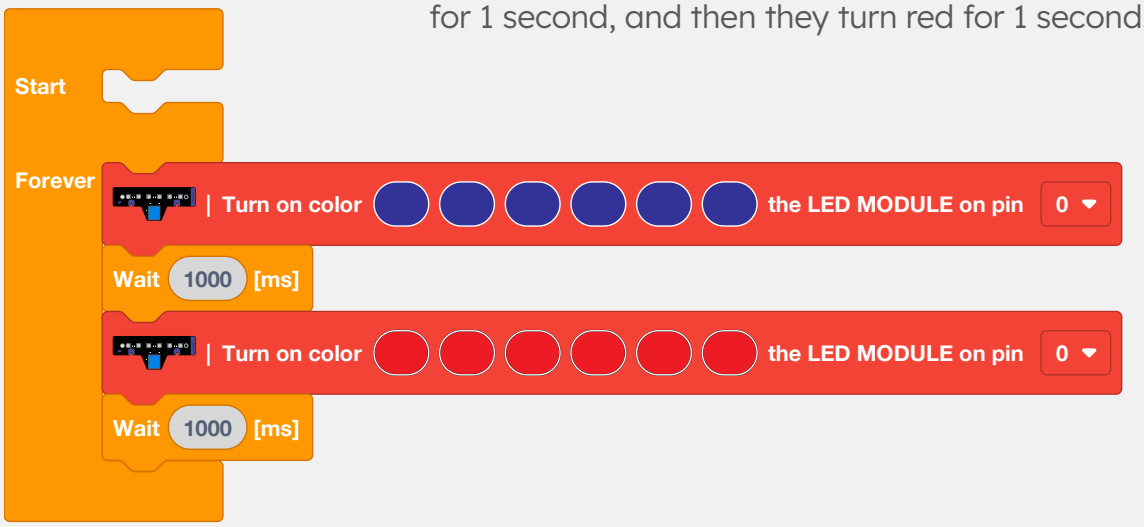


Key idea

The RGB color model allows representing a color by adding the three primary light colors: red, green, and blue. The intensity of each channel is worked on a scale ranging from 0 to 255.

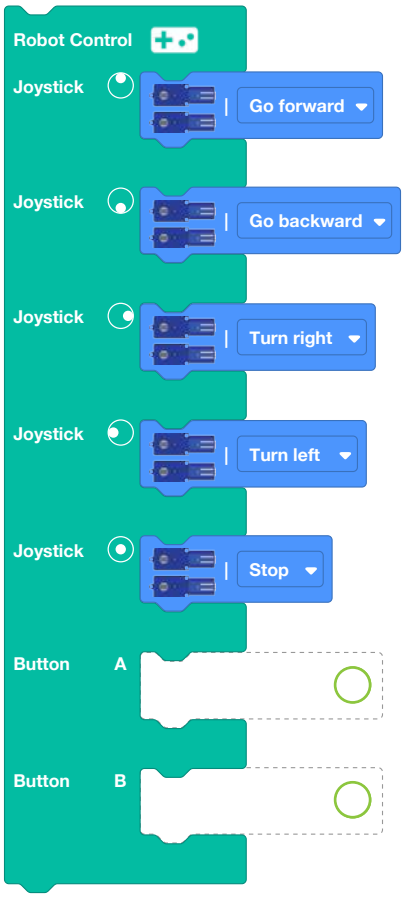
Example

In this program, the RGB LED module lights turn blue for 1 second, and then they turn red for 1 second.

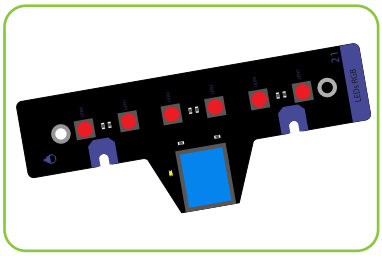


Choose the Color > >

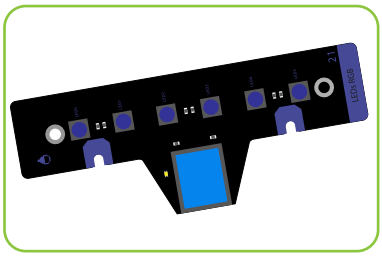
1. Analyze the program and arrange the blocks to configure the colors correctly.



Team color configuration must be done using the A and B buttons on the app.



Team A



Team B

a 

b 

With the kit> >

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to check its operation. What happens if you press button A? And button B?

.....

4. Divide into teams and play a 15-minute match. Which team managed to win?

Red Team Blue Team

Let's review

1. Circle the correct option.

The Bluetooth module allows you to...

a. Wirelessly charge the program
b. Communicate the control board with other devices
c. Play sounds

DC motors are connected to...

a. The blue pins
b. The MD and MI pins
c. The pink pins

The RGB color model allows you to represent a color by mixing...

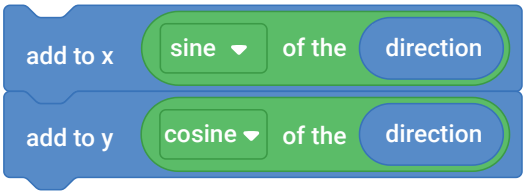
a. Red, green, and blue
b. Red, yellow, and blue
c. Cyan, magenta, and yellow

2. Mark true or false. If false, justify your answer.

a. DC motors are sensors that allow the robot to move.

☐ True
☐ False, because .....

b. These blocks use trigonometric functions to move the character in a specific direction.



☐ True
☐ False, because .....

c. The control app allows you to program the board from a mobile device.

☐ True
☐ False, because .....

Scoring System



Scoring System



On a sunny weekend afternoon, Daniel and Ester found themselves immersed in an exciting football match with a group of friends in the local park. Enthusiasm and competitiveness ran high on the field as the two teams gave their all for a full hour. At the end of the match, both teams began to celebrate the victory, confused, each one claimed that they had won by a difference of 2 goals.
Ester and Daniel wondered how they could solve this problem in a fair and peaceful way so that everyone would be happy.

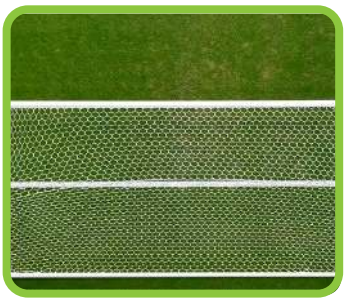
Let's think...

How can technology assist referees in detecting and recording goals?
What other technologies can help make sport fairer?

Automatic Goal Detection System (GLT) determines whether the ball has crossed the goal line and sends this information to referees and assistants.

1. Watch the following video and answer:

Scan the QR code and watch the video:
https://steamBelize.fifafoundation.org/QR/16



a. What is the Automatic Goal Detection System about?

.....

.....

b. How is it communicated to the referees that a goal has been scored?

.....

.....

c. What tests are conducted to test its effectiveness?

.....

.....

Investigate

1. Research other technologies used to assist referees in their tasks and answer the questions.

a. What technologies did you find?

.....

b. Which ones are implemented in official matches?

.....

Goal Counting

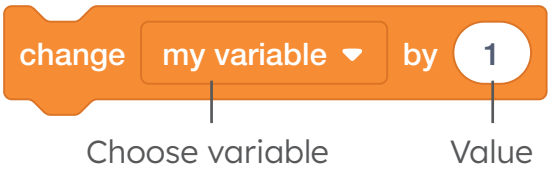
Daniel used the "Goalkeeper" prototype designed by Ester and added a goal counting system to it. To do this, he created a variable called "goals."

Variables

Set value



Add value

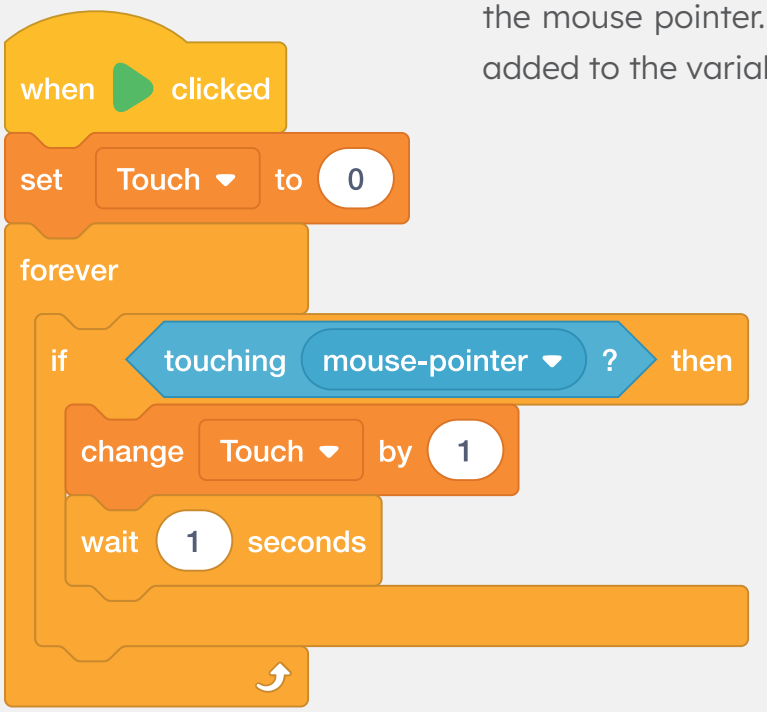


Key idea

Variables are memory spaces used to store a value. This value can be modified during program execution, and its value will be updated within the variable.

Example

At the start of the program, the variable "Touch" is set to 0. Then, it checks if Ester is touching the mouse pointer. If the condition is true, 1 is added to the variable "Touch".

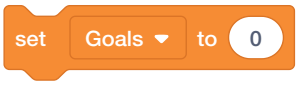




1. Access the Animations platform, run the program, and answer the questions.

a. Use the left or right arrows and press the spacebar. Were you able to score a goal?

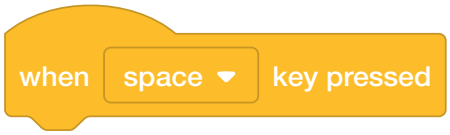
2. Access the programming of the "Football Ball" object, and analyze the program. In which event should you place this block?



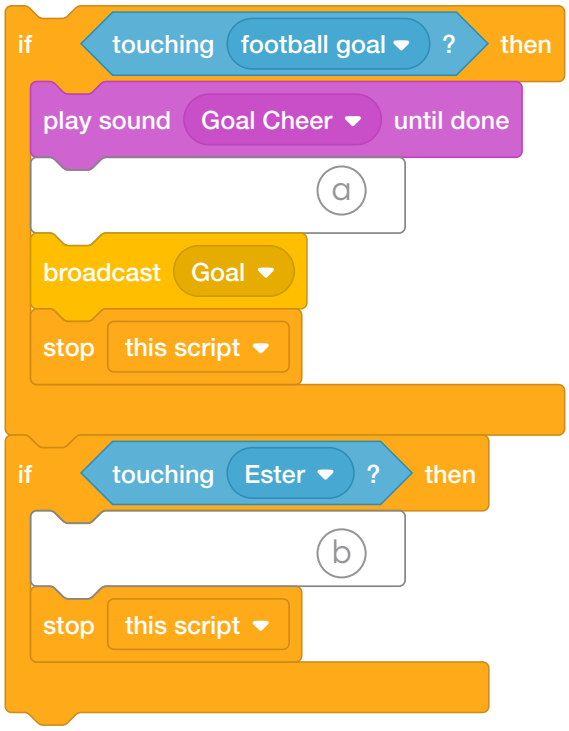
a



b



3. When the ball enters the goal, we need to add 1 to "Goals." Analyze this program and mark where you should place the "add" block.



○ 

4. Run the program with the modifications from the previous point. What happens when you score a goal?

.....

Goal Counter

It's time to create our goal registration and counting system! For this, we will use the ultrasonic sensor and the LCD display.

1. **Scan the QR code** and follow the step-by-step assembly instructions.

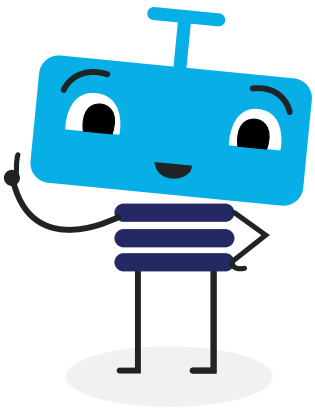


https://steamBelize.fifafoundation.org/QR/07

Components

- [ ] PC with Maker software
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] Ultrasonic sensor
- [ ] LCD display
- [ ] Football ball
- [ ] Connection cables

The ultrasonic sensor will allow us to detect when the ball passes the goal.



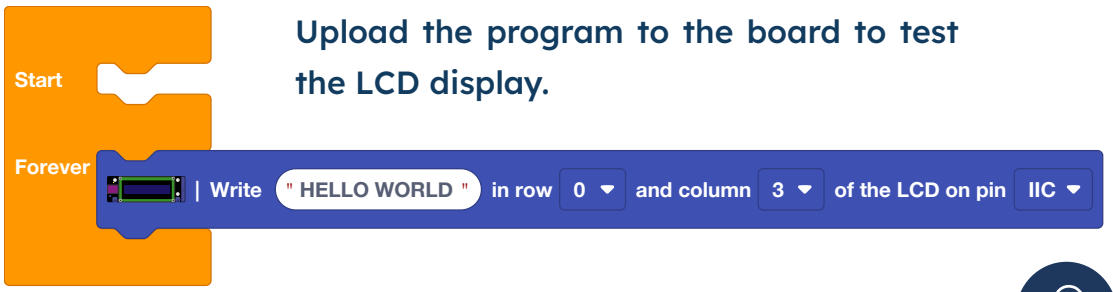
LCD display

Pin IIC | Actuator

This component allows you to display text messages with a maximum of 32 characters organized in 2 rows and 16 columns.



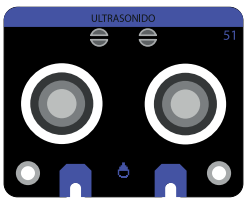
Upload the program to the board to test the LCD display.



Ultrasonic Sensor

Pin 1 | Sensor

This component allows you to measure distances. It emits an ultrasonic pulse that bounces off an object. Taking into account the speed of the pulse and the time it takes to return, the sensor calculates the distance to the object. Its reading range is from 0 cm to 200 cm.



Upload the program to the board to test the ultrasonic sensor.



Goal Detection

To identify if the ball has passed the goal, we need to know the distance measured by the ultrasonic sensor.

Digital inputs

Control

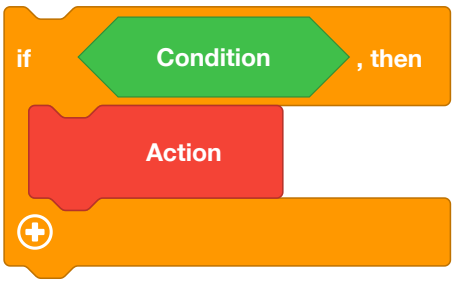
Ultrasonic Sensor Block

Get the distance to an object in cm.



Conditional Block

A structure that allows one or more actions to be executed based on a condition.

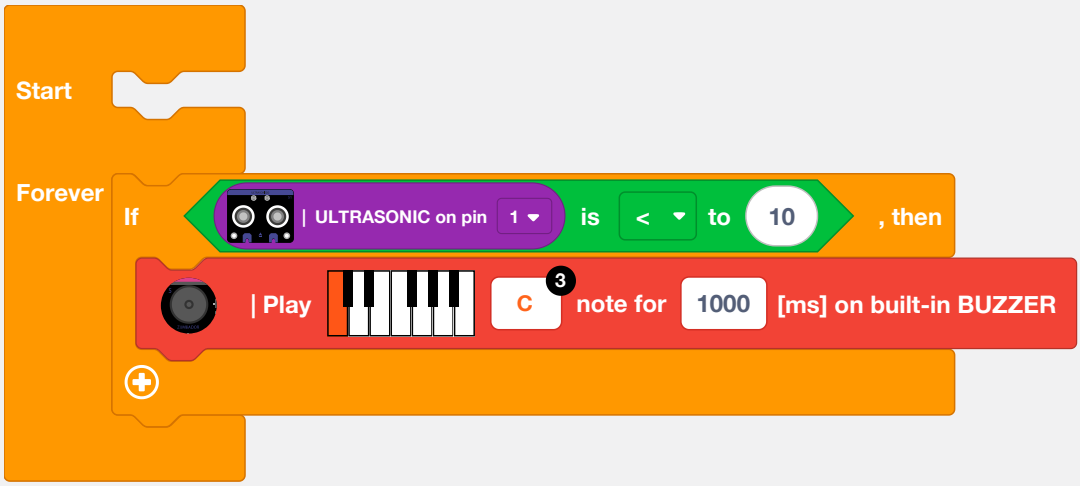


Key idea

The maximum distance that the ultrasonic sensor can measure is the distance from the sensor to the edge of the goal. If the measured distance is less than this maximum distance, it indicates that an object has crossed the goal.

Example

If the distance is less than 10 cm, a sound is played for 1 second.



Programming the Threshold > >

1. To determine if it was a goal, we need to know the distance measured by the sensor located in our setup. Load this program onto the board and write down the number it returns. Make sure there are no objects inside the goal.



Maximum Distance:

2. With the maximum distance established, complete the program to display the message “GOAL” for 1 second when a goal is detected:



With the kit > >

3. Set up the program in Maker and upload it to the board. What happens when you kick the ball into the goal?

.....

4. Add a sound every time a goal is scored.

Scoring System

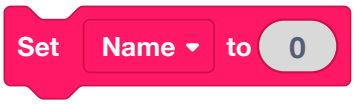
To keep track of the number of goals scored, we need to create a variable.

Create a variable

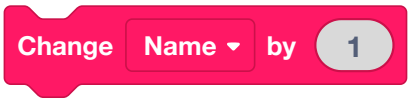
From the “Variables” tab, click the “Make a variable” button, choose a name, and press “Create.” When you create the variable, the associated blocks will be displayed.

Variables

Set variable



Change variable



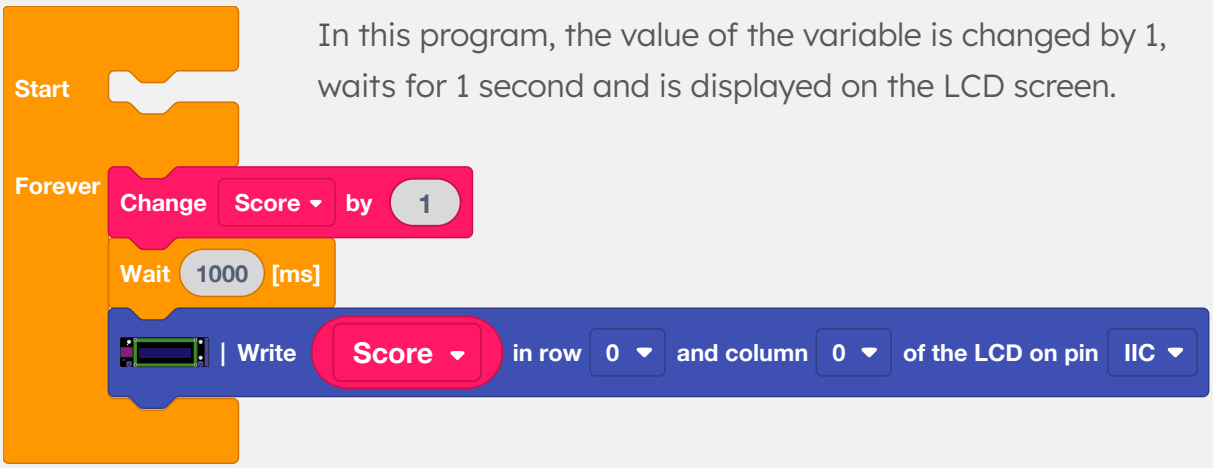
Use the value of the variable



Key idea

The set block replaces the value of the variable, while the change block adds that value to the variable.

Example

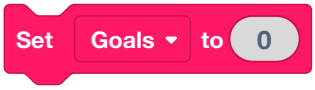


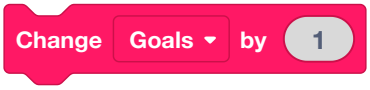
In this program, the value of the variable is changed by 1, waits for 1 second and is displayed on the LCD screen.

Programming the Variable > >

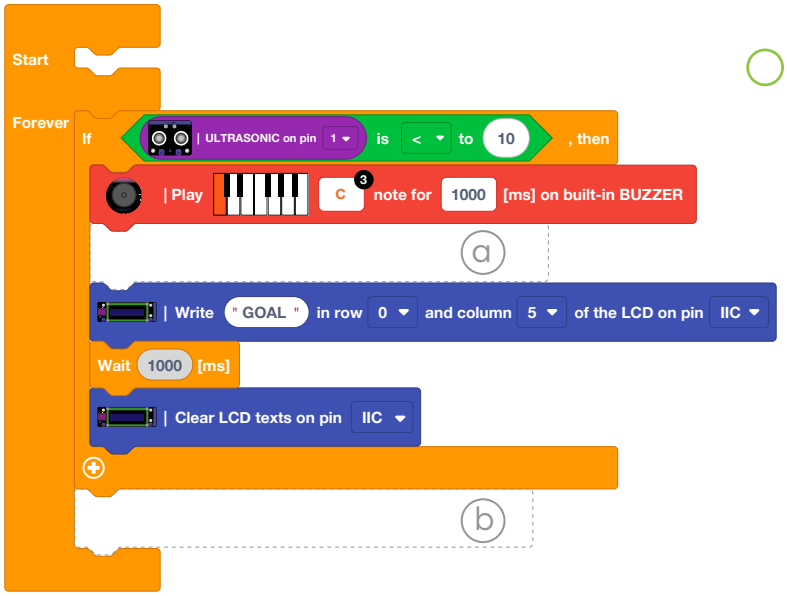
To keep track of the goals, we need to create a variable “Goals” and update it each time the sensor detects a goal.

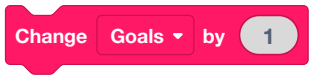
1. To add a goal to the variable, what block should we use?

ⓐ 

ⓑ 

2. Analyze the program and mark the part of the program where you should add 1 to the variable.



○ 

With the kit

3. Build the program in Maker and upload it to the board. What happens when you kick the ball into the goal?

.....

4. Incorporate the programming to display the number of goals scored on the LCD display.

Let's review

1. Mark as true or false. If it's false, justify your answer.

a. The ultrasonic sensor emits an ultrasonic pulse and calculates the distance based on the time it takes for that sound wave to bounce off an object.

- ☐ True
- ☐ False, because .....

b. The LCD display in the kit consists of 20 columns and 4 rows.

- ☐ True
- ☐ False, because .....

c. Variables are memory spaces that allow data storage.

- ☐ True
- ☐ False, because .....

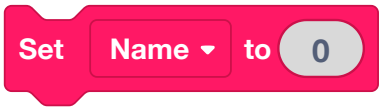
2. Explain in your own words what these blocks are used for:



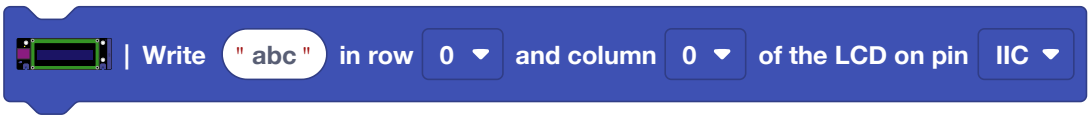
.....



.....

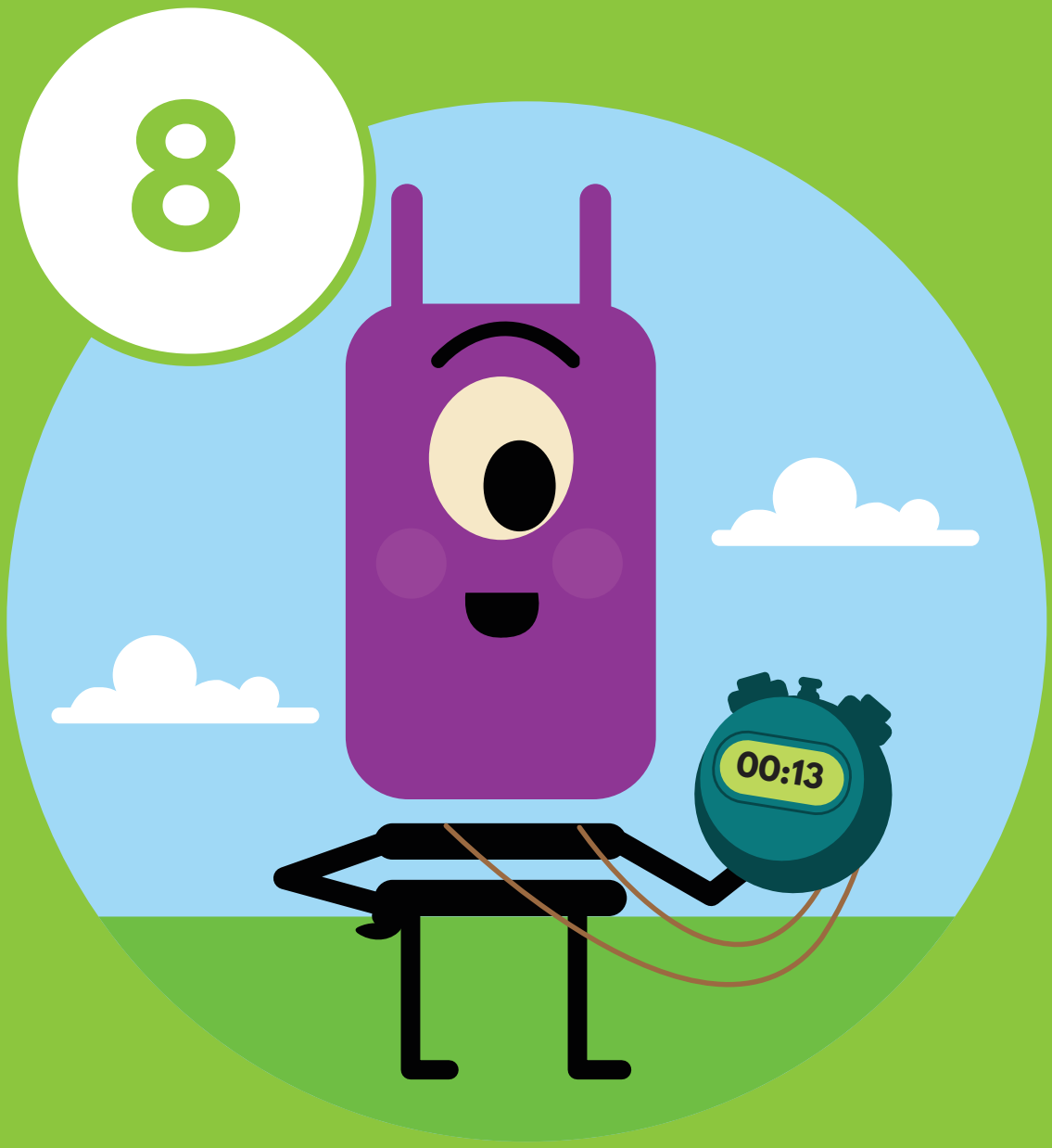


.....

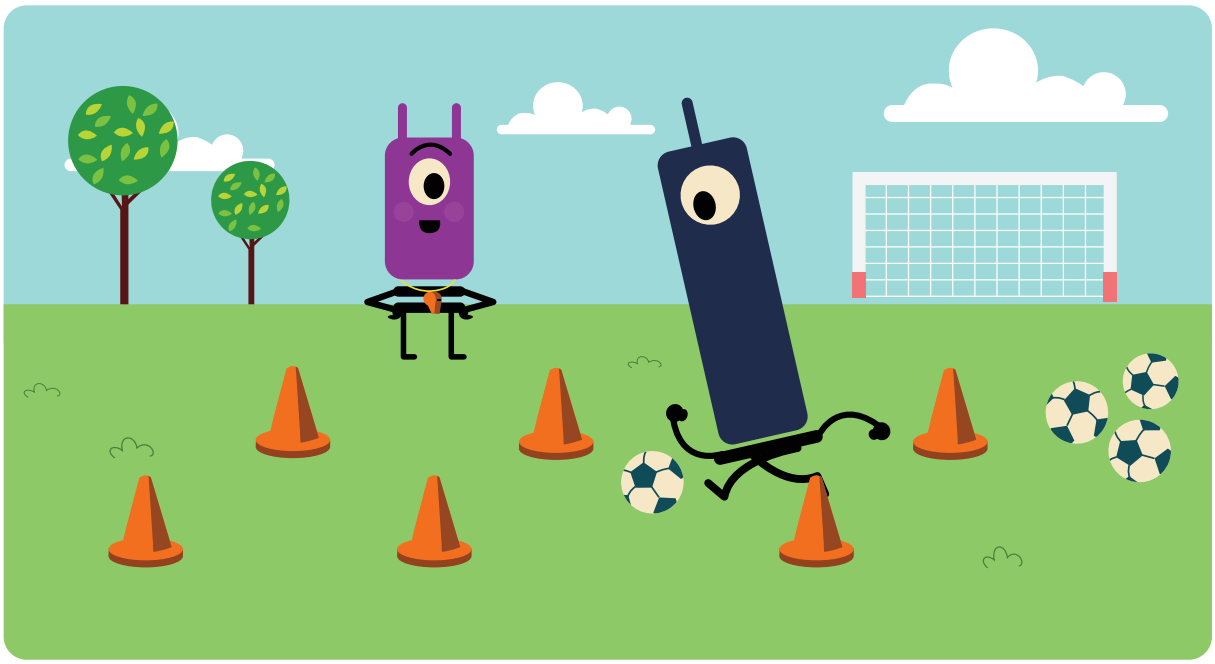


.....

Speed Training



Speed Training



Aike was deeply immersed in rigorous preparation for the upcoming football championship. His skill as a fullback relied on his astonishing speed, and to ensure he was at the peak of his performance, he pushed himself in every training session to surpass his own records. His friend Cloe always patiently helped him measure the time for each of his laps. Together, they were determined to achieve excellence on the field and leave an indelible mark on the upcoming championship.

Let's think...

How can technology contribute to athletes achieving better performance? What impact does exercise have on people's health?

1. Read the following article and answer

Electronic Performance & Tracking Systems

Electronic performance and Tracking Systems (EPTS), which include camera-based and wearable technologies, are used to control and improve player and team performance.

EPTS primarily track player (and ball) positions but can also be used in combination with microelectromechanical devices (accelerometers, gyroscopes, etc.) and heart-rate monitors as well as other devices to measure load or physiological parameters.

There are three forms of physical tracking devices available on the market:

Electronic Performance & Tracking Systems	
Benefits	Limitations
- Non-invasive to players - Commonly used in the football market - High sampling rate, ball tracking possible	- Limited number of measurements - Tracking occlusions require manual corrections - Installation time

Local positioning systems (LPS)	
Benefits	Limitations
- High number of measurements possible - Accuracy of measured data in real-time - Ultra-wideband technology reduces chances of interference in transmission path	- Fixed installation - Installation costs - Installation time

Source: https://inside.fifa.com/technical/football-technology/standards/epts

a. What are the three technologies mentioned?

.....

b. What do these technologies allow measuring?

.....

c. Which one is the most used in the current market?

.....

Investigate



1. Research other technologies used to measure and monitor player performance and answer the questions.

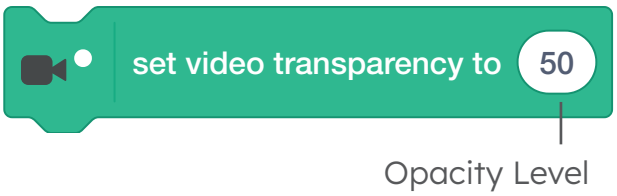
a. What technologies did you find? .....

b. What do they allow measuring? .....

Warm-up

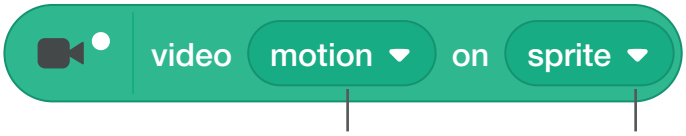
Cloe designed a prototype to help Aike with his training routine. Additionally, she created an animated simulation that follows real movement. To get it up and running, she used the "Video Sensing" extension, which allows detecting movements using the computer's camera and executing actions based on those events.

Set Transparency



Opacity Level

Amount of Motion



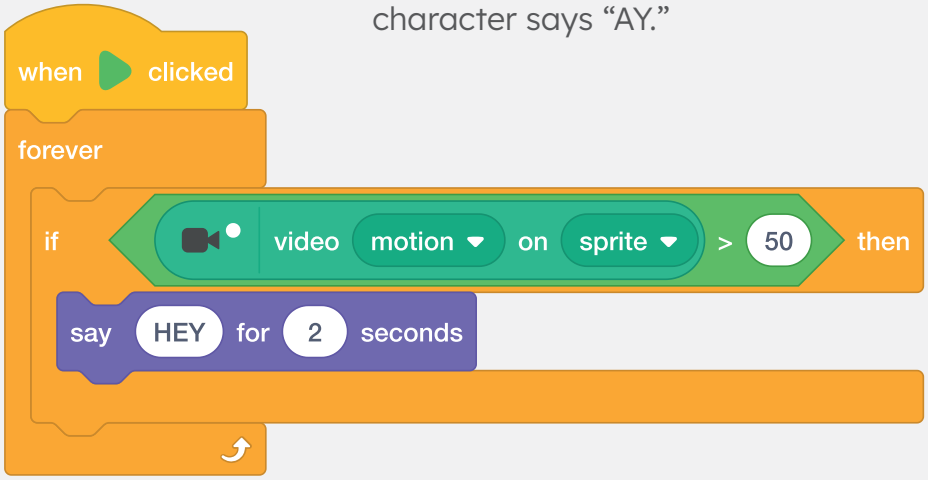
Effect Type Measurement Range

Key idea

Extensions allow us to incorporate new categories of blocks into the program. To access the computer's webcam, the "Video Sensing" extension is used.

Example

In this program, it evaluates if the amount of motion on Aike is greater than 50; if the condition is met, the character says "AY."





1. Access the Animations platform, run the program, and answer the questions.

a. Place the computer on a table, stand 1 meter away, run the program, and jump. What happens to Aike?

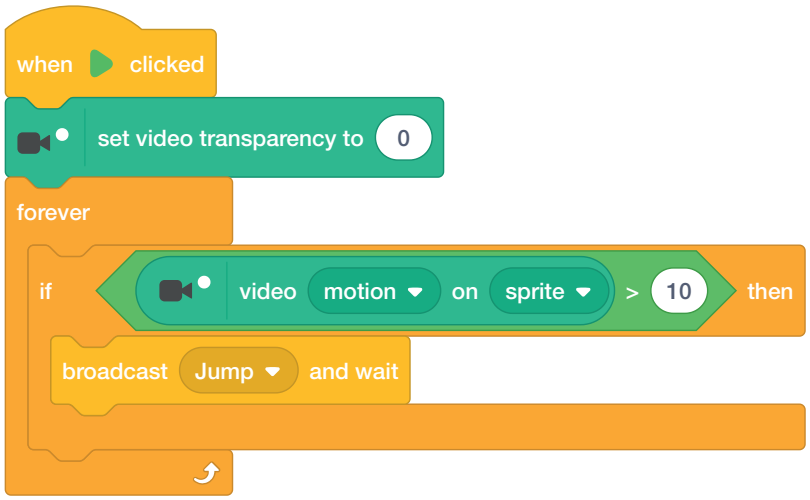
.....

b. Access the programming of the "Sensor" object and analyze the program. What message is sent when motion is detected?

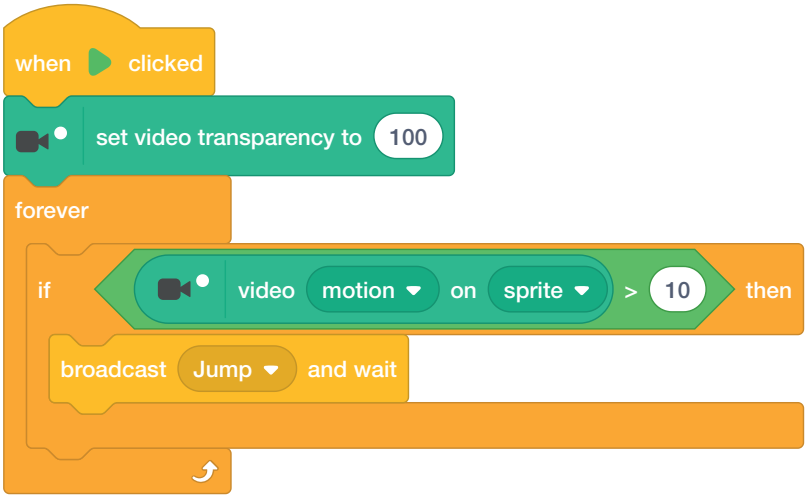
.....

2. Which of these two programs would allow you to hide the video image?

a)



b)

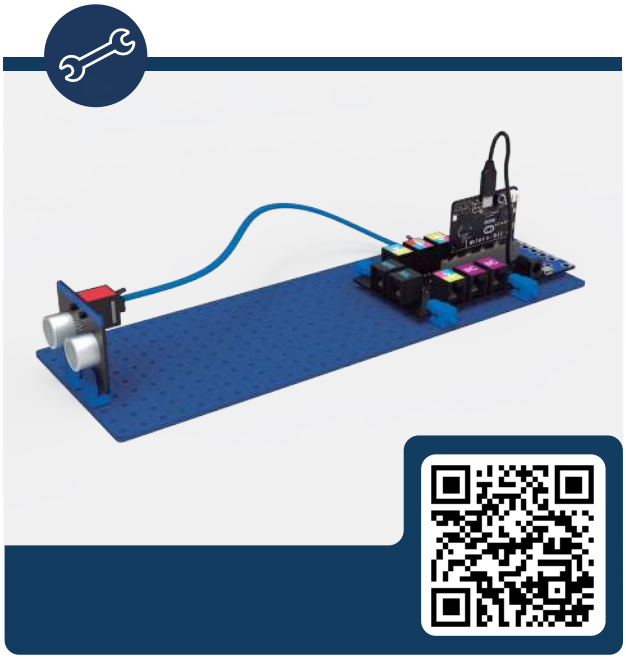


3. Run the program with the modifications and perform rounds of exercises.

Training Monitoring

It's time to create our training monitoring system! For this, we will use the ultrasonic sensor and the Control app.

1. **Scan the QR code** and follow the assembly steps.

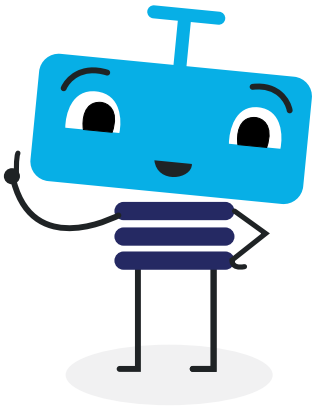


https://steamBelize.fifafoundation.org/QR/08

Components

- [ ] PC with Maker software
- [ ] Device with Bluetooth connectivity and Control app
- [ ] USB cable
- [ ] Control board
- [ ] Microbit board
- [ ] Ultrasonic sensor
- [ ] Connection cables

By identifying the start and end of the path, we can calculate the player's speed.

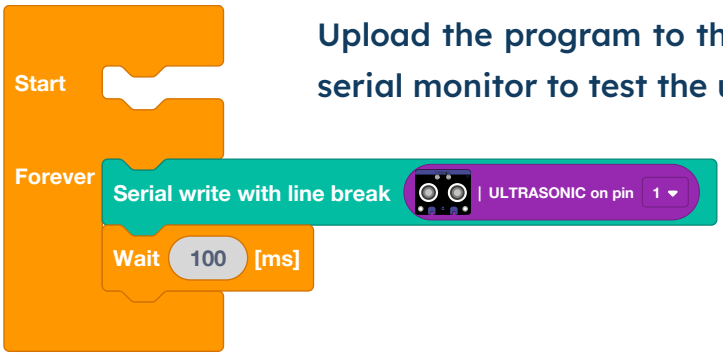


Ultrasonic Sensor

Pin 1 | Sensor

This component allows you to measure distances. It emits an ultrasonic pulse that bounces off an object. Taking into account the speed of the pulse and the time it takes to return, the sensor calculates the distance to the object. Its reading range is from 0 cm to 200 cm.



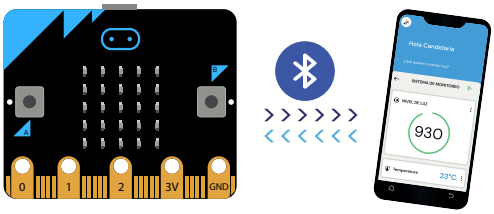


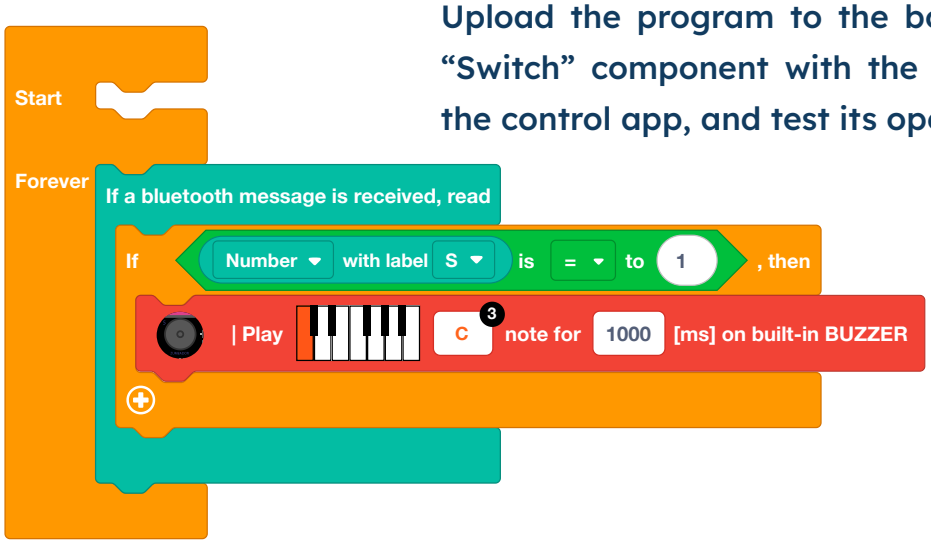
Upload the program to the board and open the serial monitor to test the ultrasonic sensor.

Bluetooth Module

Integrated | Communication

The Bluetooth module allows us to communicate wirelessly between the board and the Control app.





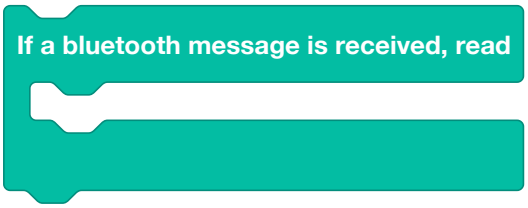
Upload the program to the board, add a "Switch" component with the label "S" in the control app, and test its operation.

Start and end of the race

To monitor the training, we need to detect the start and end of the race.

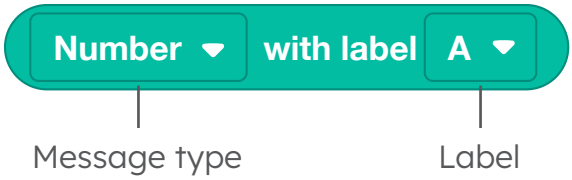
Receive data via Bluetooth

Conditional structure that runs if there is data available to read.



Read data via Bluetooth

Obtains the message containing the specified label.



Ultrasonic Sensor Block

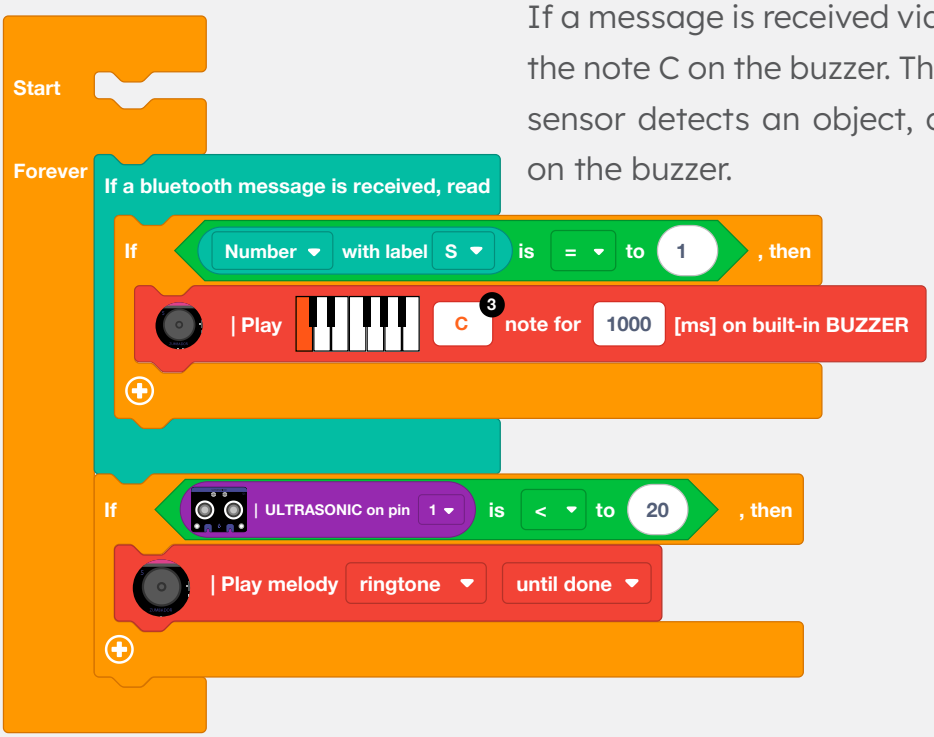


Key idea

The Control app will initiate at the beginning of the route, and the ultrasonic sensor will detect the end of it.

Example

If a message is received via Bluetooth, it plays the note C on the buzzer. Then, if the ultrasonic sensor detects an object, a melody is played on the buzzer.



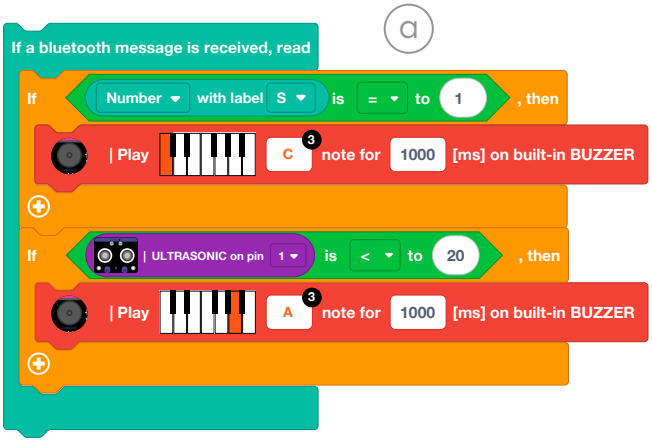
Programming the Start and Finish > >

Our system will include two conditions:

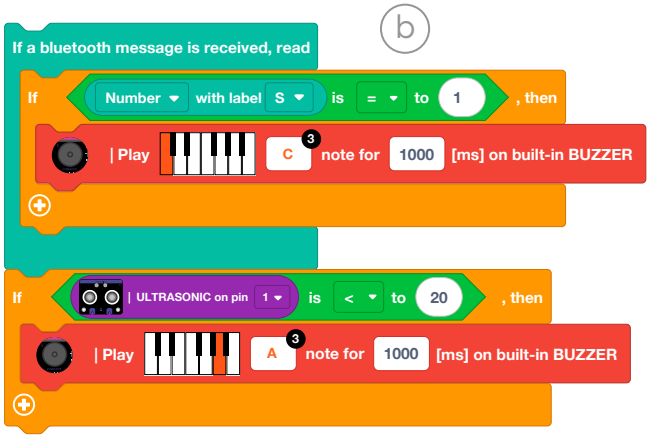
- If the number 1 with the label “S” is received via Bluetooth, a sound will be played.
- If the ultrasonic sensor detects an object less than 20 cm away, another sound will be played.

1. Analyze the following conditionals and mark which one allows for creating the conditions. Justify your answer.

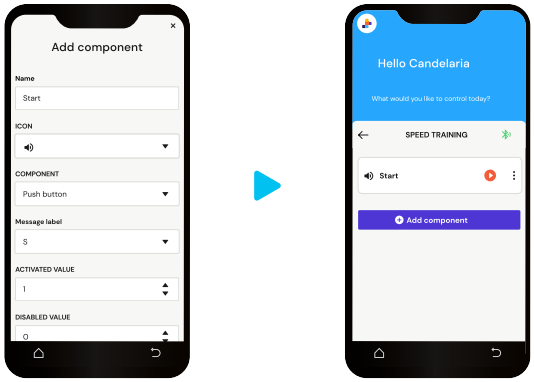
a



b



2. Create a new project in the application and add a “Button” component. Then, configure the message label to “S” and set the values to 0 and 1.



With the kit > >

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to check its operation. What happens when you press the button on the app? And when you pass by the ultrasonic sensor?

.....

4. Modify the program to play a melody when a message is received via Bluetooth.

Time Recording

To calculate the speed at which the player ran, we need to record the time that elapsed between the start and the end of the run.

Control

Math

Chronometer Block

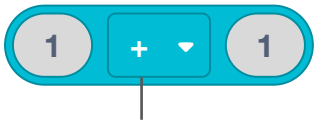
The chronometer records in milliseconds the time that has passed since it was started.



Starts the chronometer

Operation Block

Allows for mathematical operations such as addition, subtraction, multiplication, and division.



Operation

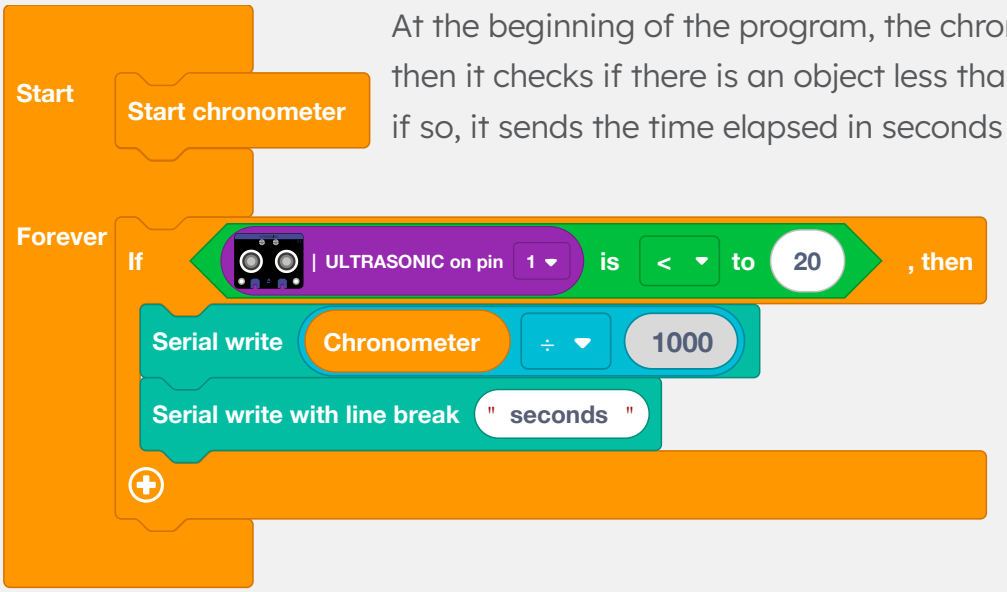


Accesses the time that has passed since the chronometer was started

Key idea

Using chronometers allows us to control the timing of actions without halting the complete execution of the program.

Example

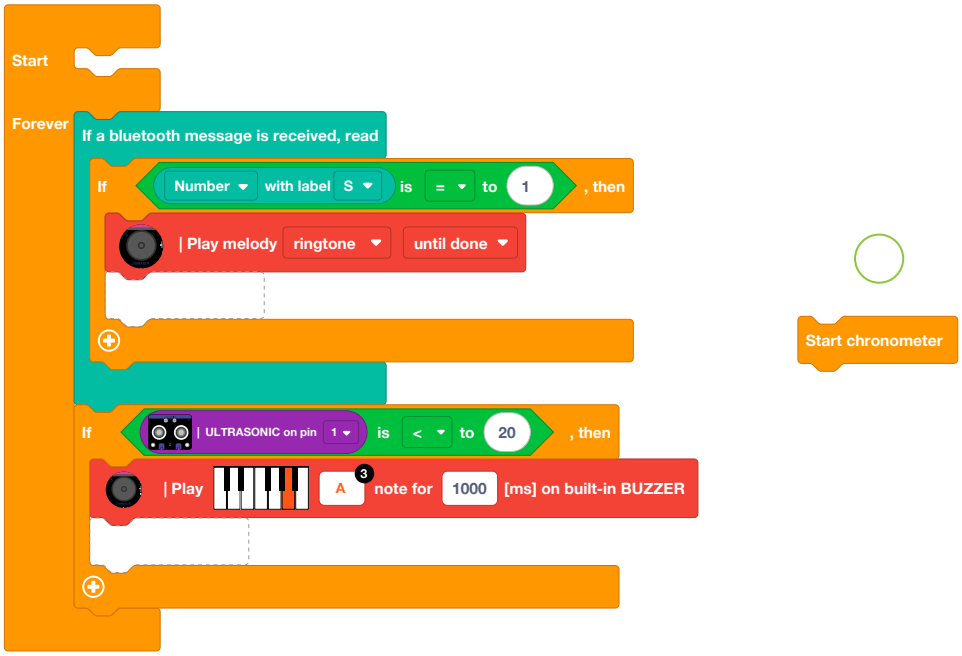


At the beginning of the program, the chronometer is started; then it checks if there is an object less than 20 cm away, and if so, it sends the time elapsed in seconds via the serial port.

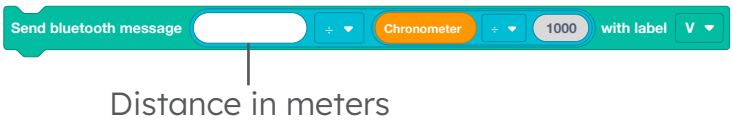
Programming the Time > >

To incorporate time monitoring, we must start the chronometer when the race begins and send it when the player crosses the finish line.

1. Analyze the program and mark in which condition the chronometer should be started.

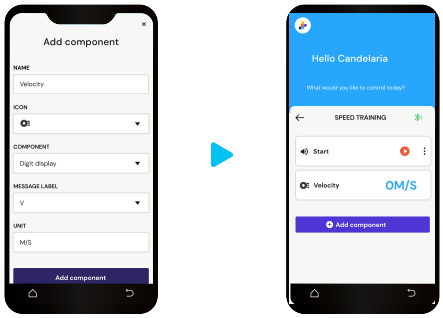


2. To calculate speed, we need to divide the meters traveled by the elapsed seconds. Measure the distance your player has to cover and complete the blocks with the corresponding information.



Distance in meters

2. Add a "Digit Display" component to the previous app. Then, set the message label to "V" and the unit to "M/S".



With the kit > >

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to check its operation. What speed does it show you in the app after completing the course?

Review

1. Circle the correct option.

Extensions in Animations allow us to...

a. Move an object on the screen.

b. Incorporate new categories of blocks into the program.

c. Export the application.

The ultrasonic sensor...

a. Measures distance in centimeters.

b. Measures distance in meters.

c. Measures distance in seconds.

2. Mark true or false. If false, explain your answer.

a. The average velocity of an object is defined as the distance traveled divided by the time elapsed.

☐ True

☐ False, because.....

b. Using timers allows us to control the timing of actions without pausing the entire program.

☐ True

☐ False, because.....

c. The ultrasonic sensor is connected to the blue pins.

☐ True

☐ False, because.....









Smart traffic



Smart traffic



Ester and Daniel had been practicing some tactics for their afternoon football training. As they hurriedly walked to the club, they encountered a significant problem: the traffic lights on the main avenue were completely broken, turning traffic into utter chaos. The traffic intensity was such that pedestrians were trapped on the sidewalks, unable to cross the street. If they couldn't cross the street, they wouldn't make it to the club on time.

Let's think...

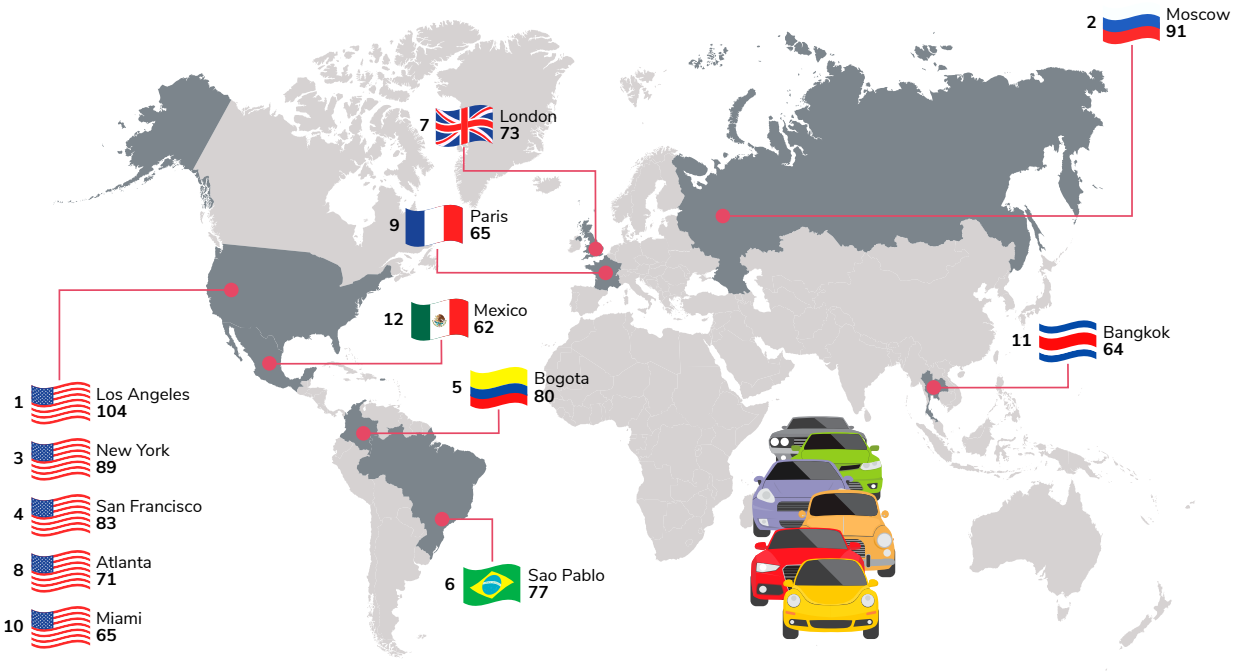
How can we use technology to facilitate traffic flow on the streets and improve pedestrian safety? What impact does it have on the development of cities?

1. Analyze the following infographic and answer:

a. Which country has the most cities within the ranking? .....

The cities with the worst traffic congestion in the world

Estimated annual hours drivers spend in traffic jams



Source: Cookson, G., & Pishue, B. (2017). Inrix global traffic scorecard–appendices. INRIX research.

2. Think together and answer:

a. What are the main factors that generate traffic congestion in cities?

b. Besides time loss, what other problems do traffic jams create?

c. What impact do you think traffic jams have on the environment?

Investigate

1. Research different transportation alternatives that exist and answer:

a. What are the advantages of using alternative transportation, such as bicycles?

b. What other measures or policies could be implemented in large cities to prevent traffic congestion?

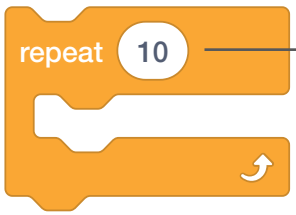
c. Does the city where you live have any alternative transportation system? What does it consist of?

Pedestrian light

Aike made a prototype of a pedestrian traffic light with two colors, red and green, to organize traffic. Additionally, he made an animated simulation to show how it would work. To do this, he programmed a character to walk along the pedestrian path.

Control

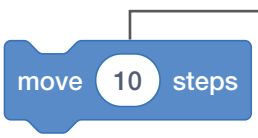
Repeat block



Number of repetitions

Motion

Move block

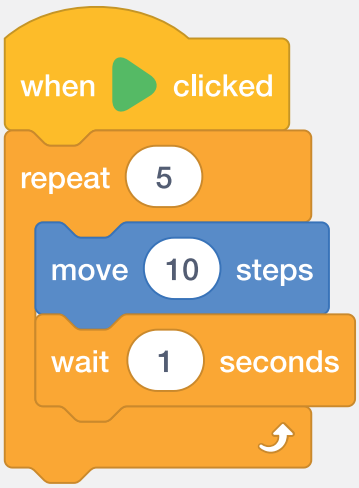


Number of steps

Key idea

The "Repeat" block allows one or more instructions to be executed a certain number of times. It helps us avoid having to write a specific set of instructions several times.

Example



When the program starts, Aike repeats the following actions 5 times: move 10 steps, wait 1 second.



1. Access the Animations platform, run the program, and answer the questions.

a. What happens to Aike when you run the program? And with the traffic light?

---

2. Analyze the program and circle the correct option.

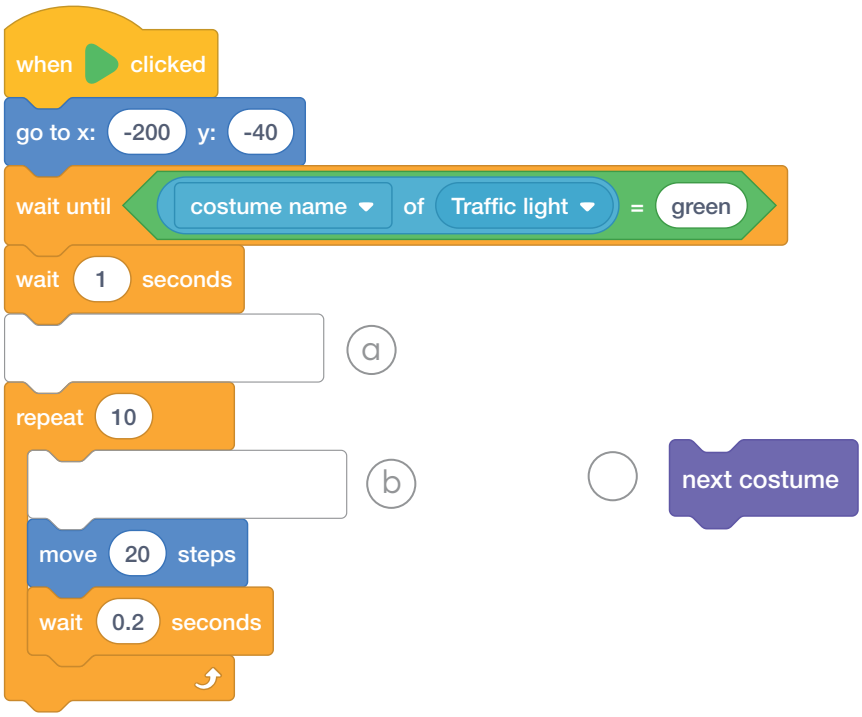
Aike starts walking when...

- ☐ a second passes.
- ☐ the traffic light changes to green.
- ☐ you click on the green start icon.

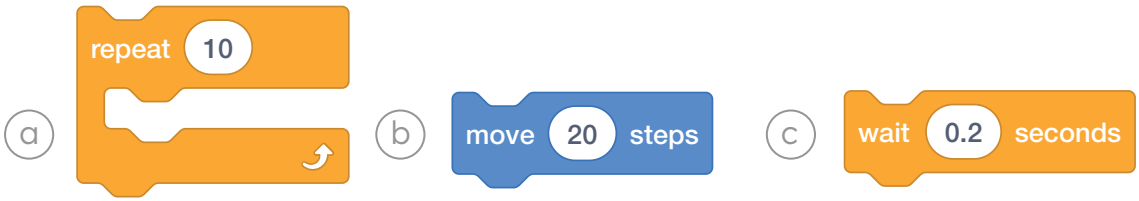
Aike walks...

- ☐ 20 steps
- ☐ 100 steps
- ☐ 200 steps

3. Add the "next costume" block to have Aike move his legs. Mark where in the program you would place it.



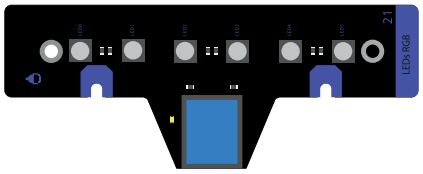
4. Modify the program so that Aike can cross the entire street. Which of these blocks would you modify? Check the option that you consider correct.



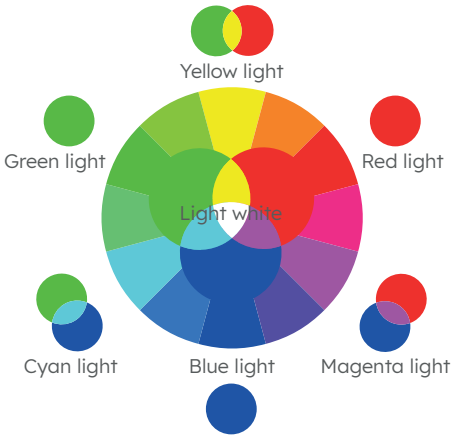
RGB LED module

Lights and colors play a fundamental role in traffic control systems. Lights, because they are clearly visible from long distances and in different weather conditions. Colors, on the other hand, because they have informative meanings. It is common, for example, to use red to draw attention, yellow to indicate caution, and green for information.

In smart cities, light indicators use RGB LED lights. This is a type of LED that allows representing any color by combining the three primary light colors: red, green, and blue, therefore the name RGB.



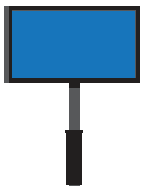
Connects to a digital pin



Everyday examples

LED billboards

In advertising billboards, RGB LEDs allow displaying text and images in different colors.



Outfit

Some clothes come with integrated LED lights. For example, in some sneakers, these lights turn on and off when you step.



Decorative lighting

This technology is used to illuminate the facades of some iconic buildings with different colors and enhance specific aspects of their architecture.



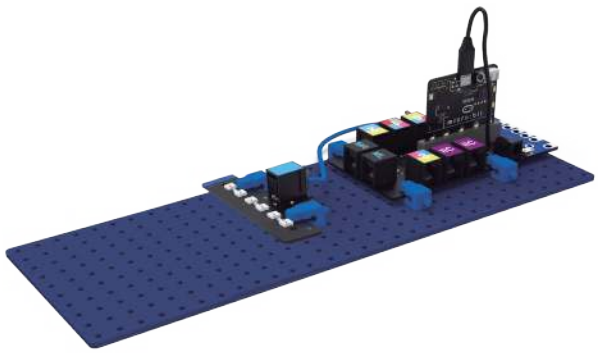
Cellphones

Many mobile phones include RGB lamps that change color depending on the type of notification (green for messages, blue for missed calls, red for low battery, among others).



Let's experiment!

We will test different combinations of red, green, and blue with the RGB LED module. We will use a white sheet to see the intensity of color delivered by each LED. We will start by preparing the experimentation setup.



Required Components

- PC with Maker software
- USB cable
- Control board
- Microbit board
- Connection cables
- RGB LED module
- White sheet

Connections

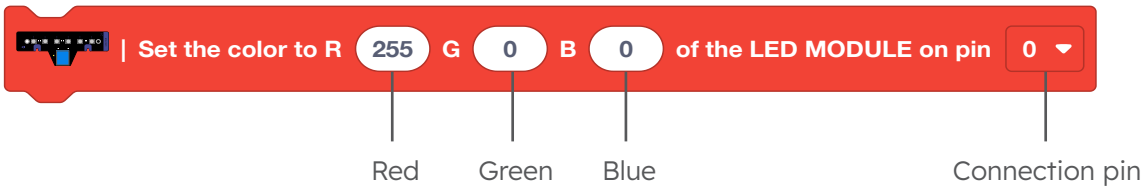
1. Connect the RGB LED module to pin 0.
2. Connect the board to the PC using the USB cable.

Programming Block

To complete this experiment, we will need to use the following block:

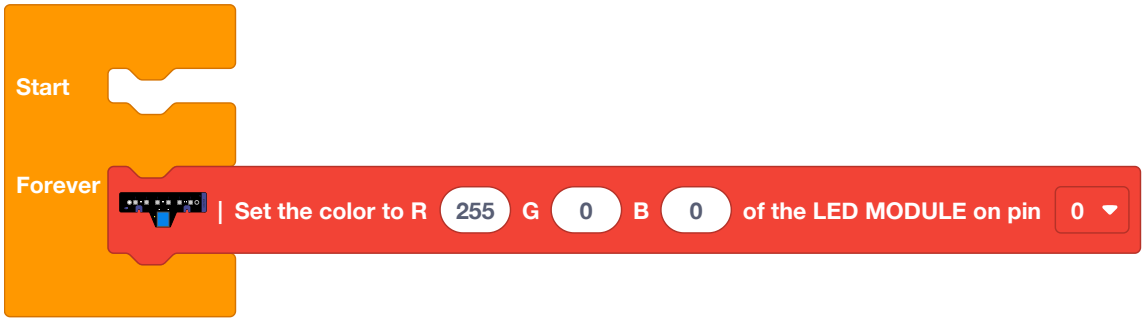
Block "Set color"

This block allows you to control the intensity of red, green, and blue individually. To turn the color red on, we should set the value R to 255, the value G to 0, and the value B to 0.



Program for experimentation

Create the following program in Maker and upload it to the board.



1. With the RGB LED module turned on, direct the illumination towards the white sheet to properly see the generated color.
What is this color? .....

a. Modify the program using the following combinations, upload the new versions to the board, and indicate the colors formed:

(R: 0; G: 255; B: 0). The color is: .....
(R: 0; G: 0; B: 255). The color is: .....

b. Program the RGB LED module to light up with the colors from the table.
Complete the values you used to achieve each color.

Remember to upload the updated program each time you modify the values of R, G, or B.

Colors	R	G	B
Violet			
Yellow			
Orange			
Pink			
Sky blue			

2. Discuss among yourselves the conclusions of this experiment.

a. What did you learn from this experience?

b. What difficulties did you find? How did you solve them?

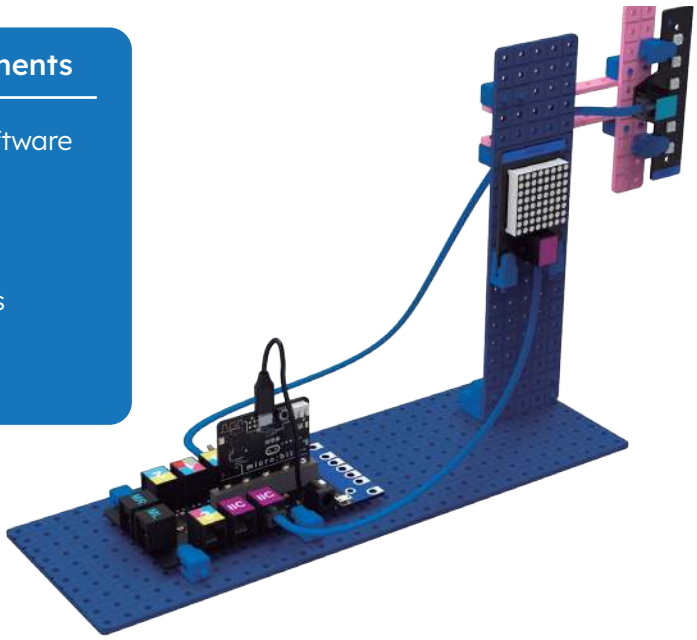
Maker Moment

It's time to work with the kit! We will create our own intelligent signaling system in two parts. First, we will use the RGB LED module to build a traffic light; then, we will add a LED matrix to include a pedestrian traffic light synchronized with the vehicle traffic light.

1. **Scan the QR code** to see the step-by-step assembly instructions.

Necessary Components

- PC with Maker software
- Controller board
- Microbit board
- USB cable
- Connection cables
- RGB LED module
- LED matrix

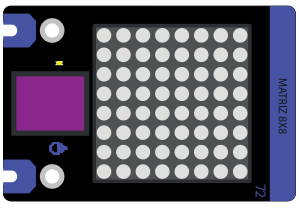


https://steamBelize.fifafoundation.org/QR/09

In addition to the RGB LED module, we will use this component:

LED matrix

Function: Display drawings, text, or animations



Displays

PIN IIC | Actuator

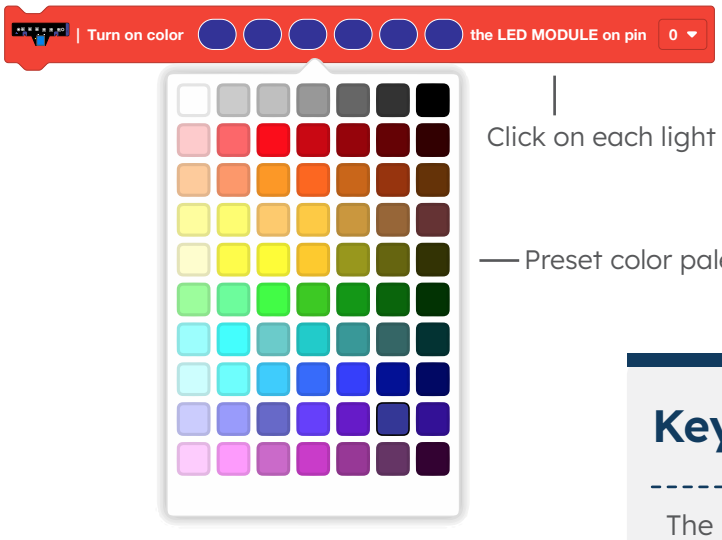


Creating a traffic light

In this first challenge, we will program a signal known to everyone: a traffic light! We will program the LED lights to synchronize their operation. For each state of the traffic light, we will need to turn on the LED lights individually.

Turn on color block

Allows you to choose different colors for each LED of the module.

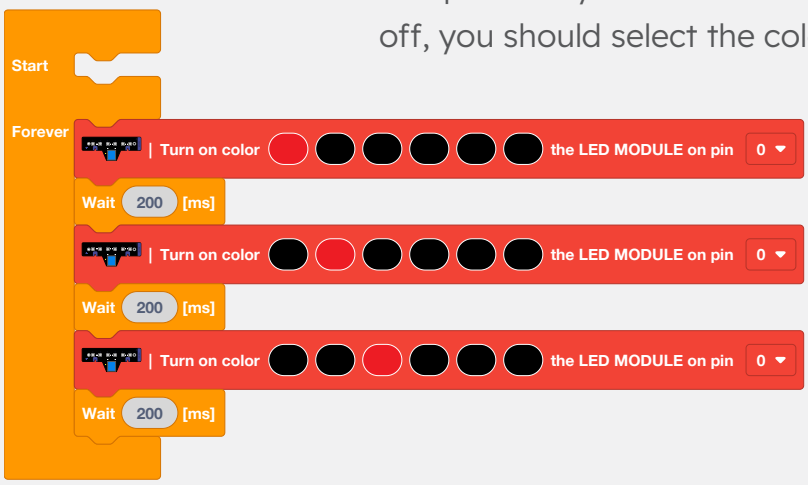


Key idea

The lights of the RGB LED module can be controlled independently and lit in different colors. To turn them off, you should select the color black.

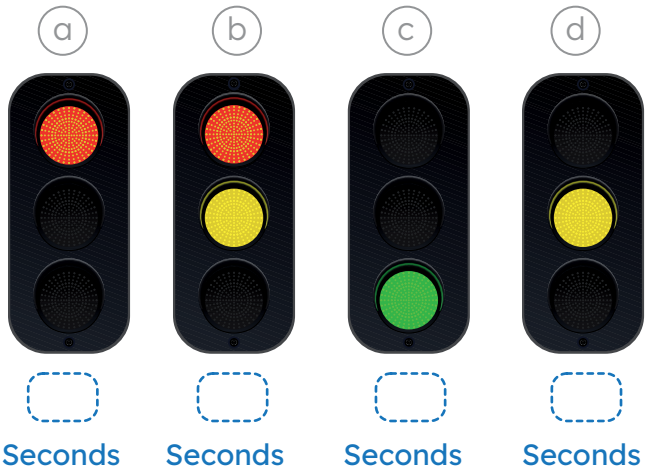
Example

The lights of the RGB LED module can be controlled independently and turn on different colors. To turn them off, you should select the color black.

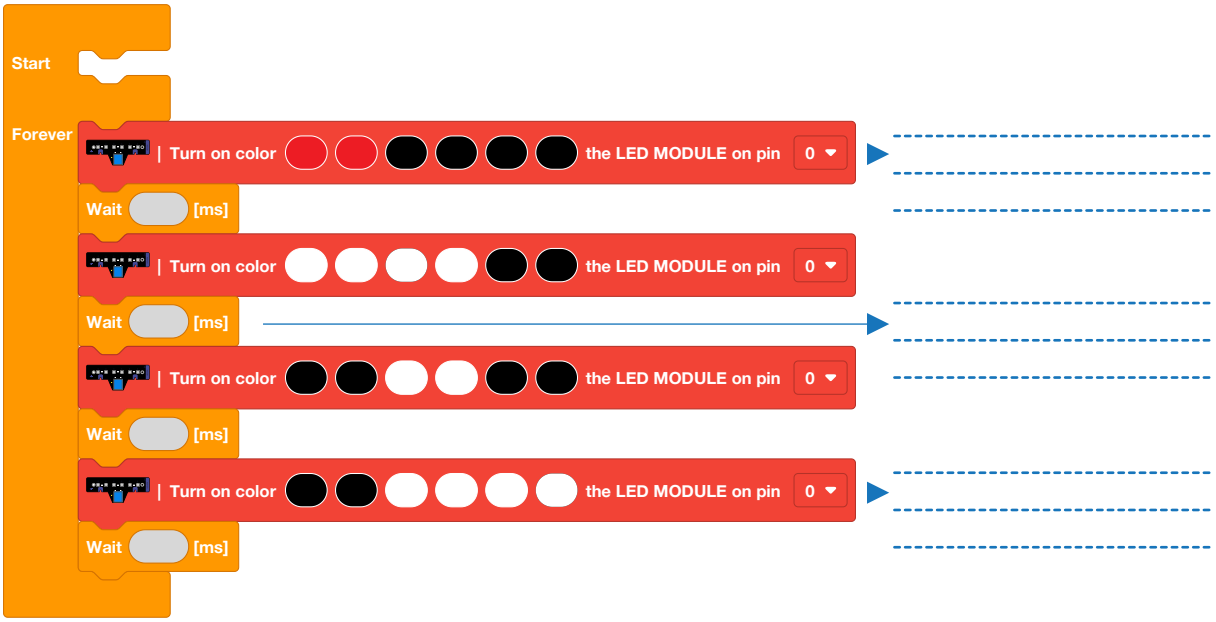


1. The complete cycle of our traffic light should last thirty seconds. How much time would you allocate to the red state? And to the green state? Do the yellow states last the same amount of time?

Complete the following chart with the values (in seconds) for the corresponding wait time for each state.



2. The following program should activate all the states from the previous exercise according to the times you defined for each one. Complete the missing information in the blocks and write in the dotted lines what function each highlighted block serves.



With the kit > >

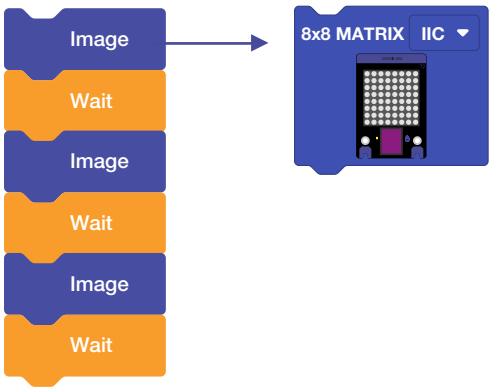
3. Build the program in Maker and upload it onto the board.

4. Modify the program so that, after the green light time has finished, the RGB LEDs flash three times in green before turning yellow.

Synchronize the traffic light with the crosswalk

We have already managed to program a traffic light. It's time to add pedestrian signals to our system. In this second challenge, we will program an animation on the LED matrix to create a pedestrian traffic light. Additionally, we will synchronize this part of the program with the vehicle traffic light. To generate an animation, we will use the matrix block combined with a wait.

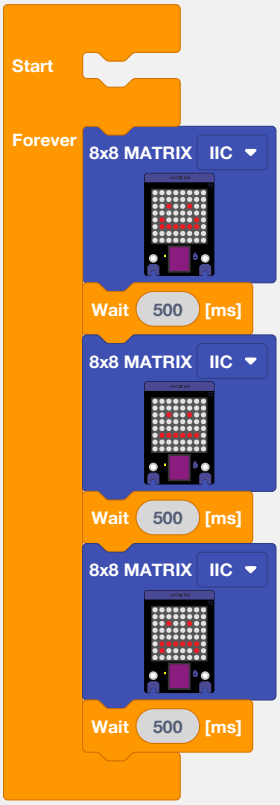
Create an animation



Key idea

To create an animation, it is necessary to establish the pattern of images that will be repeated. The more images there are, the smoother the animation will be. It is also important to adjust the waiting time between images: the shorter the time, the smoother the animation will be.

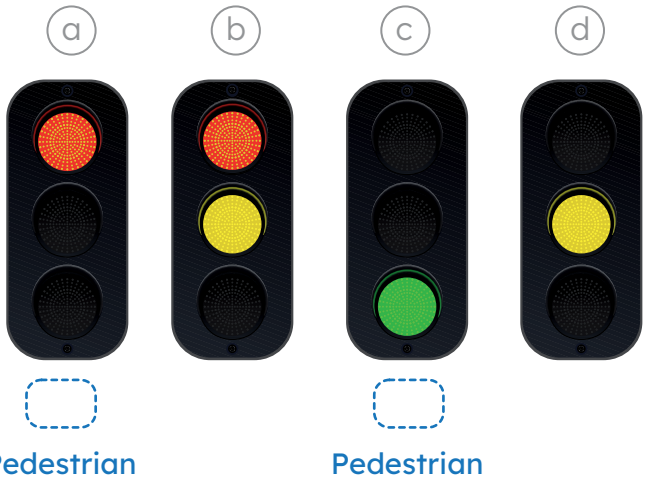
Example



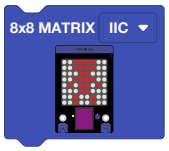
The program cyclically repeats the animation on the LED matrix.

Our system will work as follows: The LED matrix will display a walking person when the pedestrian can cross, and a stationary person when they cannot cross.

1. Observe the traffic light cycle and indicate in which state the pedestrian should be shown walking and in which state the pedestrian should be shown still.



a



b



2. Fill in the blank spaces in the paragraph:

The animation of the walking pedestrian lasts a total of ..... seconds. The state of the traffic light during which it should be displayed is the one with the ..... color, which, as we programmed in the previous challenge, lasts ..... seconds. Therefore, for the animation to occupy the entire duration of that state, it should repeat ..... times.

With the kit > >

3. Access the Maker platform and add the instructions for the pedestrian traffic light to the previous challenge's program. Then, upload it to the board to verify its operation.

4. Modify the program so that the durations of the green and red states are 16 seconds each.

To think and discuss: > >

In smart cities, there are traffic lights that regulate the timing of each state (red/green) and synchronization between traffic lights based on the time of day and traffic volume. How could we add this functionality to the system? What sensors would be necessary? What changes would need to be made to the program?

Choose Your Own Challenge

Daniel has three ideas to improve the city's traffic system.
Select a challenge. Then, build the model and solve the chosen challenge.

Program the animation so that the character blinks when the traffic light is yellow.

5,000 points

Add an audible signal to the traffic light for visually impaired people to indicate when it is safe to cross.

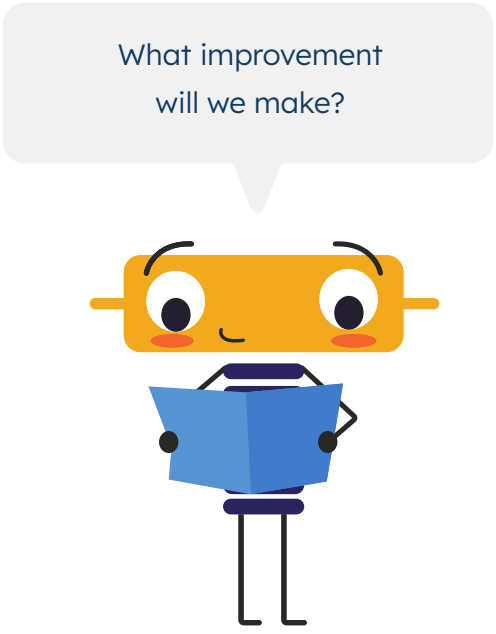
7,500 points

Build a traffic light with a push button to activate the pedestrian crossing.

10,000 points

Helpful Tips > >

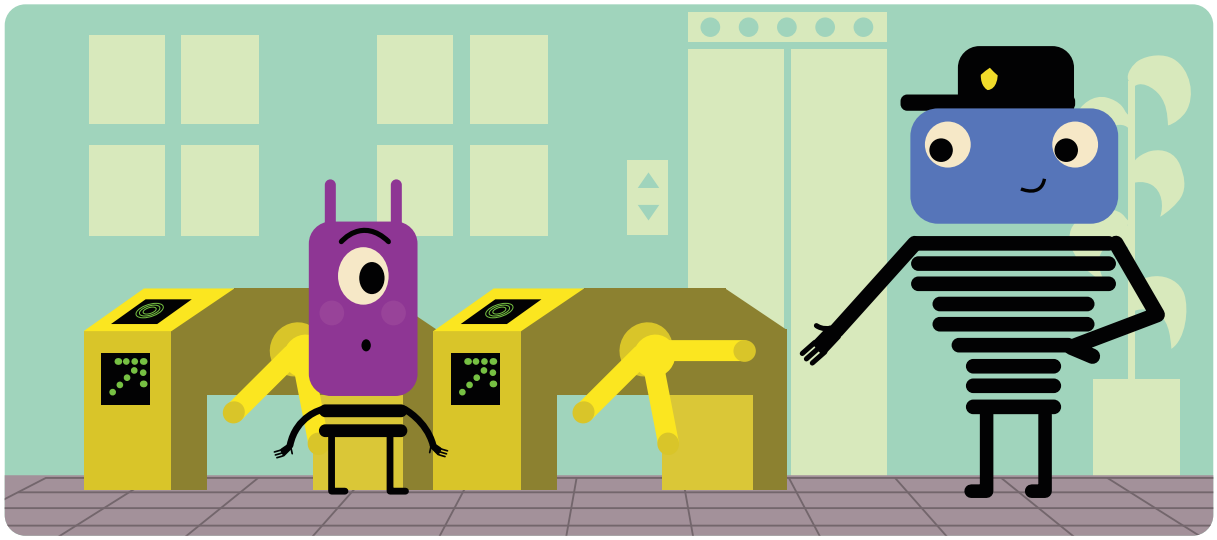
- Consider the on and off times in the LED matrix to combine the animation with the different traffic light states.
- For the sound indication, use different wait times in the green and red traffic light states.
- To add a button that activates the pedestrian crossing, you will need to include a condition in the program.
- Before you start programming, write the algorithm (sequence of instructions) on paper and share it with the rest of the team.



Smart access



Intelligent Access



Cloe was very excited to take her kids to their first football match. When the day came, she noticed something different, at the entrance there were some turnstiles that used fingerprints. Intrigued, she approached the friendly security guard who was nearby and asked him about this new security system. With a friendly smile, the guard explained to her that the building was implementing a series of security improvements. There were many areas with restricted access for the general public, and this new fingerprint technology was part of an effort to ensure a safer environment for all employees and visitors.

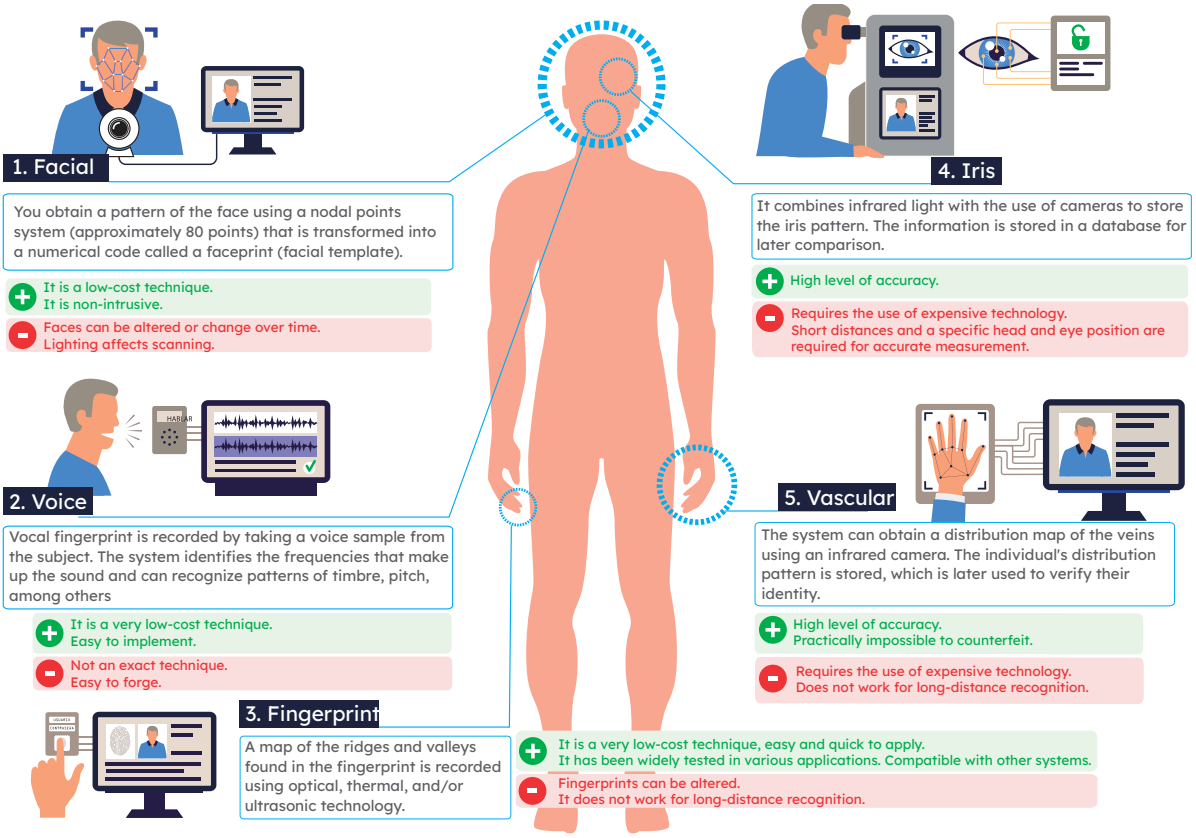
Let's think...

How can we improve security and access systems through technology?
What benefits does it have for community development?

1. Analyze the following infographic and answer:

a. What are the most effective biometric identification systems, and which one is the least effective? Why? .....

Biometric identification systems



Source: Giraldo, A. y Gómez Ramírez, D. P. (2017). Estado del arte de la seguridad en sistemas biométricos.

2. Choose one of the systems and complete the sentence by stating in what context and for what purpose you would use it.

We would use the recognition system in .....in .... for .....

Investigate

1. Research on entry systems in buildings and workplaces and answer:

a. Do you consider it important and beneficial to use these systems? Why?

b. Do you know of any building or house that uses an identification system?

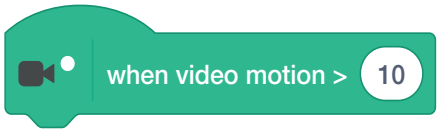
c. If you had to choose an identification system to enter your homes, which one would you choose? Why?

Security System

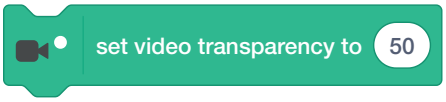
Cloe designed a security system that allows for the detection of intruders and the issuance of a visual and audible alert. To set it in motion, it is necessary to define the sequence of instructions and learn how to program the “Video Sensing” extension, which enables motion detection using the PC’s camera and executing actions based on those events.

Video sensing

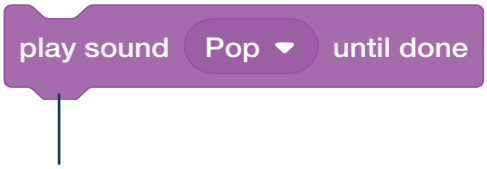
Sound



Event detection instruction that is triggered when the camera detects motion.
When activated, the connected blocks are executed.



Set the video transparency level.
The supported values are from 0 (no transparency) to 100 (completely transparent).

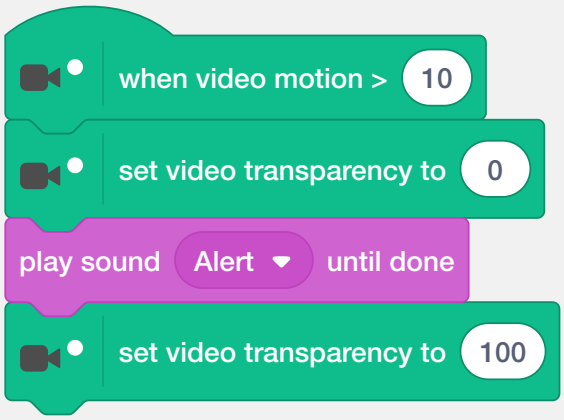


Play a sound and wait until it finishes.

Key Idea

Extensions allow us to incorporate new categories of blocks into the program. To access the computer’s webcam, the “Video Sensing” extension is used.

Example



When the webcam detects motion, the image is displayed on the stage, a sound is played, and then the video image is hidden again.

1. Access the Animations platform, run the program, and answer the questions.

a. What happens on the stage when the program is executed?

.....

.....

.....

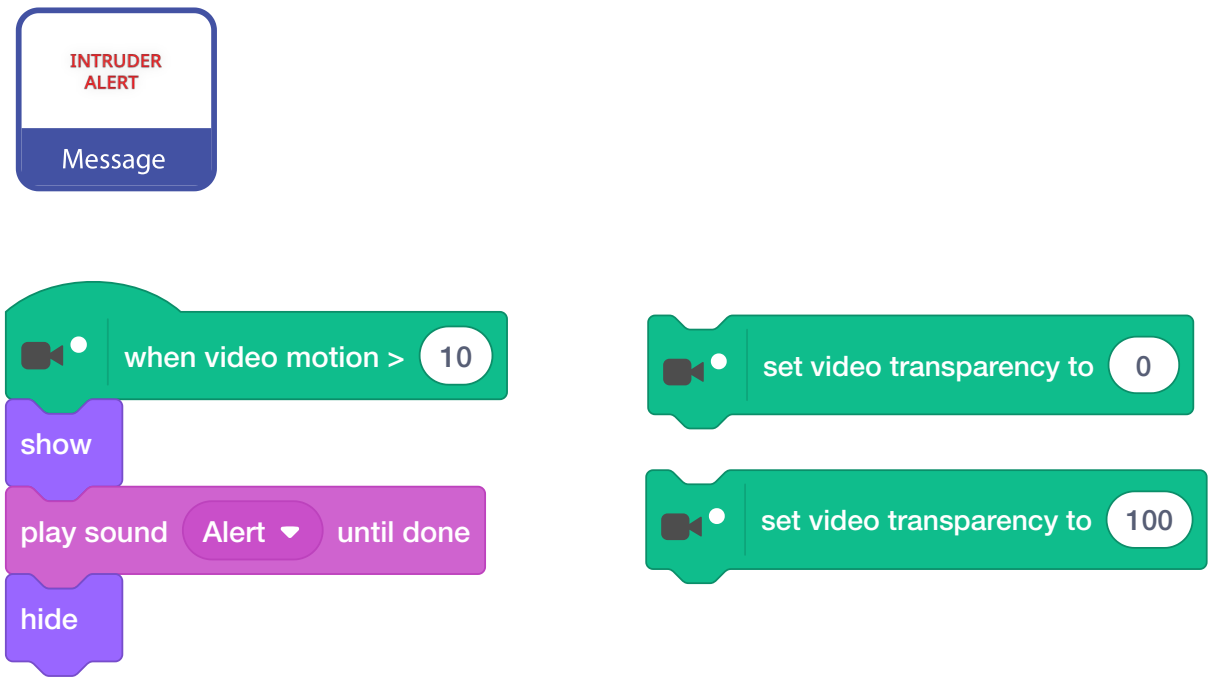
b. What happens when you move in front of the camera?

.....

.....

.....

2. Use arrows to indicate where in the program you would place the missing instructions to display the video on the stage when motion is detected and hide it after playing the alarm sound.



3. Modify the program so that the alarm sounds five times when motion is detected and display other alert messages.

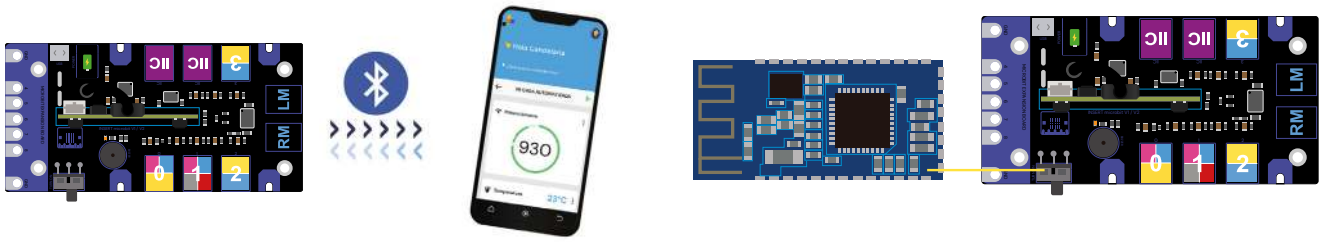
Bluetooth Module

The Bluetooth module allows us to communicate the board with other devices wirelessly. It is one of the most cost-effective methods for designing short-range wireless connections. It is integrated into the control board and can be easily identified by its Bluetooth antenna (a printed circuit board with a square wave shape, located at the end of the board).

Slave Mode

This module operates in “slave” mode, meaning it relies on another device to initiate communication. Once established, it can send and receive messages with the master device.

Controller board | Mobile device



Everyday examples

Cellphones

It is used for data transfer to and from other devices. For instance, when connecting to the phone in “hands-free” mode, we can send commands without the need to use our hands.



Audio systems

It is used to wirelessly transmit sound from a device to a speaker or headset.



Printers

It is used to send images from a device, for projecting or printing.



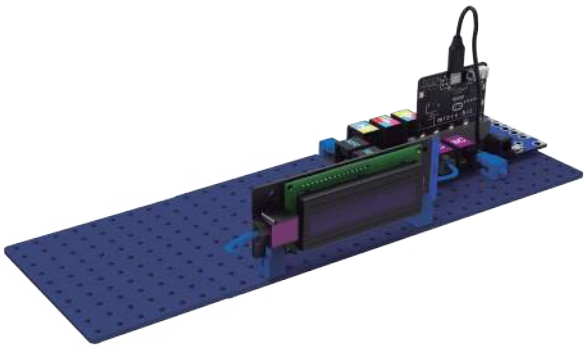
Video game consoles

It is used to establish communication between the console and the joystick without the need for cables.



Let's experiment!

We are going to exchange messages between the board and the device to test the Bluetooth module. We will begin by setting up the experimentation environment.



Necessary components

- PC with Maker software
- Control board
- Microbit board
- USB cable
- Connection cables
- LCD display
- Device with Bluetooth connectivity and the Control app installed

Connections

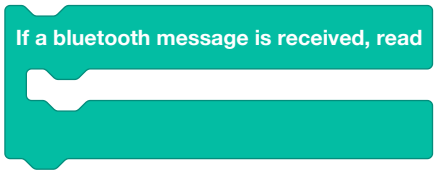
1. Connect the LCD display to the IIC pin.
2. Connect the board to the PC using the USB cable.

Control App

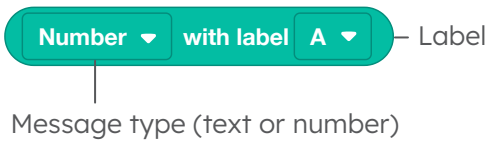
We will connect the board to the mobile device using the Control app. Within each project created from the app, we can customize the control panel and add components for sensor monitoring and controlling actuators connected to the board.

Programming Blocks

To complete this experimentation, we will need to use blocks that allow us to receive, obtain, and read messages. We will also need to program an LCD display.



Conditional structure that executes if there is data available to read.

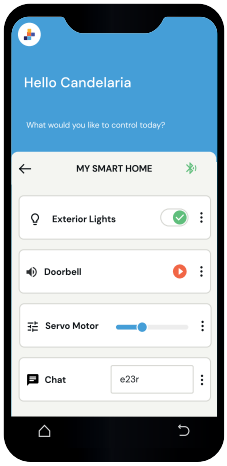


Message type (text or number)

Obtains the message containing the specified label. The message format can be text or a number.

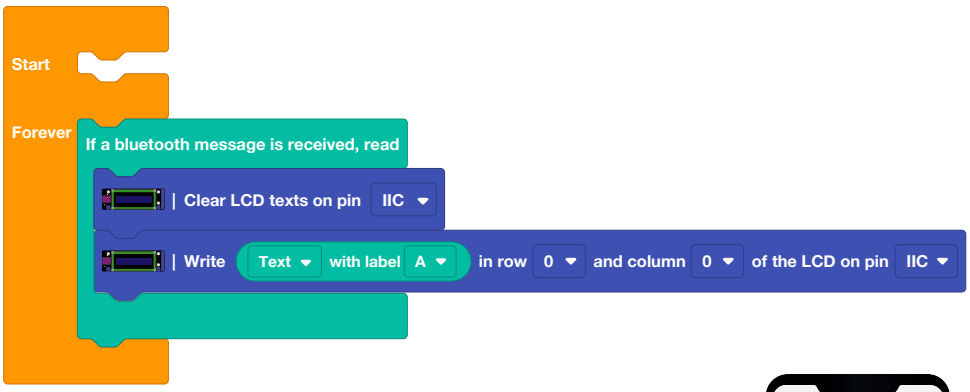


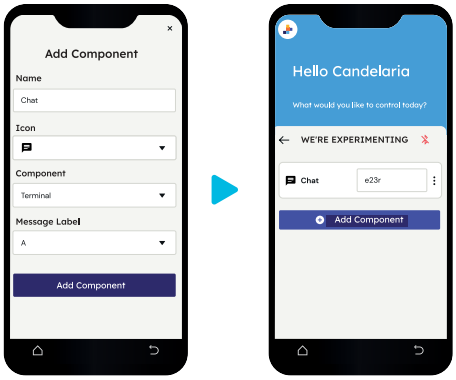
It will allow us to visualize the data we send from the app to the board.



Experimentation Program

To complete this experimentation, we need to determine if we receive data from the app, and if so, display it on the LCD display. Create the following program in Maker and upload it to the board.





1. Create a new project in the application, add a "Terminal" component, and configure the message label as "A."

2. Pair the device with the control board and complete the following activities:

a. Send the word "Hello." What happens?

b. Send another message. What happens to the previous message?

c. Can you send more than one word per message?

○ Yes ○ No

Watch the video to learn how to link the control app with the controller board.

https://steamBelize.fifafoundation.org/QR/14

3. Discuss the conclusions of this experimentation among yourselves.

a. What did you learn from this experience?

b. What difficulties did you find, and how did you solve them?

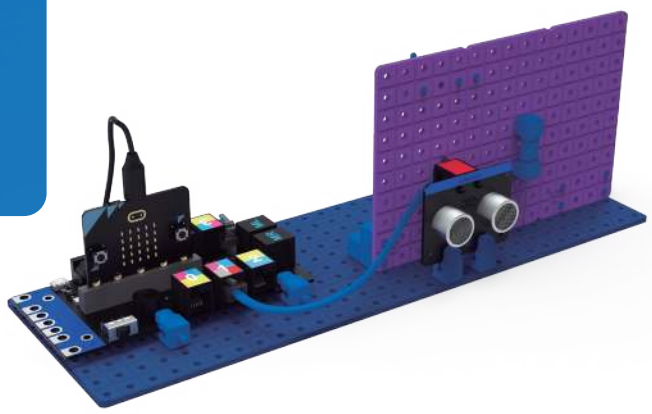
Maker Moment

It's time to work with the kit! We will create our own access and security system in two parts. First, we will create a password in the application and send it to the board to validate if it is correct or not. Then, we will add a proximity alert system.

1. Scan the QR code for step-by-step assembly instructions.

Required Components

- PC with Maker software
- Device with Bluetooth connectivity and Control app installed
- Control board
- Microbit board
- USB cable
- Ultrasonic sensor

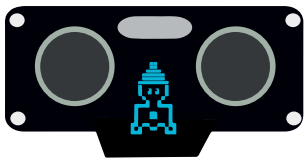


https://steamBelize.fifafoundation.org/QR/10

In the challenges, we will need to use the following components:

Ultrasonic sensor

Function: measure distances

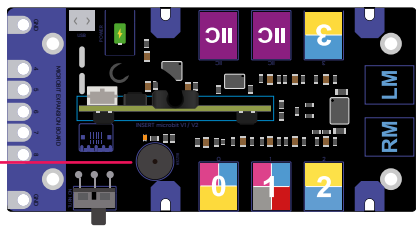


Digital inputs

PIN 1 | Sensor

Built-in buzzer

Buzzer function: Play square wave sounds



Outputs

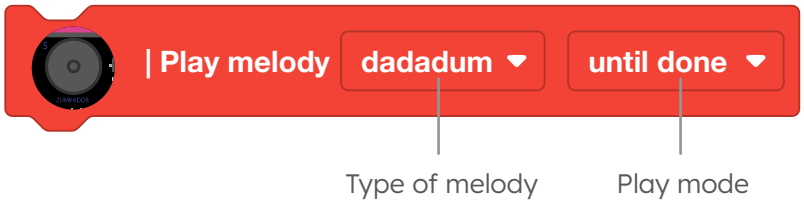
Integrated into the board | Actuators

Coded Access System

In this challenge, we will create a keypad access system. To do this, we will use the Bluetooth module, the built-in buzzer, and a smart device with the Control app installed. Let's learn how to program melodies with the buzzer.

Outputs

Program melodies



Key Idea

The melody can play in the background by changing the play mode in the block. For this they must be used in the start block.

Example

In this program, the "birthday" melody is played until it ends, you wait 1 second, then the "entertainment" melody is played until it ends and you wait another second.



Our system will work as follows:
We will enter a password through the application. When the board receives the password, it will play “entertainment” melody on the built-in buzzer.

1. Choose a password and write it down below to remember. It can consist of numbers or letters (uppercase or lowercase).

PASSWORD:

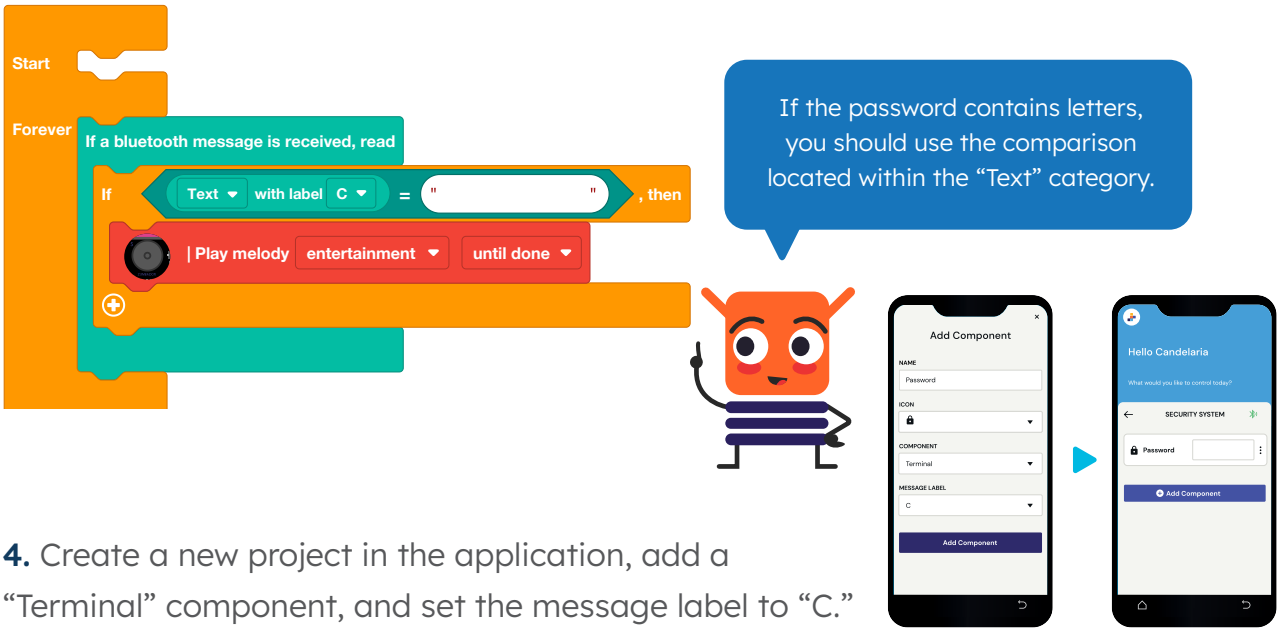
2. When receiving data via Bluetooth, we need to determine if it matches the password. Mark which of these blocks you would use to correctly obtain the information. Justify your answer.

a) Text with label C

b) Number with label C

c) Send bluetooth message " password " with label C

3. To be able to play the melody, we need to know if the password is correct. Complete the program with the missing information.



4. Create a new project in the application, add a “Terminal” component, and set the message label to “C.”

With the Kit > >

5. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to verify its functionality.

6. Modify the program to play a sound if the password is incorrect.

Intelligent Security System

In this challenge, we will create a comprehensive alarm system that detects the presence of intruders and alerts people. To do this, we will need to incorporate an ultrasonic sensor into the system.

Digital inputs

Communication

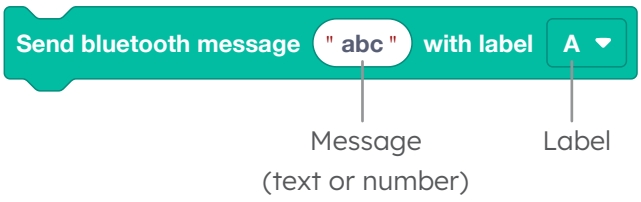
Programming the Ultrasonic Sensor

The ultrasonic sensor allows us to detect nearby objects and determine their distance.



Sending Messages

Send data with a specific label through the Bluetooth module. The message to be sent can contain text or numbers.

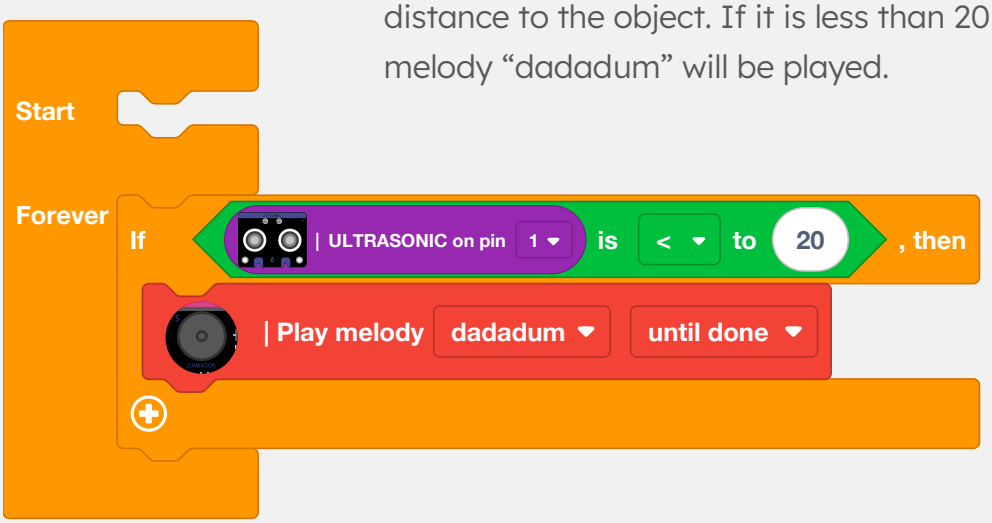


Key Idea

The sensor consists of two components: a speaker that emits an inaudible ultrasonic wave for the human ear, and a microphone that receives the reflected wave returning from the object. For this reason, it is connected to a special dual-pin.

Example

In this program, the ultrasonic sensor measures the distance to the object. If it is less than 20 cm, the melody “dadadum” will be played.

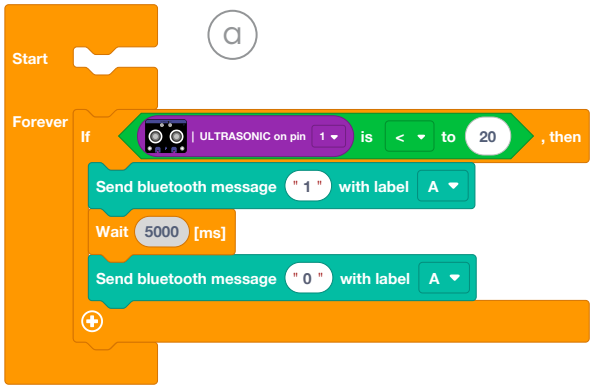


Our system will work as follows:

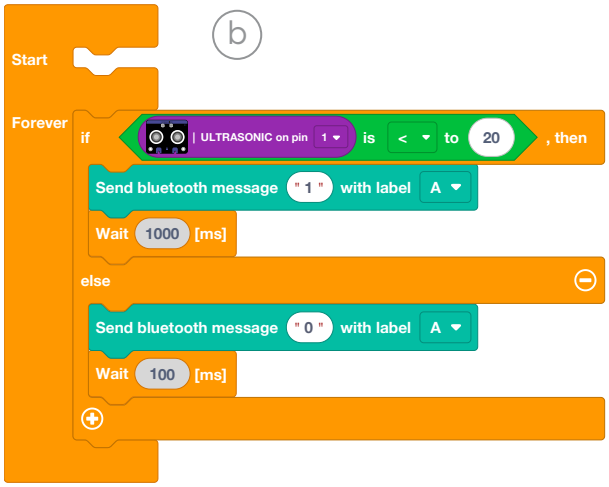
If the sensor detects the presence of a person or object within 20 cm, send the message “1” with the label “A” to the application, wait for 5 seconds, and then send the message “0” with the label “A.”

1. Analyze the following programs and mark with a cross which one you consider solves the challenge. Justify your choice.

a



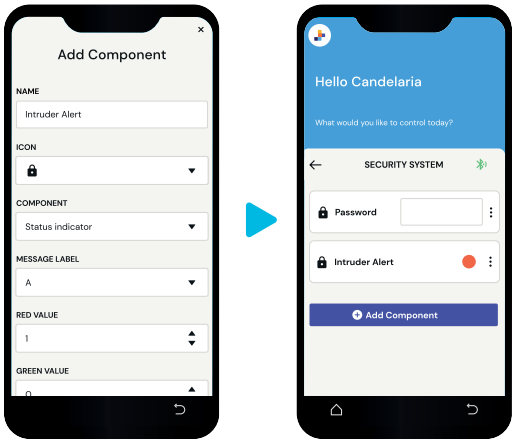
b



.....

.....

2. Incorporate a status indicator to display the sensor’s status. Remember to specify the type of message to receive.



With the Kit

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to verify its functionality.

Choose Your Own Challenge

Cloe has three ideas to improve building security. Select one challenge. Then, create a project model and program the system to solve the chosen challenge.

Change the melody that plays when the password is correct.

5.000 points

Incorporate an LCD display to visualize the status of the security system.

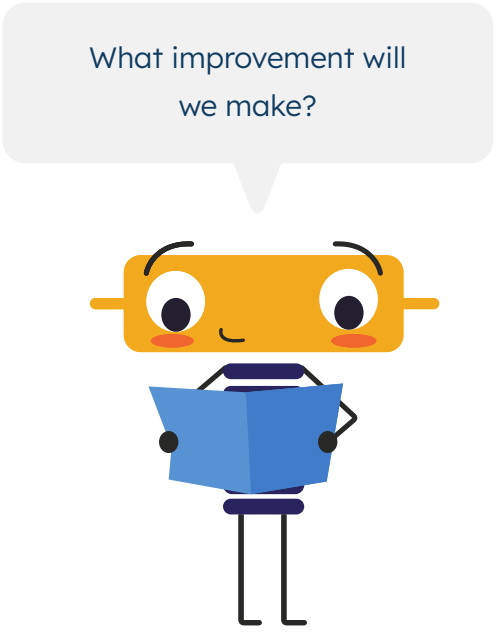
7.500 points

Incorporate a servomotor to lock and unlock the club entrance based on the password.

10.000 points

Helpful Tips > >

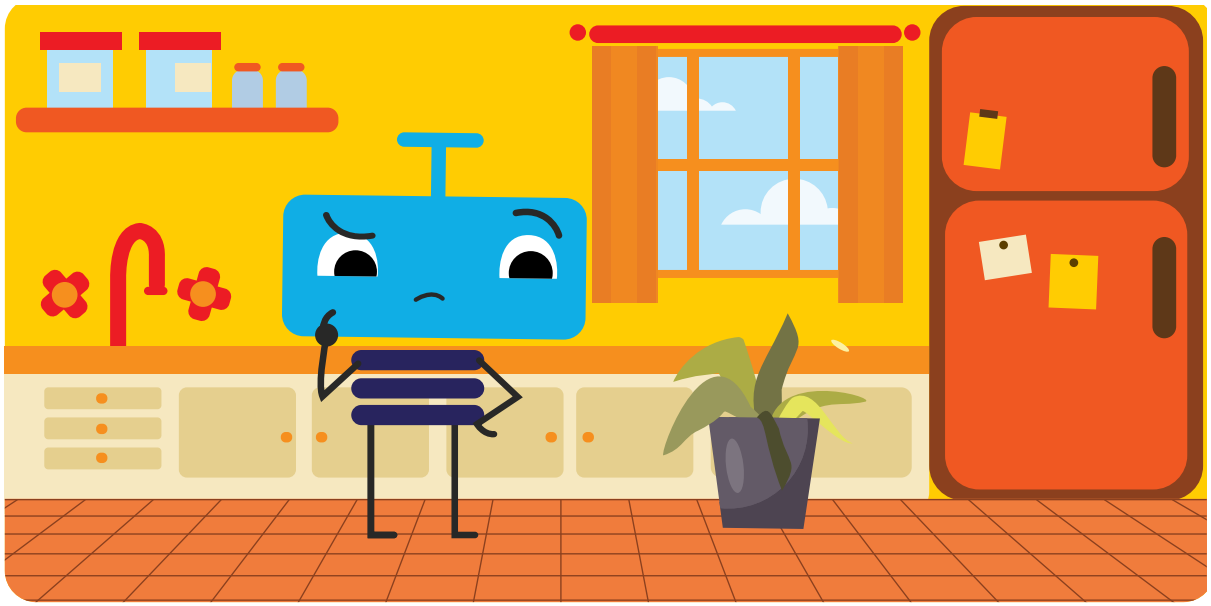
- Define a strategy to tackle the challenge (task distribution, steps to follow, deadlines, among other points).
- Make a list of the necessary components.
- Define the role of each team member (assembly, programming, documentation, etc.).
- Refer to previous challenges and seek information to solve the project.



Smart pots



Smart pots



Ester loves plants, but she's not very good at remembering to water them, and many times they die. When her friend gave her a new plant, she went to a garden center to learn about its care requirements. The employee told her that this type of plant is for indoors and needs a lot of water, so it's important to keep the soil consistently moist.

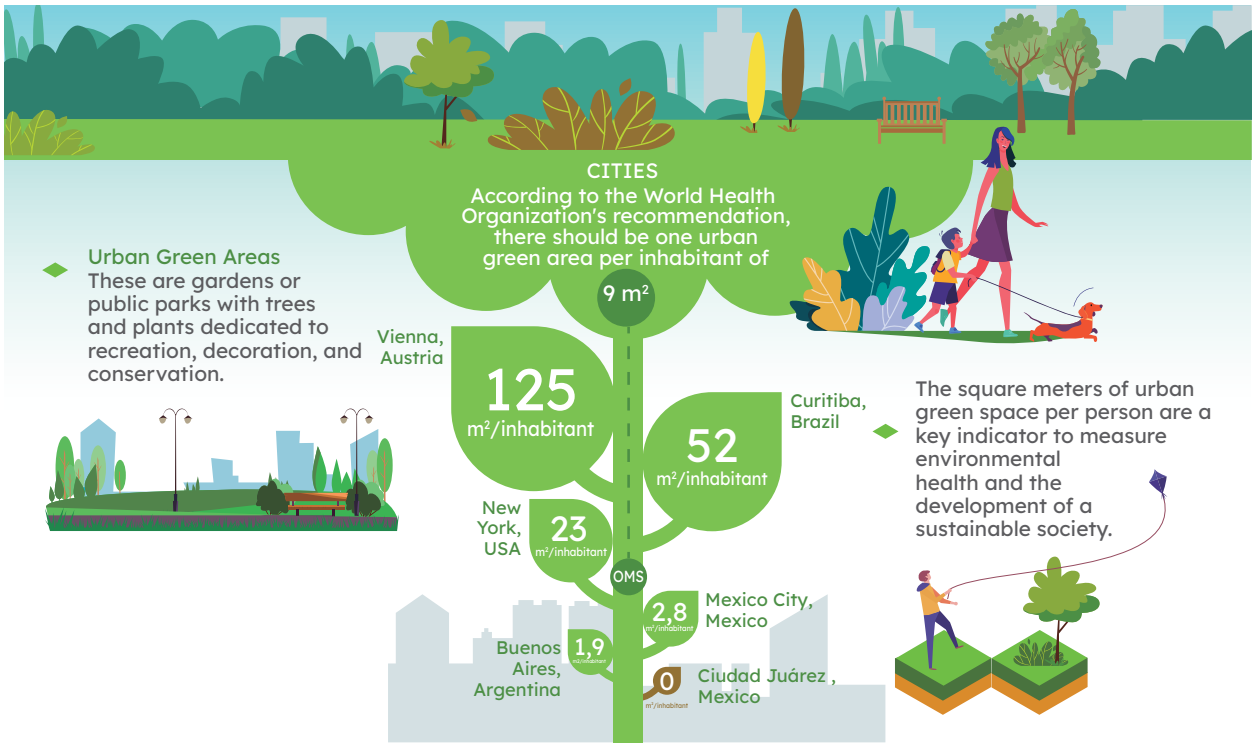
Worried about keeping her plant healthy, Ester started thinking about ways to help her remember to water it.

Let's think...

How technology can help Ester know when it's time to water her plant?
How can it be used for environmental preservation?

1. Analyze the following infographic and answer:

Urban green areas



Source: "World Health Organization. (2017). Urban green spaces: a brief for action. In Urban green spaces: a brief for action."

a. What is an urban green area?

.....

b. According to the World Health Organization, how many square meters of urban green space per inhabitant should a city have?

.....

c. Which city has the highest number of square meters of urban green space per inhabitant?

.....

Investigate

1. Research the importance of green spaces and answer the following questions.

a. What direct and indirect benefits do urban green areas provide?

b. What is the importance of trees in large cities?

c. What projects related to the construction of urban green spaces does your city have?

Smart Gardening

Ester designed a prototype of smart gardening that allows you to know the moisture level of a plant. Additionally, she created an animated simulation to demonstrate how it would work. To program it, she used variables and value ranges.

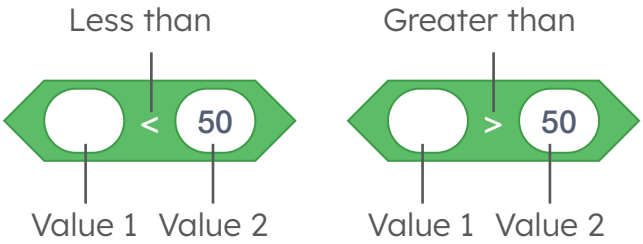
Operators

Variables

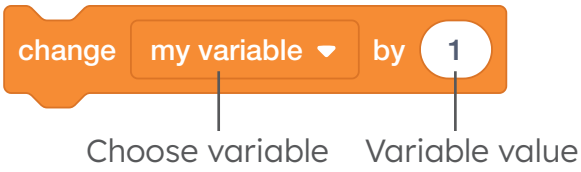
Logical operators



Logical operators



Add value to the variable



Access the value of the variable



Key Idea

To define a range of values, it is necessary to establish a minimum value and a maximum value.

Example

In this program, it evaluates whether the value of “my variable” is greater than 10 and less than 50; if the condition is true, Ester switches to “costume 2,” if not, she switches to “costume 1.” Then, it adds 1 to the variable’s value.





1. Access the Animations platform, run the program, and answer the questions.

a. What happens when you start the program? .....

.....

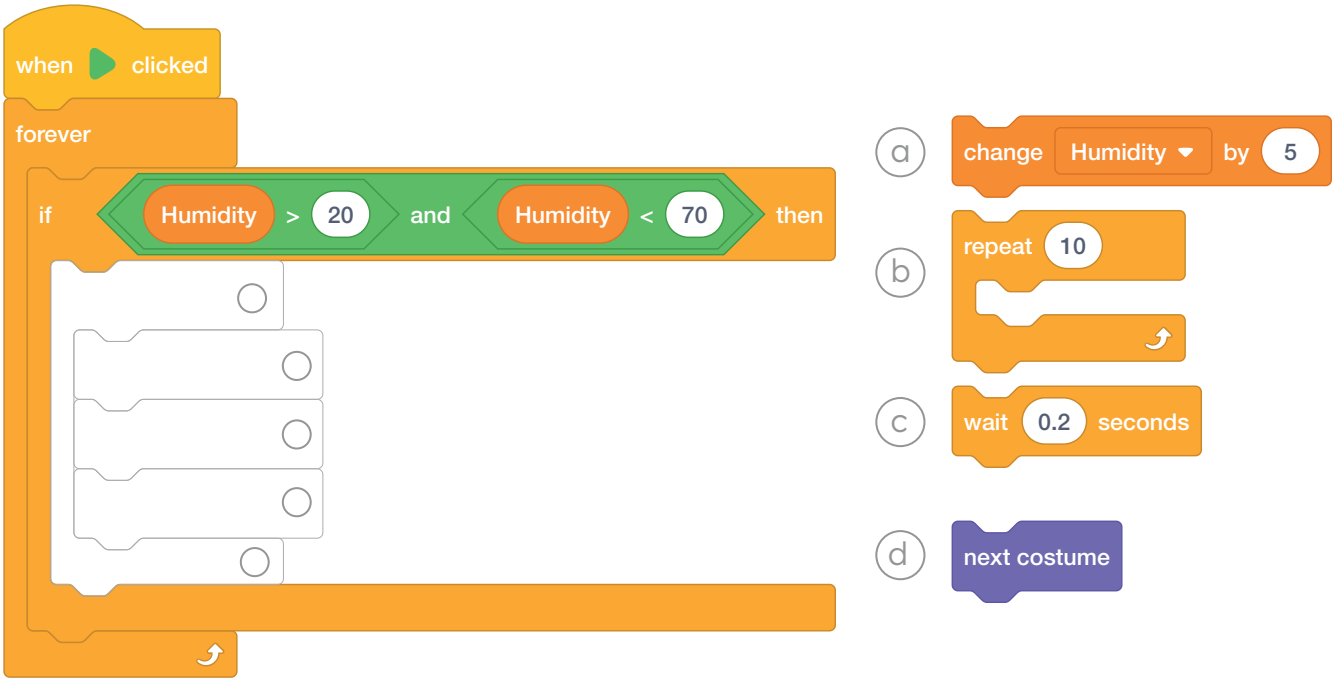
b. At what humidity level does the plant dry up? .....

.....

2. Analyze the program inside Ester and circle the correct option. Ester is asking...

- ▢ **a.** If humidity is greater than 70 and less than 20
- ▢ **b.** If humidity is greater than 20 or less than 70
- ▢ **c.** If humidity is greater than 20 and less than 70

3. If the condition is true, Ester should repeat the following actions 10 times: switch to the next costume, add 5 to humidity, and wait for 0.2 seconds. Arrange the blocks to program this behavior.



4. Run the program with the modifications and answer:

a. What happens to the plant?

b. What happens if you change the waiting time to 0.5?

c. What happens if you reverse the placement of the blocks inside the “repeat” block?

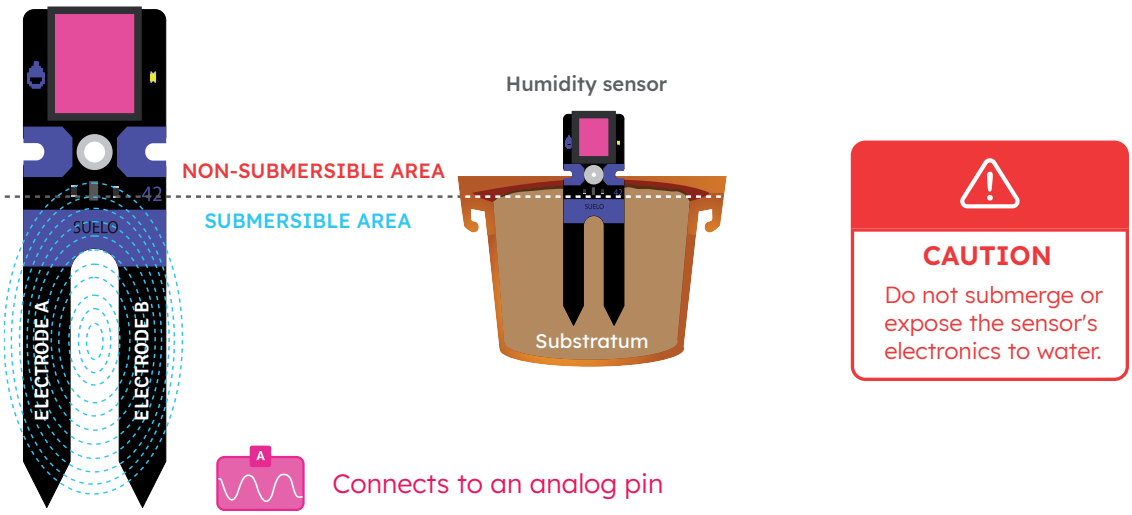
The soil moisture sensor

The soil moisture sensor or hygrometer is generally used to detect the moisture level in soil, sand, or any permeable substrate.

The measurement result is a variable analog signal between 0 and 5 volts. The analog input of the control board is capable of reading this signal and converting it into a value between 0 and 1023. The delivered value will depend on the amount of water present in the substrate near the module's terminals.

Operating Principle

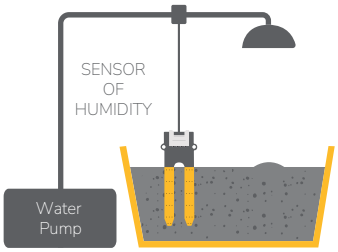
To measure soil moisture, this sensor uses two electrodes that are inserted into the substrate to be analyzed and measures a property of the materials in contact with them: their dielectric constant. This characteristic is related to the electrical capacitance of a material.



Everyday Examples

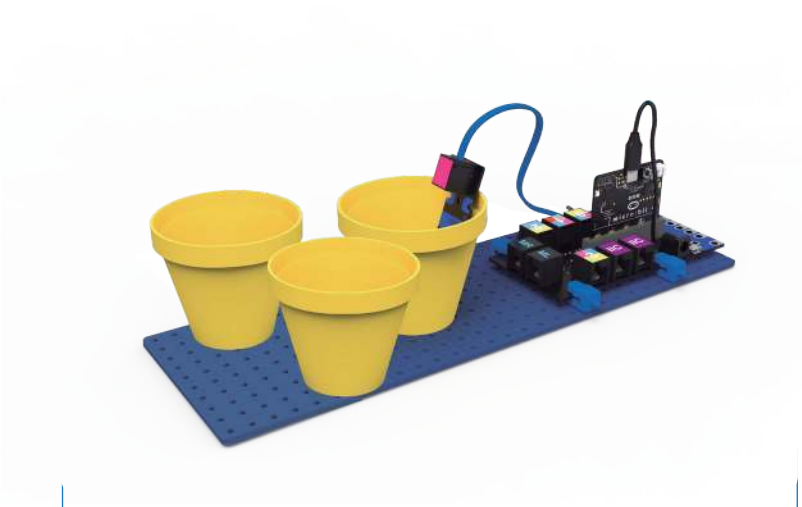
Irrigation System

When the sensor detects low moisture in the soil, irrigation is automatically activated. This helps regulate and maintain an appropriate level of soil moisture.



Let's Experiment!

We are going to test the soil moisture sensor by measuring moisture in different substrates. We will start by setting up the experimentation environment.



Connections

1. Connect the soil moisture sensor to pin 0.
2. Connect the board to the PC using the USB cable.

Required Components

- PC with Maker software
- USB cable
- Control board
- Microbit board
- Connection cables
- Soil moisture sensor
- Container with sand (5 cm)
- Container with soil (5 cm)
- Container with rice (5 cm)
- Container with water (100 ml)
- Scissors

Programming Block

To complete this experimentation, we will use the following block, which allows us to program the soil moisture sensor.

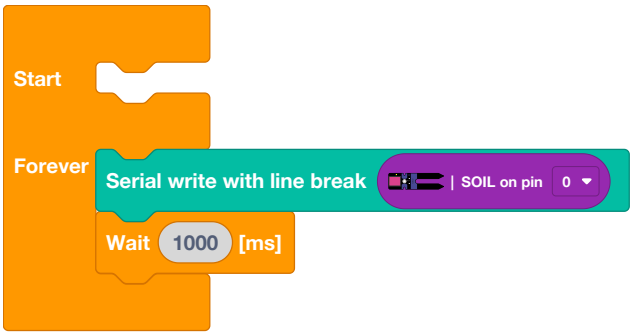


To view the values delivered by the sensor, we will use the serial monitor of the platform.

https://steamBelize.fifafoundation.org/QR/13

Experimentation Program

Create the following program in Maker and upload it to the board.



1. Place the soil moisture sensor in the different containers and complete the table with the values obtained

	Dry	Relatively humid	Very humid
Sand			
Land			
Rice			

2. Answer the following questions.

a. Even with the substrate very wet, were you able to obtain the maximum measurement value of 1023? .....

b. Did you find measurement differences between one substrate and another?

.....

3. Perform these tests and answer the questions.

a. Submerge the sensor electrodes in 3 cm of water. What value did you obtain? .....

b. Place the edge of scissors over both electrodes. What value did you obtain? .....

c. Did you find differences between the sensed value of water and the edge of the scissors?

Explain why .....

d. Experiment with different substrate humidities until you reach a measurement value of 400.

e. What measurement value do you find optimal for the soil moisture of a plant?

☐ Less than 300 ☐ Between 301 and 600 ☐ Between 601 and 900 ☐ Greater than 900

Indicate true or false.

If the sensor delivers a value of 700, it means there is little moisture in the substrate.

☐ True ☐ False, because .....

4. Discuss among yourselves the conclusions of this experiment.

a. What did you learn from this experience?

b. What difficulties did you encounter? How did you solve them?

Maker Moment

It's time to work with the kit! Let's create our own humidity control system and monitor the weather conditions to take care of our green spaces. In the first challenge, we will program pots that detect and inform us about soil moisture; in the second one, we will configure a comprehensive monitoring system, including temperature and light level measurements in the environment.

1. Scan the QR code for the step-by-step assembly instructions.

Required Components

- PC with Maker software
- Device with Bluetooth connectivity and Control app installed
- Control board
- Microbit board
- USB cable
- Connection cables
- Soil moisture sensor
- Temperature & humidity sensor
- Light sensor

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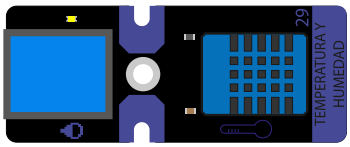
In the second challenge, we will need to use the following components:

Temperature & humidity sensor

Function: Measure humidity and ambient temperature.

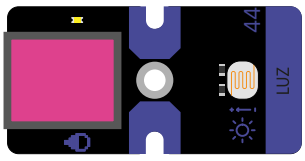


Digital inputs

PIN 2	Sensor

Light sensor

Function: Measure light level in the environment.



Analog inputs

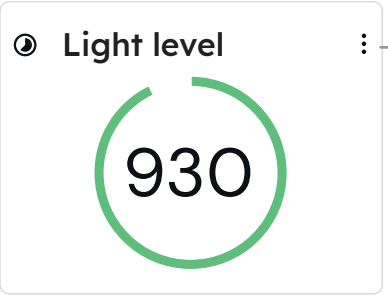
PIN 1	Sensor

Smart Plant Pots System

In this challenge, we will create a smart plant pot that sends the soil moisture level to the application. To do this, we will use the Bluetooth module, the soil moisture sensor, and a smart device with the Control app installed. From the app, we will need to use the circular viewer.

Circular Viewer

Allows us to visualize different numbers within a specified range of values.



Setting up the message format

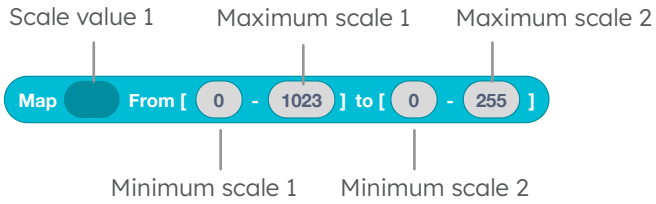
In the program, we will need to include a mapping.

Map block

Allows us to transform a value from an origin range to its proportional value in a destination range.

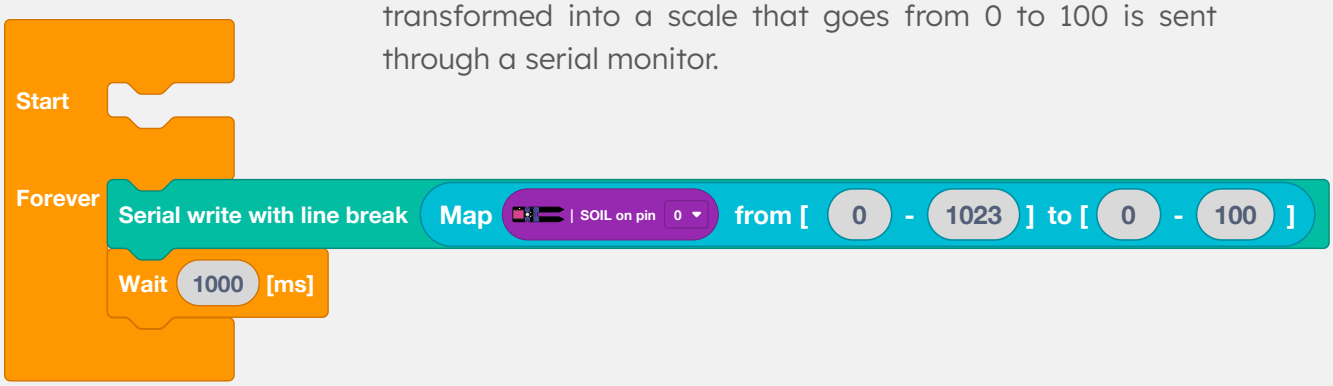
Key Idea

The “map” function allows us to transform a value from an origin range to its proportional value in a destination range. It is often used to transform the reading from an analog sensor.



Example

In this program, the value of the soil moisture sensor transformed into a scale that goes from 0 to 100 is sent through a serial monitor.



Math

Our system will work as follows:
The control board will read and send via bluetooth soil moisture values, transformed into a range of 0 to 100, every 3 seconds.

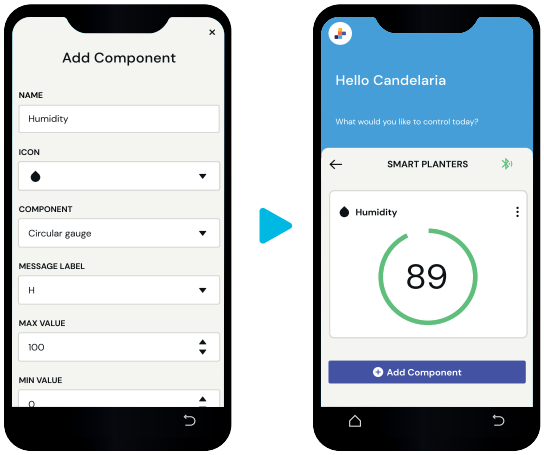
1. Mark with a checkmark which of the following blocks allows sending the translated soil moisture values to the specified range. Justify your choice.



2. Complete the following block with the time to wait before sending the message again.



3. Create a new project in the application and add a “Circular Viewer” component. Then, configure the message label as “H” and set the minimum value to 0 and the maximum value to 100.



With the Kit > >

4. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to test its functionality.

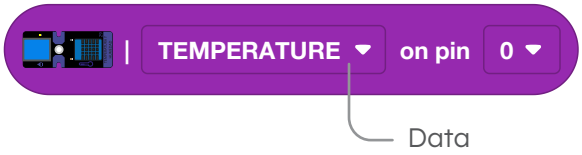
5. Place the soil moisture sensor in different pots and check the received data.

Weather Station

A weather station is a facility designed to regularly measure and record various weather variables. The data obtained is used to create weather predictions based on numerical models and to conduct climate studies.
In this challenge, we will create a comprehensive monitoring system. To do this, we will use an ambient temperature and humidity sensor and a light sensor.

Temperature Sensor

It is a digital temperature and relative humidity sensor that provides the temperature value in degrees and the percentage of humidity.



Light Sensor

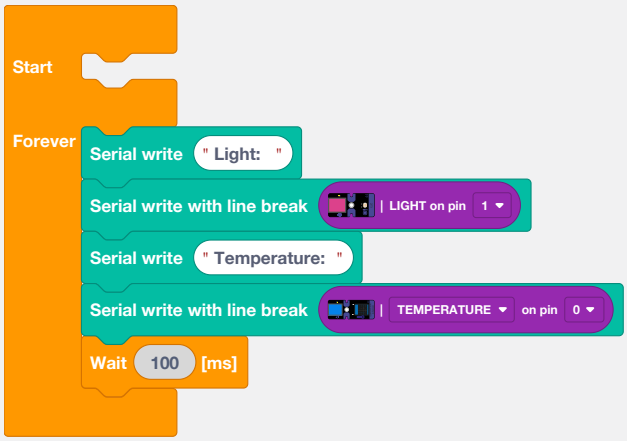
It contains an LDR (Light Dependent Resistor), which is a photoresistor that varies its resistance value depending on the light that falls on the component.



Key Idea

The resistance value of the light sensor decreases when there is light falling on it and increases when there is none. Due to its internal connection, when it is completely dark, the sensor will give us a reading of 0, and as it receives more light, it will increase up to 1023.

Example

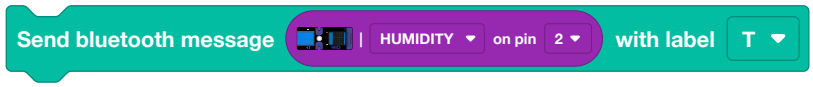


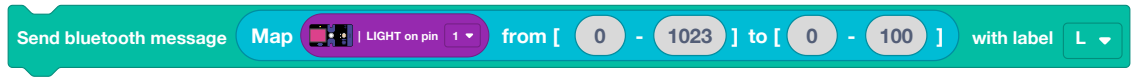
In this program, light and temperature data are sent through the serial communication port to be visualized on the platform.

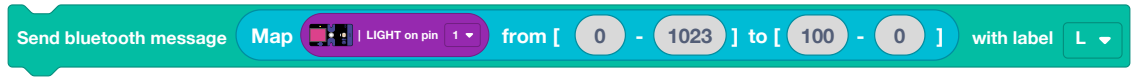
In this second challenge, we will program the device to send the light percentage and ambient temperature.

1. To send light and temperature data, we need to correctly configure the labels and adjust the necessary values. Analyze the following blocks and select the ones that allow you to send the values correctly. Justify your choice in each case.

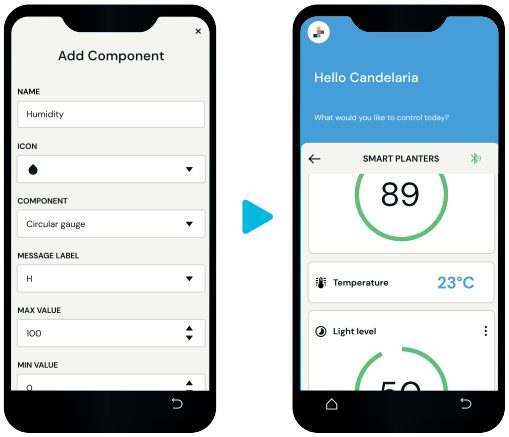
a) 

b) 

c) 

d) 

2. Add a "Circular Viewer" to the application. Configure the label as "L" and set the minimum value to 0 and the maximum value to 100. Then, add a "Digit Viewer" component. Configure the label as "T" and the unit as °C.



With the Kit > >

3. Build the program in Maker and upload it to the board. Then, from the Control app, establish a connection with the device to test its functionality.

4. Place the pots in different lighting and temperature conditions and check the received data.

Choose Your Own Challenge

Ester has three ideas to improve the care of green spaces. Select a challenge. Then, build a project model and program the system to solve the chosen challenge.

Play an alert sound when the soil is dry.

5.000 points

Program a color system with the RGB LED module to display the temperature.

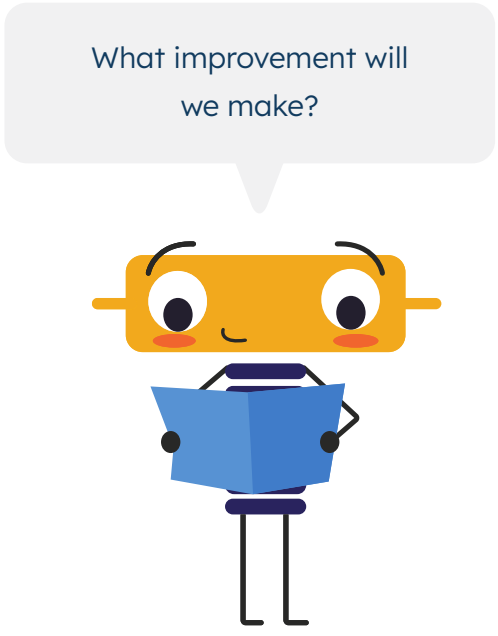
7.500 points

Incorporate an LCD display to display sensor values.

10.000 points

Helpful Tips > >

- To program an alert, it is necessary to define the threshold value and add a conditional statement to the program.
- To define the threshold value, it is advisable to test the sensor in different substrates (dry and wet) to see what values it provides.
- To display the temperature level on the LED module, you need to define the temperature ranges you want to display and select a LED configuration for each one.

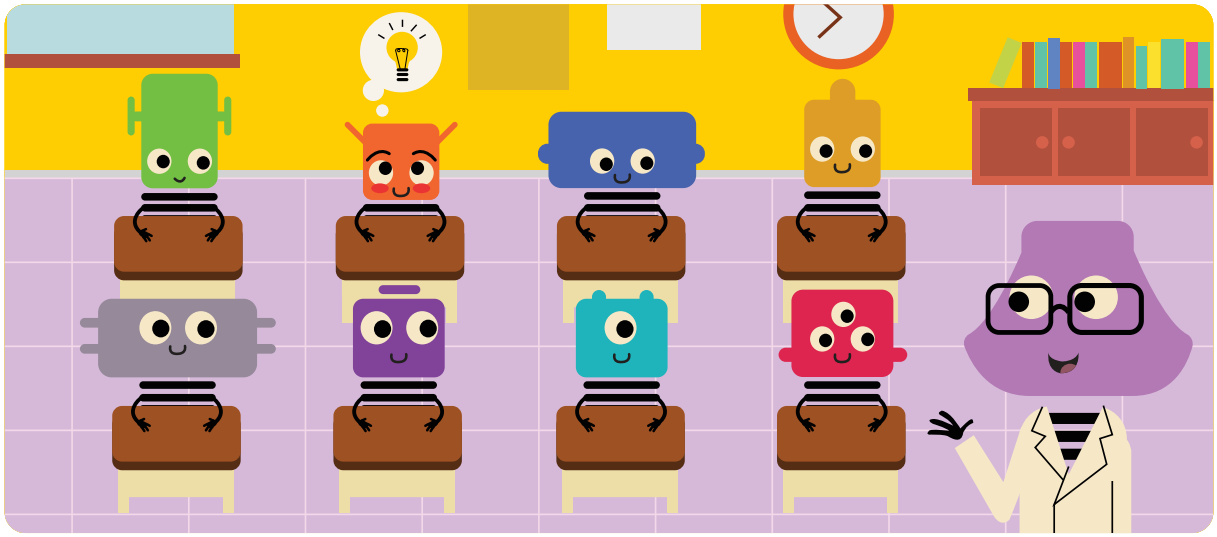


Mental agility

12



Mental agility



In the classroom, the teacher gathered her students and shared exciting news with them: they had to prepare a carnival where all the families would participate.

The students' faces filled with surprise and joy as they listened carefully while the teacher explained that they had to think of games that were not only fun but also helped improve their motor or mental skills. Among the students, Ubaldo was particularly intrigued by the idea and began to imagine how he could merge his two great passions: technology and games.

Let's think...

How can we use technology to create games that help develop skills?
What impact does it have on learning?

1. Analyze the following infographic and answer:

a. What benefits do video games provide to the user?

.....

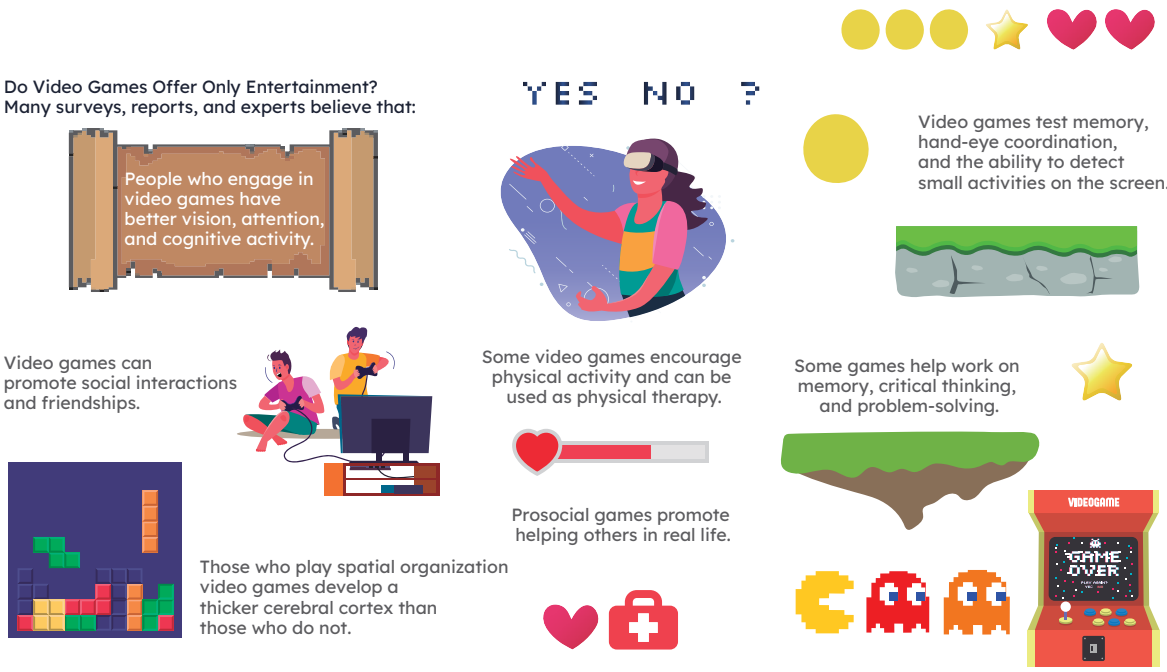
b. According to the infographic, many video games help exercise memory. Do you know any that develop this ability?

.....

c. According to the infographic, what other skills do video games help develop?

.....

Benefits of video games



2. Discuss among yourselves: Do you think gaming is a good tool for making friends and working as a team? Why? What problems can excessive dedication to video games bring? How much time do you think would be reasonable to allocate to them each week?

Investigate

1. Search the internet for information on the benefits and drawbacks of video games and answer the following questions.

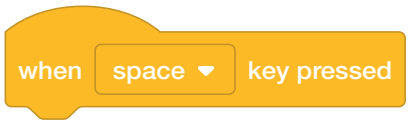
a. Do you believe that one can learn something by playing? If you answered yes, what can be learned?

b. Do you think there is an age limit for playing? Why?

Exercise memory

Ubaldo designed a game to exercise memory and find the four treasures hidden in space before time runs out. To make it work, we need to learn how to program the following blocks.

Events



Structure executed when a specific key is pressed.

Motion



Move the object's y position by the defined number of pixels.



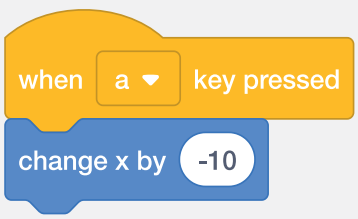
Move the object's x position by the defined number of pixels.

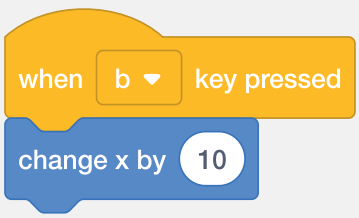
Key idea

"Key pressed" events allow us to create control commands for our video games.

Example

When the "a" key is pressed, ten pixels are subtracted from Ubaldo's x position, causing him to move to the left. When the "d" key is pressed, ten pixels are added to the x position, causing the character to move to the right.







1. Access the Animations platform, run the program, and answer the questions.

a. What happens on the screen when the program is executed?

.....

.....

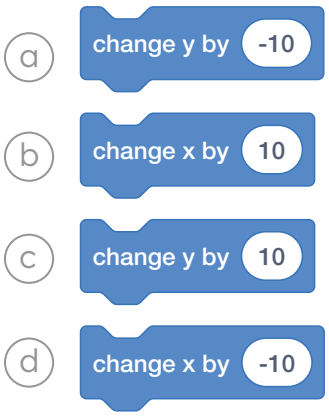
b. What message appears when the time runs out?

.....

.....

2. The following structures correspond to the program that allows Ubaldo to move around the screen by pressing the arrow keys. Complete them by writing the missing block letter in each case.



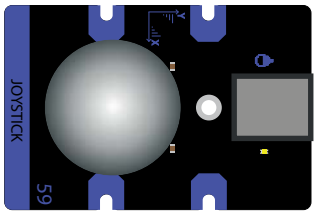


3. Design the "You Win" and "Try Again" screens within the "Background" object and modify your program to display them when the game ends.

4. Are you up for adding music and sound effects to make the game more appealing?

The joystick

A joystick is a device that allows control of movements based on the tilt angle of a lever. We usually associate it with video games. However, its use has expanded to control a wide variety of devices.

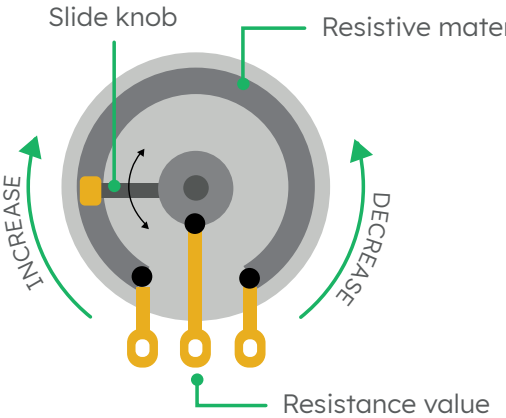




Connects to a pin triple special

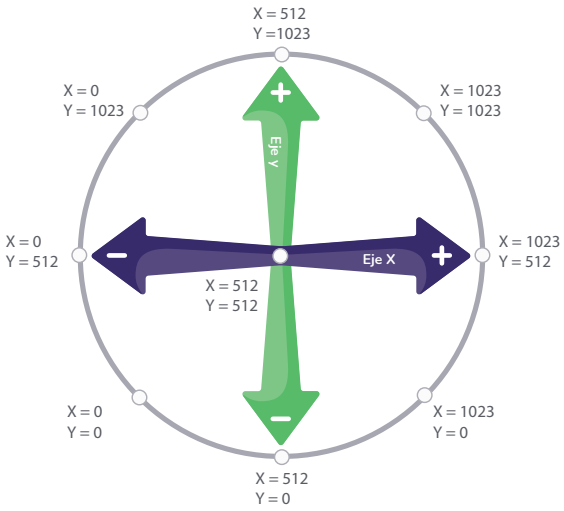
Operating principle

The lever of the component is linked to two potentiometers. One is for horizontal movement, and the other is for vertical movement. A potentiometer is a variable resistor that allows control of the amount of current in a circuit based on the angle of rotation.





Joystick movement



Lever position

Each of the potentiometers works with an analog signal; one corresponds to horizontal movement (x-axis), and the other corresponds to vertical movement (y-axis). By combining their values, we obtain the exact position of the lever.

Everyday examples

Drones

They are used to control the movement of the device in the air.



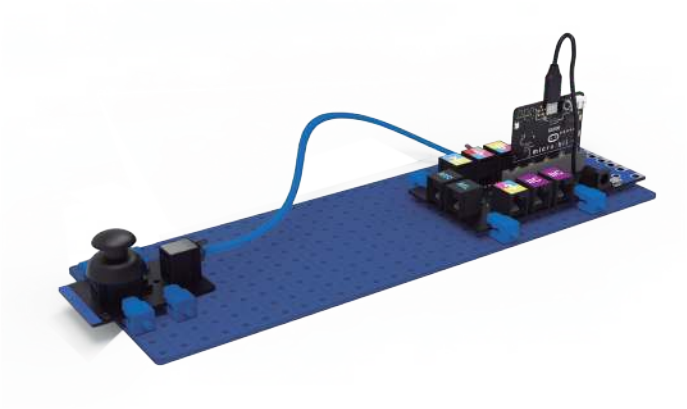
Security cameras

They are used to control the movement of cameras at different angles and positions.



Let's experiment!

Organized in groups, we will experiment with the values provided by the joystick. We will start by setting up the experimentation scenario.



Required components

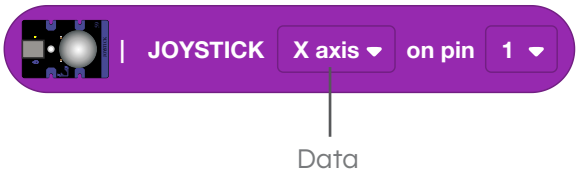
- PC with Maker software
- USB cable
- Control board
- Microbit board
- Connection cables
- Joystick

Connections

1. Connect the joystick to pin 1.
2. Connect the board to the PC using the USB cable.

Programming block

To access the position of the joystick, we can use the following block:

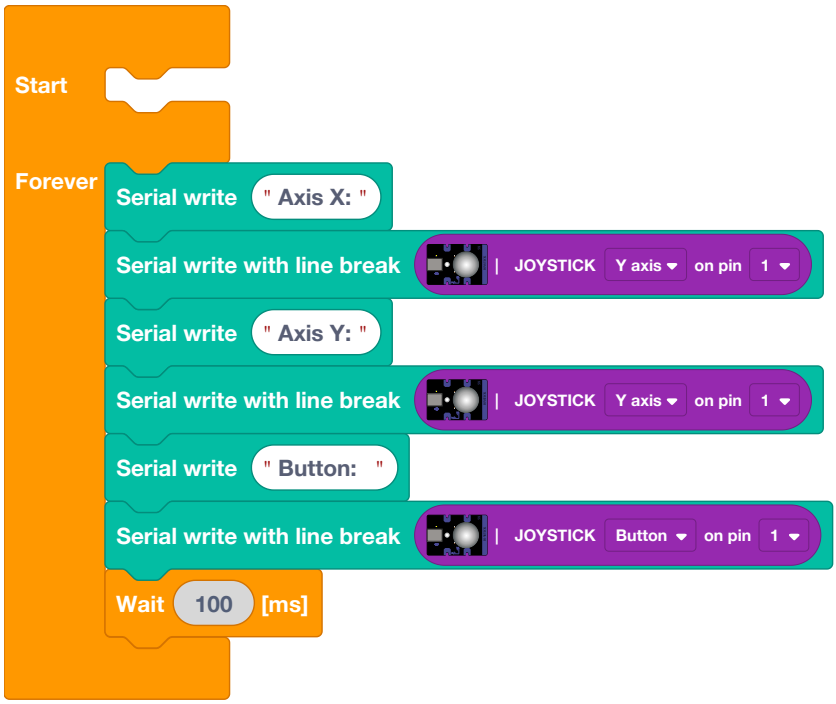


To perform this experiment, we will visualize the values of the joystick on the serial monitor.

https://steamBelize.fifafoundation.org/QR/13

Experimentation program

Build the following program in Maker and upload it to the board.



1. What values does the joystick provide in the x and y axis in its resting position?

○ x: 0; y: 0 ○ x: 1023; y: 0 ○ x: 512; y: 512 ○ x: 0; y: 512

2. Answer the following questions:

a. Move the joystick lever to the right. What values does it provide?

x: _____ *y:* _____

b. Move the joystick lever to the left. What values does it provide?

x: _____ *y:* _____

c. Move the joystick lever upwards. What values does it provide?

x: _____ *y:* _____

d. Move the joystick lever downwards. What values does it provide?

x: _____ *y:* _____

e. Press the joystick button. What happens? .....

3. Discuss among yourselves the conclusions of this experimentation.

a. What did you learn from this experience?

b. What difficulties did you encounter? How did you solve them?

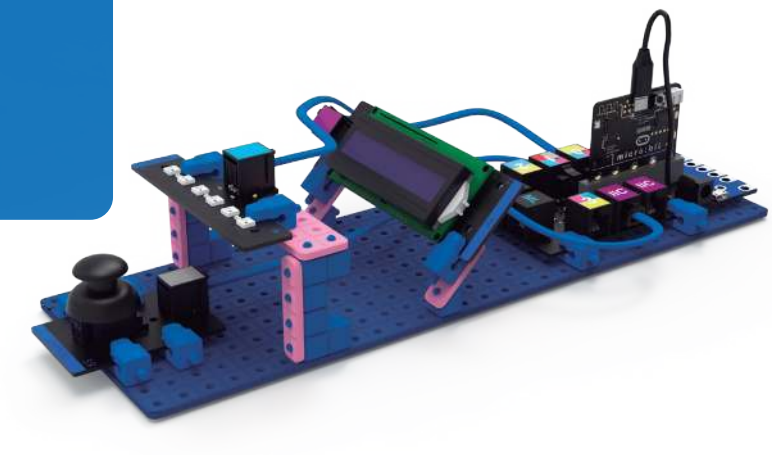
Maker moment

It's time to work with the kit! We will create our own game in two parts. First, we will program the internal functioning of the game and the instructions that the joystick should execute to turn on the RGB LED module. Then, we will include a system that allows us to add and display scores.

1. Scan the QR code to see the step-by-step assembly.

Required components

- PC with Maker software
- Control board
- Microbit board
- USB cable
- Connection cables
- Joystick
- RGB LED module
- LCD display



https://steamBelize.fifafoundation.org/QR/12

In addition to the joystick, we will use these components:

LCD display

Function: project texts

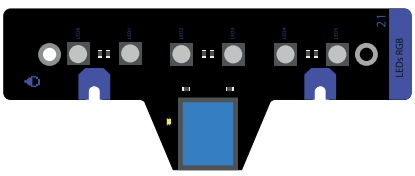


Displays

PIN IIC | Actuator

RGB LED module

Function: Illuminate lights.



Outputs

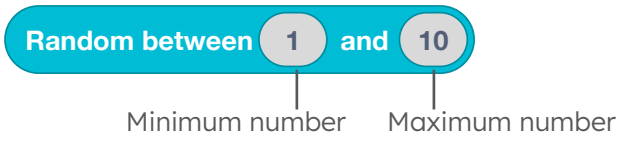
PIN 0 | Actuator

Color matching game

In this challenge, we will create a game that allows us to develop and strengthen coordination and memory. This game will involve correctly classifying colors. To do this, we will use the RGB LED module and the joystick, and we will need to program a random function.

"Random" Function

When this function is executed in the program, a random number is chosen between the minimum and maximum numbers.

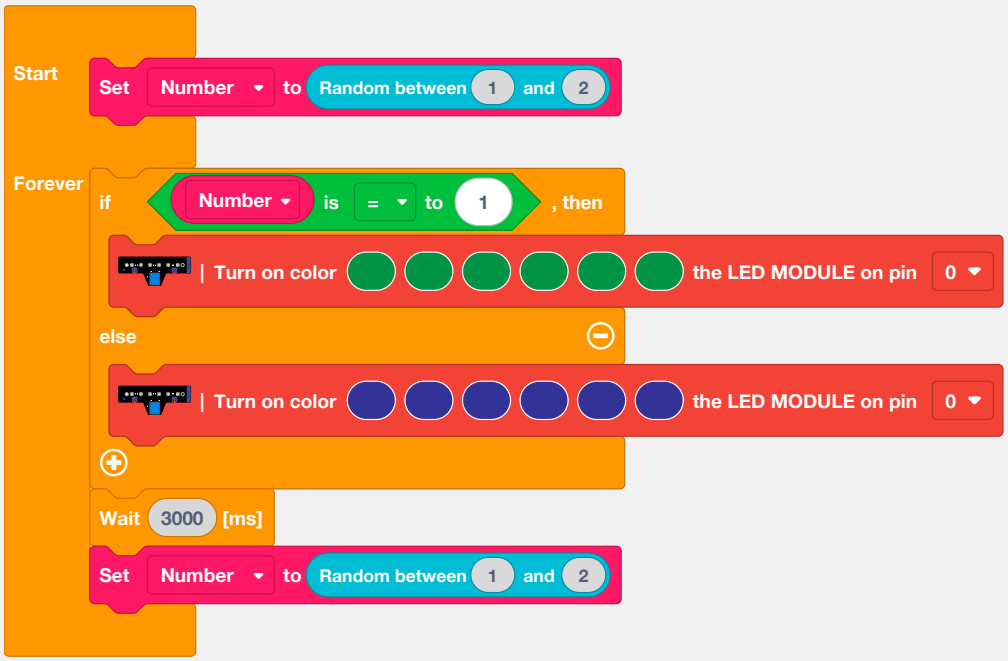


Key Idea

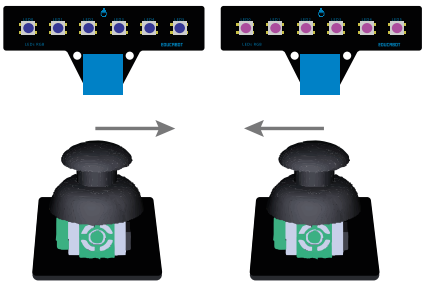
Each time the "random" block is executed, a new value is chosen. For this reason, the result is usually stored in a global variable so that it can be used in different parts of the program.

Example

At the beginning of the program, the "Number" variable is set with a random value between 1 and 2. Then, within the "Repeat" block, a condition is evaluated: if the number is equal to 1, it turns on the RGB LED module in green, otherwise, it turns it on in blue.



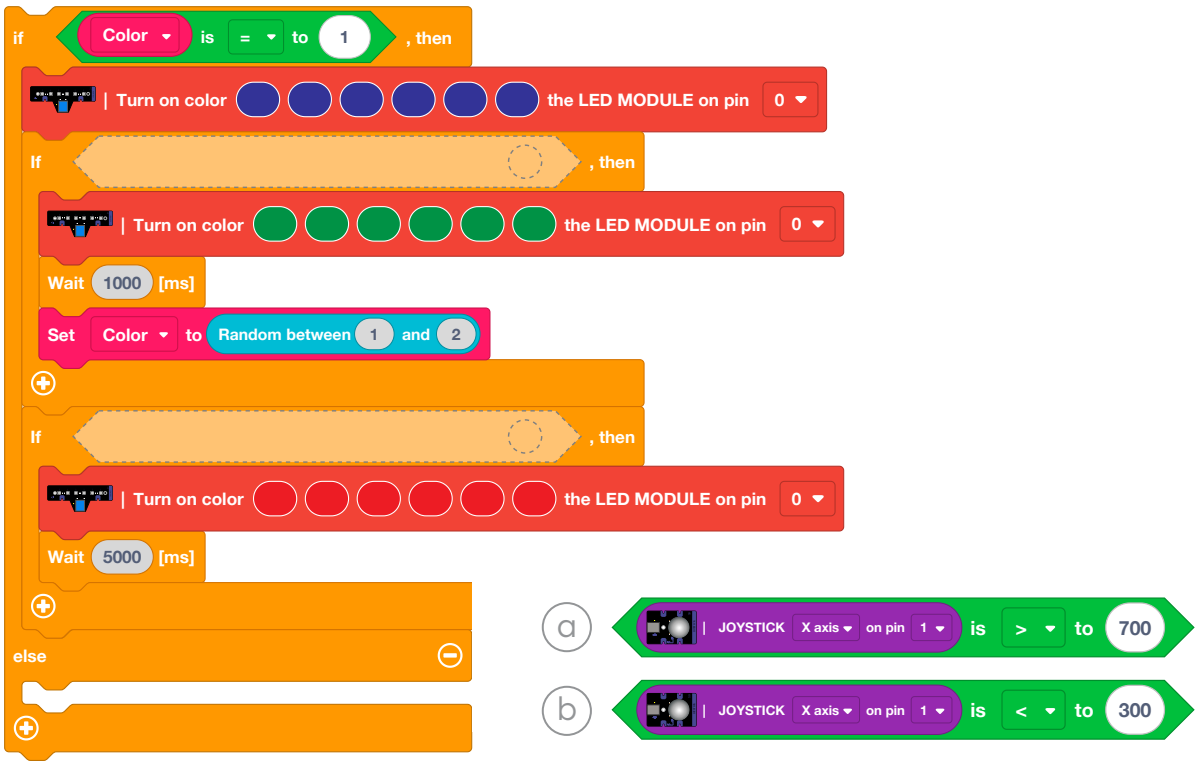
Our game will work as follows:
If the LEDs are blue, the user will move the joystick to the right. If they are violet, they will move it to the left. When the user moves the joystick correctly, the LEDs will light up in green. If they make a mistake, the LEDs will light up in red.



1. When the program starts, the "Color" variable must be set to a random number between 1 and 2. Indicate in which part of the program should be set.

○ **START** ○ **FOREVER**

2. If the variable "Color" is equal to 1, we should turn on the LEDs in blue and ask if the joystick is tilted to the right or left to determine if it's correct or incorrect. With this information, complete the program by writing the missing block in each space.



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3. Build the program in Maker and upload it to the board.

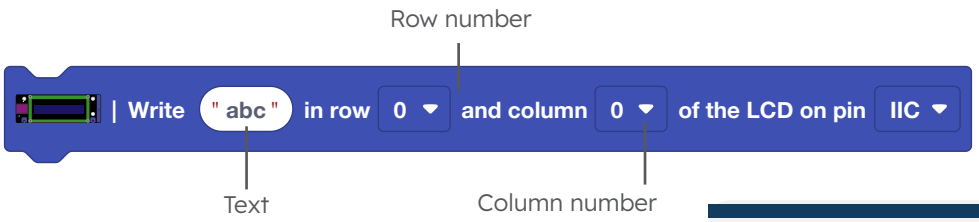
4. What steps should we take if the condition is not correct, e.g., if the variable "Color" is equal to 2?

Scoring System

One of the most commonly used components in games is the scoring system, which allows us to quantify the performance of each player. In this challenge, we will create one for our game using an LCD display.

LCD display

The acronym LCD corresponds to Liquid Crystal Display. The LCD screen is made up of 2 rows and 16 columns and allows us to write up to 32 characters.





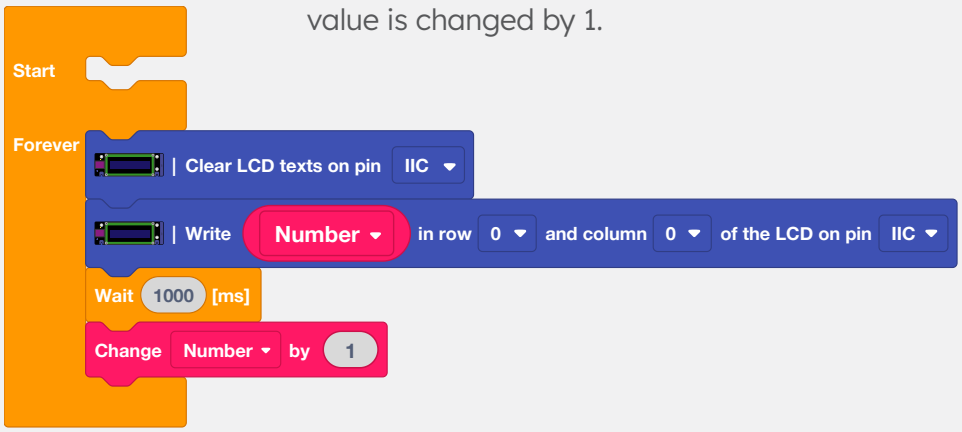
Delete all texts from the display.

Key Idea

Every time you write on the LCD, the new text overlays the previous one, but it is not erased. Therefore, it is always recommended to clear the display before writing.

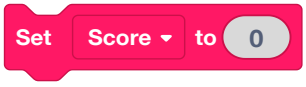
Example

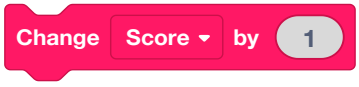
In this program the screen is cleaned and the variable “number” is shown on the LCD screen, then it waits one second and the value is changed by 1.



In this second challenge, we will incorporate a variable that will count the score. Our system will work as follows:
Every time the user answers correctly, one point is added. When they make a mistake, the game ends and the score obtained is displayed on the LCD.

1. To add a value to a variable, which block should we use? Justify your answer.

a 

b 

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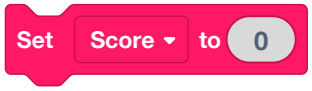
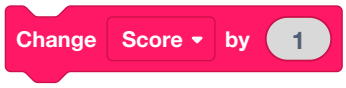
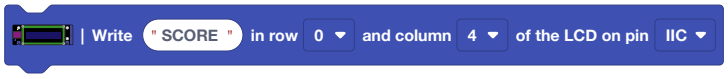
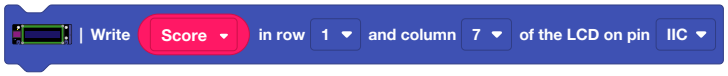
2. Analyze the following blocks and indicate with arrows which ones should be executed if the classification is correct and which ones if it is incorrect.

a 

b 

c 

d 

e 

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Correct classification

Incorrect classification

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3. Based on the previous activities and the information provided, build the program in Maker and upload it to the board to check its functionality.

4. Modify the program to play a sound when classified incorrectly.

Choose Your Own Challenge

Ubaldo has three ideas to improve the gaming system. Select a challenge. Then, create a project model and program the system to solve the chosen challenge.

Display instructions on the LCD display before starting.

5.000 points

Incorporate two more colors to play with the y-axis of the joystick as well.

7.500 points

Incorporate a thirty-second countdown timer.

10.000 points

Helpful Tips > >

- Define a strategy to address the challenge (task distribution, steps to follow, deadlines, among other points).
- To include elements that appear only once before the game, remember to add them in the “Start” section.
- To generate a countdown timer, use the “startup times” block and a variable to count one second every thousand milliseconds.

