HANDBOOK OF ROBOTICS

CRISTIAN LĂCRARU

SHAPE ROBOTICS TEAM

www.shaperobotics.com

36 lessons for an intelligent lab

Bucharest
2022

The Fable App – 2-Step Lesson

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Install the FableBlockly app
- Explore the graphical interface, identify the work areas.
- Identify the command blocks in the app's menu.
- Write a program without connecting the hardware equipment.

STEP 1 INSTALL THE APP

5 min

To be able to control the Fable robots, you need to download the FableBlockly app directly from the manufacturer's website.

Access the link below and follow the installation instructions:
https://www.shaperobotics.com/download/

STEP 2 FABLE GRAPHICAL INTERFACE

30 min

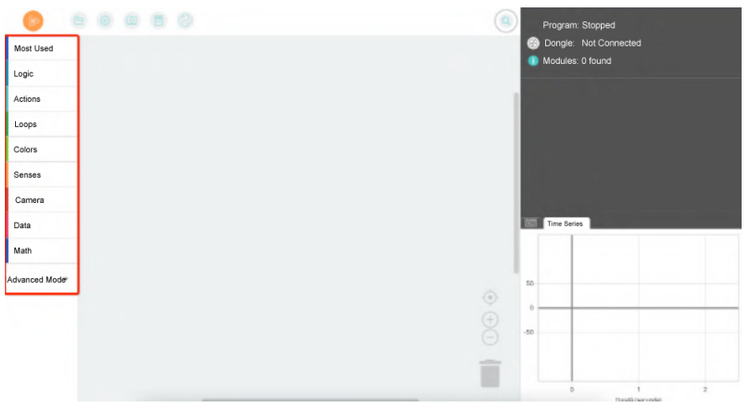
Once you have installed the app, you will be able to explore the graphical interface of the program for the first time.

Your next step is to discover the delimitation and functionalities of the work "areas".

AREA 1: Main Menu

Under this area, you will find the command sets. Each set is marked by a specific colour and title: Logic, Actions, Loops, Colours, Sensors, Camera, Data, and Math. The Advanced Mode section contains sets of advanced commands, such as Data, Variables, Text, Lists, as well as new commands for the previous sets.

The Most Used section provides you with the blocks that are most often used by a user in the programming process. It gives you quick access to the commands needed to create a new program.



Each set is formed by a cluster of commands from the same work area. For example, the Actions section in the menu gives you access to a variety of action-related commands, such as: direction, movement, expressions, animations, rotations.

10-15 min

ACTIVITY

Discover each of the commands that the FableBlockly app includes. Using your intuition, try to figure out each one's role.

THE FABLE SYSTEM

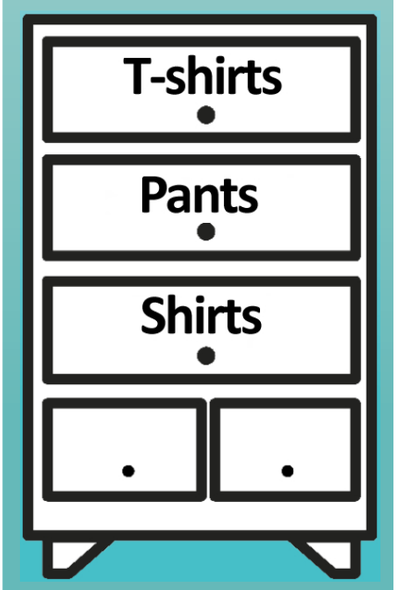
Fable is a modular robotic system that allows you to build a new robot in seconds.
You can assemble the components in a variety of configurations and create your own robotic systems.

GRAPHICAL INTERFACE

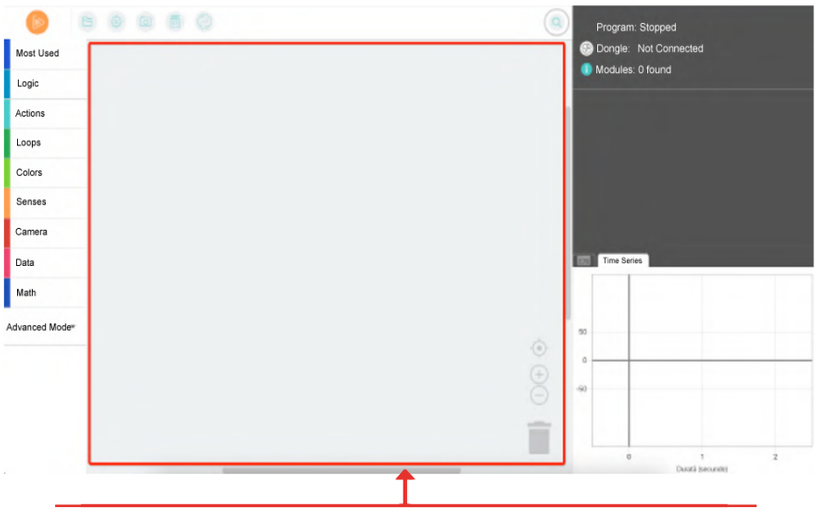
All the graphical elements in an operating system that allow the user to interact with the software.

MENU

To better understand the organization of command blocks, try to visualize a chest of drawers for storing clothing. Each drawer contains a specific type of clothing. Let's say you're keeping your T-shirts in Drawer 1. In this drawer, you have short- and long-sleeved T-shirts of different colors and sizes. But keep in mind that in Drawer 1 you only have T-shirts. The commands in the FableBlockly app are grouped based on the same logical principle.

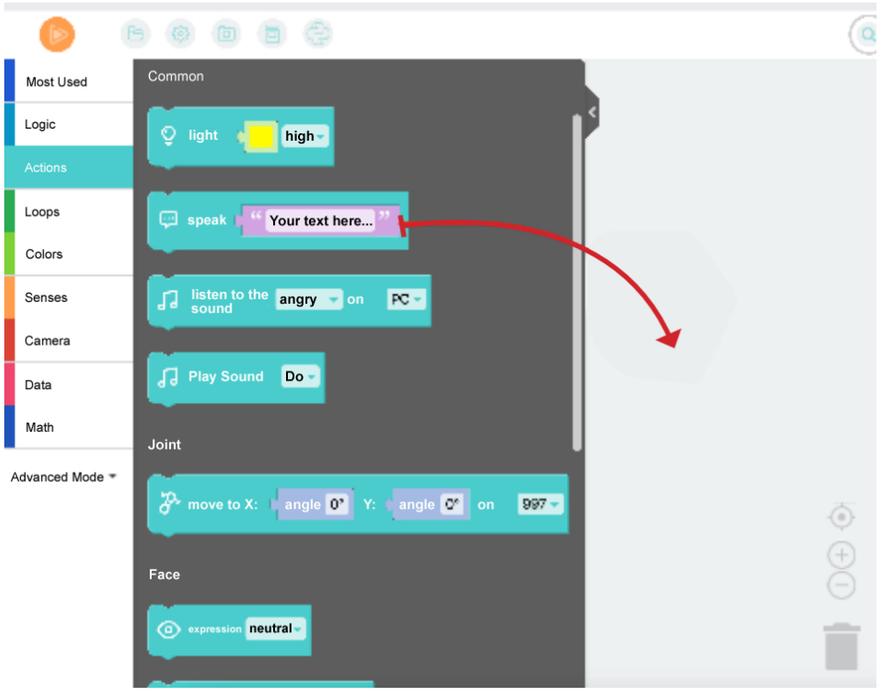


AREA 2: Workspace



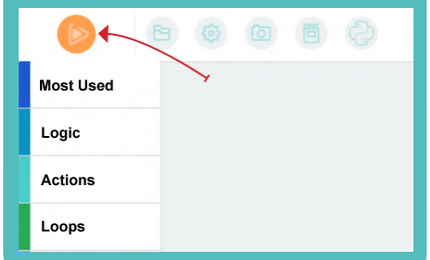
AREA 3: Communication

This area displays the codes of the modules that are connected to the software (the code of the Hub, the code of the Joint module, etc.). Here you can also see if the program is running or not.



"PLAY"

To start running the program, you need to click the yellow "play" button. The program is run from top to bottom, on a command-by-command basis.

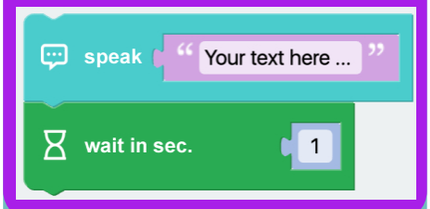


DID YOU KNOW?

Douglas Engelbart and his team at the Stanford Research Institute were the creators of the forerunner of today's graphical interfaces. They developed the use of text-based hyperlinks that can be manipulated with a mouse.

DID YOU KNOW?

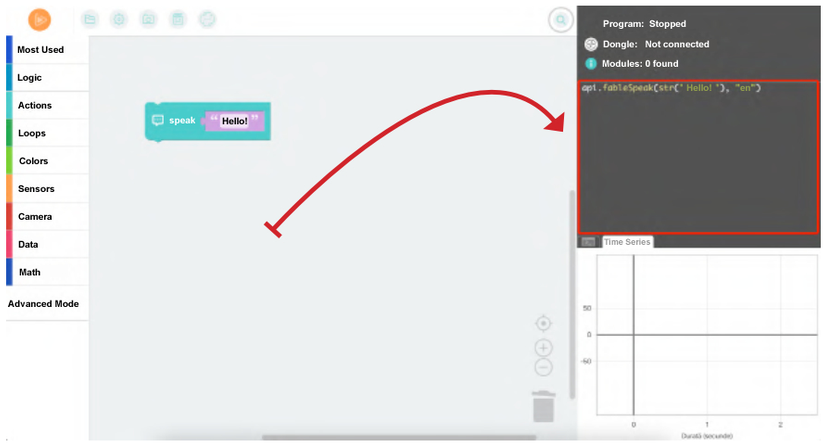
The FableBlockly app works with command blocks. These blocks are organized by functionality, but also by color, to allow for an easier identification. The idea of "blocks" first appeared in programming around 1950.



AREA 4: Lines of code

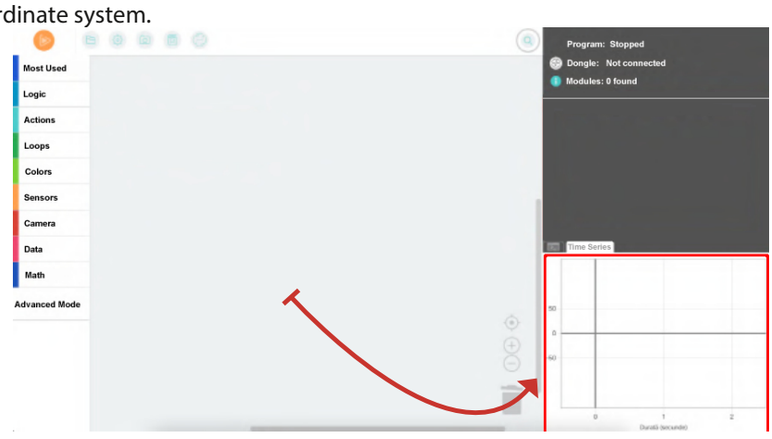
As the user begins building the program using command blocks, the lines of code appear on the right side of the workspace.

The same program that the user is working on with blocks is displayed simultaneously in a different programming language. To be more precise, the program created in Blockly is automatically "translated" into Python.



AREA 5: Coordinates

The Coordinates area is dedicated to graphic representations, regardless of the field of work/subject of study, the system used being the orthogonal coordinate system.



AREA 6: Functions

On the top bar are located icons that suggest very effectively certain functions, such as: Project, Settings, Video Streaming, Documents, Python Mode, and Search.

CONCLUSIONS **GRAPHICAL INTERFACE**

The graphical interface is also referred to by the acronym GUI, which stands for Graphical User Interface. An operating system with a graphical interface is easier to manipulate, because it allows you to no longer memorize the commands, but see them. With a GUI, users don't need to know a programming language. Operating systems such as Microsoft Windows and Apple MacOS use a GUI. So do browsers like Edge, Chrome and Firefox.

DID YOU KNOW?

Python programming language was created by the Dutch programmer Guido van Rossum. He called it Python because, at the time when he was developing the code, Guido van Rossum was watching the BBC comedy series Monty Python's Flying Circus. He also chose the name Python because it was short and slightly mysterious.

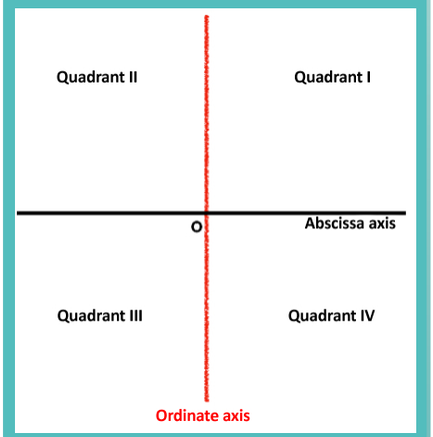
DID YOU KNOW?

Python programming language has a wide range of uses, including web development, artificial intelligence, data analysis, Internet of Things (IoT), machine learning.

REMEMBER!

ORTHOGONAL AXES

Two perpendicular lines that have a common origin and a single unit of length form an orthogonal coordinate system. The four resulting quadrants are called as shown in the diagram below.



Joints and Motors – 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
HUMAN BODY (ANATOMY)/ART

LEARNING OBJECTIVES

- Recognize a joint.
- Identify the servomotors in the robotic Joint module.
- Program the servomotors for movement using the FableBlockly app.
- Use motion commands for servomotors.
- Use the Wait command.

STEP 1 WHAT IS A SERVOMOTOR?

The Joint module is an active module, which means that it can move. This is made possible by the two powerful servomotors with which the robotic arm is equipped.

The servomotor is a motor that rotates only up to a certain point and whose speed can be controlled. For instance, the movement of a robotic arm is possible with the help of the servomotors.

Other examples of uses of a servomotor include the rudder of a model ship, the steering of a remote control car.

ACTIVITY 10 min

Take a sheet of paper/cardboard and trace on it the contour of your palm (left or right). Cut out the traced palm following the contour. Next, customize/decorate this "hand". You can use pencils, gouache, sequins, paper clips...

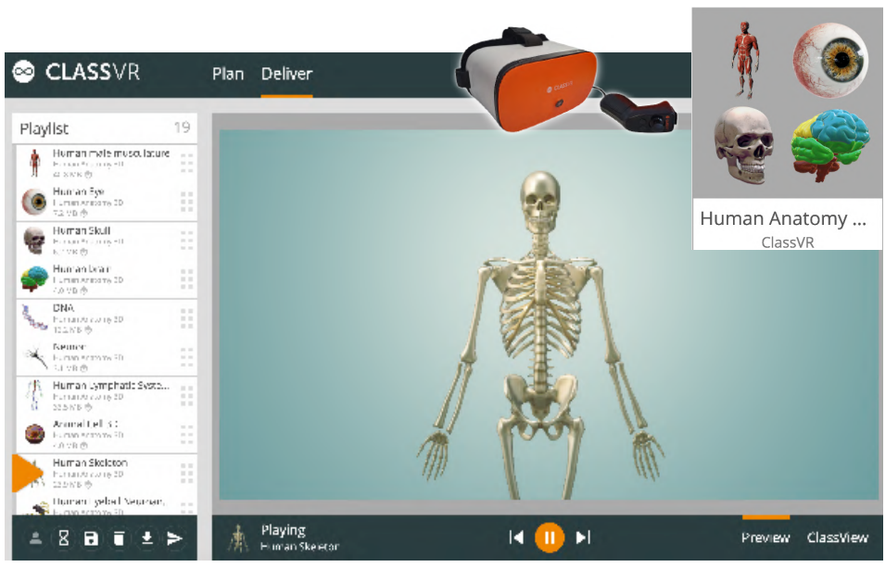
Let the substances applied to the paper (glue, colors...) dry, then set your creation aside for a later activity within the lesson.

STEP 2 WHAT IS A JOINT?

A joint is a connection between two solid bodies that allows rotation or movement around an axis. Although it may sound complicated, this process is actually quite simple to understand.

ACTIVITY 5 min

Open the ClassVR app and type "Body" in the search bar. Load the resource packet "Human Anatomy 3D".



THE SERVOMOTOR

- can be controlled, that is, you can determine how much it should rotate and, therefore, where it should stop
- has three wires inside, unlike a motor, which only has two; the third wire of a servomotor has a control function

DID YOU KNOW?

In the human body there are 360 joints.

The most mobile joint is the shoulder. It allows movements in different directions – more than 3600 –, hence the possibility to make arcs with the arms.

NEW BLOCKS!

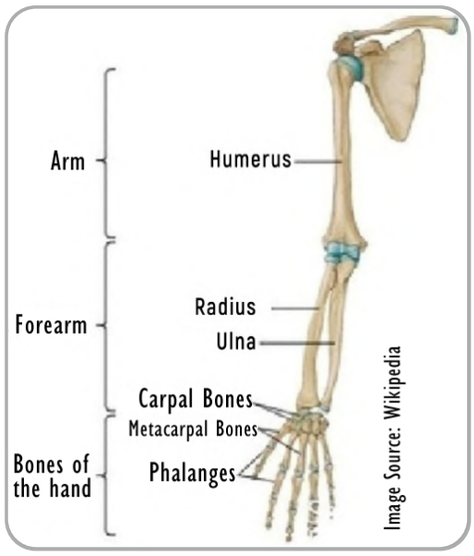
The Wait command creates a pause of "n" seconds between the previous block and the next action.

ACTIVITY 5 min

Reach one arm out in front and move your palm without moving the rest of the arm or the fingers. Look closely to see the exact point where this movement is occurring. It's right where the palm meets the forearm.

Now, keeping your arm straight, do some forearm movements; note that the place where they occur is at your elbow level. Both of the earlier actions are examples of joint movements.

How many joint points do you use when you shake someone's hand?



CHALLENGE! 5 min

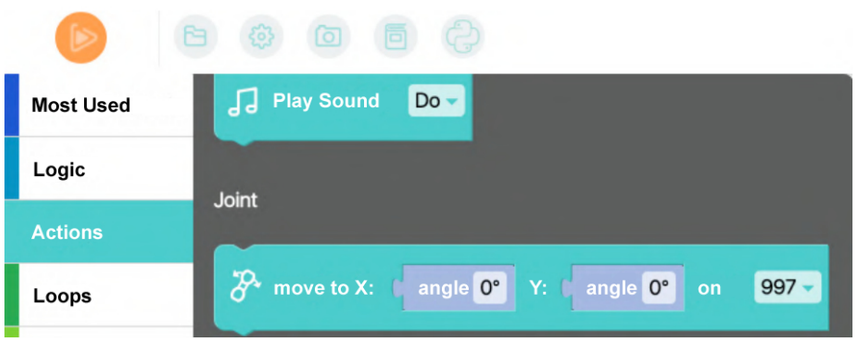
Imagine what you could do if your palm allowed for a full rotation. If this were possible, what other activities could you do?
What would be the advantages and disadvantages?

STEP 3 ROBOTIC JOINT MODULE

Attach (in vertical orientation) the Joint module to the base element. This is necessary in order to ensure good stability and to be able to observe the movements that the robotic arm performs as your programming work progresses. Notice how the two motors are built. Identify the inscribed symbols (+ and -).

ACTIVITY 5 min

1. Start the Joint module (behind the Fable logo you will find a button).
2. Connect the Hub to the computer by means of a USB cable.
3. Select the color of the Hub (click on it) and make sure the Joint module has the same settings.
4. In the Actions section of the FableBlockly app menu, command blocks specific to the Joint module are displayed.



DID YOU KNOW?

The hyoid bone is the only bone that does not articulate to another bone. It is a horseshoe-shaped bone located between the chin and the thyroid gland. It protects the esophagus and facilitates a wide range of movements involved in speaking and swallowing.

JOINT MODULE

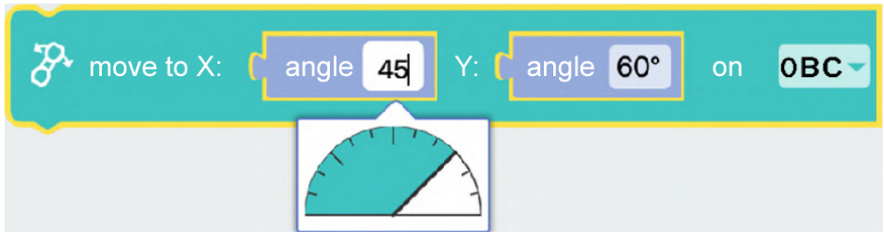
KEY INFO

Modules communicate to each other only if they have the same color settings.

REMEMBER!

To run multiple commands one after the other, you need to insert a pause for the execution time of each command. Use the wait command from the Loops menu.

Use the command below and choose which angles you want.



Note that angles can take various values and can be denoted by + or -. The same signs are also marked on the motors, indicating the direction of movement.

On the right side of the command block is indicated the code 0BC for the Joint module (Be careful: your module may have a different code than the one shown here). Make sure you select your robotic arm code, and not your colleague's. After entering the angles, you can start the program using the PLAY button.

What do you notice? Continue modifying the angle values for the two motors and analyze the movements performed by the robotic arm.

ACTIVITY

10 min

Attach the paper palm created at the beginning of the lesson to the Joint module. Program the robotic arm so that you can simulate a hand movement, specifically a greeting.

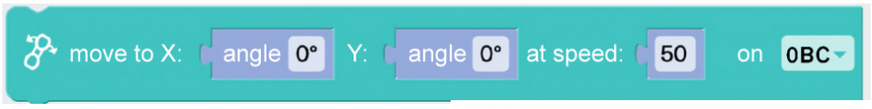
What do you notice during programming? Is it necessary to program both motors or is just one sufficient?

EXTRA ACTIVITY

5 min

Program the robotic arm to simulate a tennis player's serve. To accomplish this, try using the command blocks in the Advanced Mode category. There's even one that allows you to set the execution speed.

"Play" with the numbers, experiment with the angle and the speed values until you achieve the best tennis serve. Good luck!



CONCLUSIONS

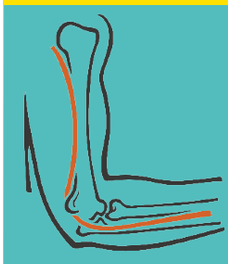
ROBOTIC ARM

Perhaps the most widely used robot model, the robotic arm is particularly useful in most robotic equipment that performs operations such as screwdriving, painting, or welding. Depending on how it is made, a robotic arm can be very precise, being used in medicine or even in space missions.

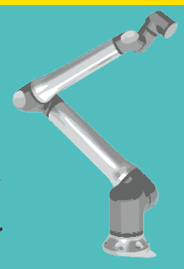
CONNECTING

The code on the Joint module can be seen here.

REMEMBER!



The elbow joint

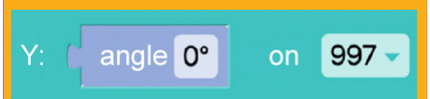


The joint of a machinery

DID YOU KNOW?

- The word "tennis" originates from the Old French imperative "tenez!", which translates as "take!".
- The longest ever tennis match was played at 2010 Wimbledon, in the first round, and lasted 11 hours and 5 minutes. The shortest was a 1992 Wimbledon Final tennis match that lasted 23 minutes.
- Sabine Lisicki hit the fastest serve of all times, at 210m/h, in 2014.

NEW BLOCKS!



This block allows the programming of the two motors of the Joint module

Loops – 4-Step Lesson

LEVEL: **BEGINNER** **INTERMEDIATE** **ADVANCED**

FIELD ROBOTICS / PROGRAMMING / SPORTS

LEARNING OBJECTIVES

- Use the Loops commands in the Fable Blockly app.
- Identify errors in default programs.

STEP 1 REVIEW

Servomotor: is a motor that rotates only up to a certain point, so that its speed can be controlled.

Joint: A connection between two solid bodies that allows rotation or movement around an axis.

ACTIVITY 10 min

- list some examples of the uses of servomotors.
- name several joints of the human body.
- program the Joint module to perform left-right movements, simulating a greeting.

STEP 2 WHAT IS A LOOP?

In many situations, there is a need to repeat an action or a set of instructions. In programming, a loop is a repetitive structure that executes a statement or a block of statements multiple times.

Let's consider as an example the preparation of a chocolate pancake. In order to spread the chocolate, you need to do a few rotation movements over the pancake. If I made three such rotations, for example, it means that I performed a loop, that is, I repeated an instruction three times.

ACTIVITY 10 min

From the Art&Craft area, take a sheet of paper, a ruler and colored pencils. Make some drawings using repetitive commands. Here are some ideas:

- Move the pencil 5 cm up and then 3 cm to the right, then change the color. Repeat these commands four times.
- Draw a circle, move the pencil 3 cm up, change the color, then draw another circle of the same size. Repeat these commands five times.

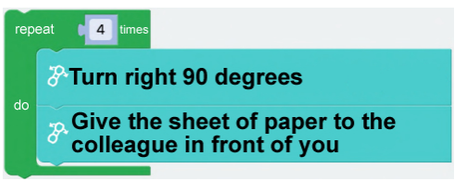
These activities involved repetitive actions.

STEP 3 TYPES OF LOOPS

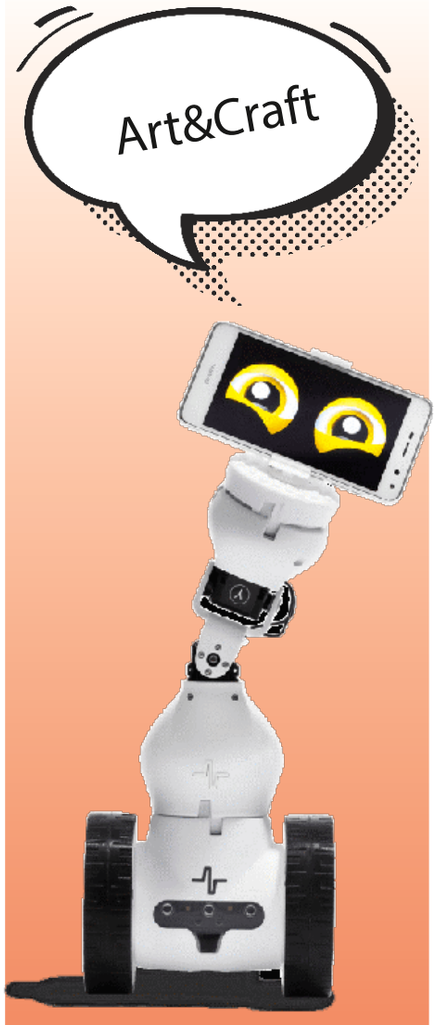
There are several types of loops. Some may be infinite, others involve execution until a condition is met. For example, walking to school represents, for your legs, a loop, due to the repetition of the action of the legs.

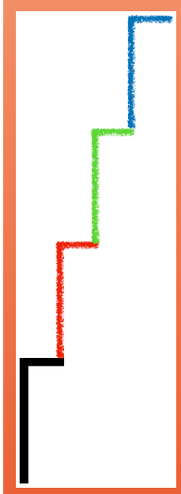
TEAMWORK ACTIVITY 5 min

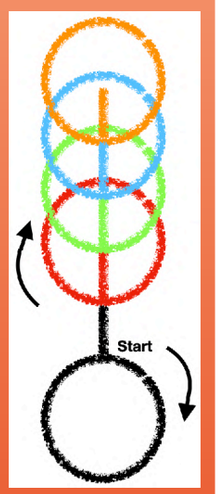
Prepare an A4-size sheet of paper. Stand up and execute the commands in the blocks below. Pay attention to the number of repetitions mentioned.



In this activity, you ran a loop with four executions. The two commands inside were run four times.







DID YOU KNOW?

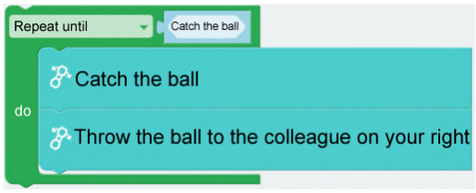
There are about 50 sports that require using a ball.

It is uncertain when the ball was invented, but it was the Greeks who came up with the great idea of filling the ball with air.

5 min

TEAMWORK ACTIVITY - WORKING AS A TEAM

Using elements from the Art&Craft area, make a ball. With your classmates, form a circle and execute the program below.



Notice that the ball game, i.e., the "program", ran until the ball dropped. So this loop is not infinite, the actions were repeated until the "ball dropped" condition was met.

STEP 4 PROGRAMMING

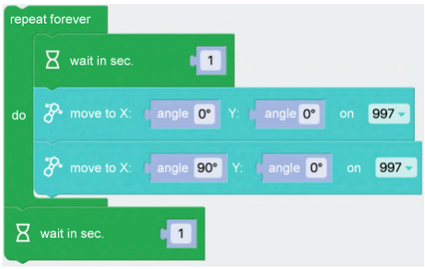
Discover the commands in the Loops menu of the FableBlockly app. Create your own programs involving the robotic Joint module..

10 min

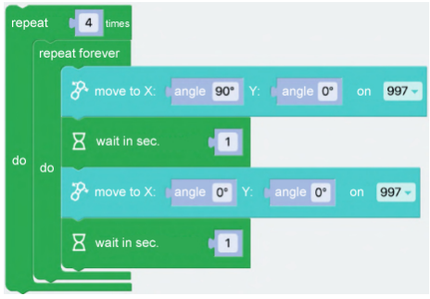
ACTIVITY

Identify and correct errors in the following programs. Check the program in the app.

- We want the robotic arm to move the X motor at one second intervals.



- We want the robotic arm to repeat the movement four times.



5 min

ACTIVITY

Under certain conditions, it is necessary to interrupt a loop as was done in the game where you threw a paper ball to your right-sided colleague. The loop was interrupted by the ball being dropped. There can be many situations where we need to stop a loop from running.

What do you think the robotic arm will do if it executes the following program?

CONCLUSIONS REPETITIO EST MATER STUDIORUM

"Repetition is the mother of learning" is a precept you may have heard before. Robots too specialize by repeating the tasks they perform, just like humans. Ideally, verification systems can improve/correct how robots work, so that they specialize more and more over repetitions.

A robot vacuum uses many loops in its program. It can repeat a brush rotation until it detects an obstacle or until a problem occurs (a wire blocks the brush motor). In a car factory, a robotic arm performs several repetitive actions when painting the car body.

NEW BLOCKS!

This command involves repeating the commands placed inside the loop forever (from top to bottom).

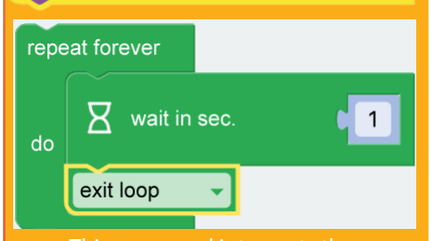
NEW BLOCKS!

This command involves repeating the commands placed inside the loop a number of times. The number of repetitions can be modified as needed.

KEY INFO

Be careful when you use forever loops! A forever loop failure can freeze your computer or your running app. For example, if the app performs a reset, and after restart it performs another reset, it will not run another command.
So you will be stuck with a continual reset problem.

NEW BLOCKS!



This command interrupts the loop it is in and moves to the following command.

One Hub, two modules – 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS / PROGRAMMING / HISTORY / ARTS

LEARNING OBJECTIVES

- Identify connected modules in the Fable Blockly app.
- Control two robotic components through a single connecting Hub.
- Design and build a robot that can move.

10 min

ACTIVITY

Objective: Create a fossil

Work materials: clam or snail shell, wooden stick, two plastic or thicker paper cups, brush, gloves, oil, plaster, container with water, plasticine.

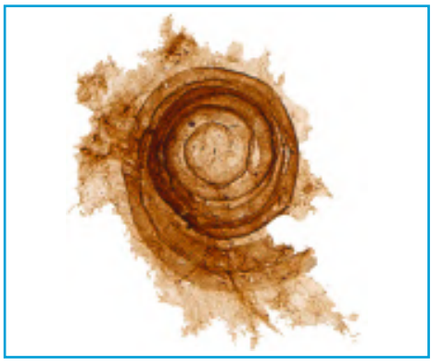
Instructions: Put on gloves and knead the plasticine in order to warm it up and make it more malleable. Place a layer of plasticine of about 2 cm on the bottom of the cup; its surface should be flat. Using a brush, oil the flat surface. Take the shell and press it into the plasticine as much as possible, being careful not to break it. Carefully remove the shell. You can now see the outer shape of the shell on the plasticine. Grease the plasticine with oil again.

In the other glass, put a layer of plaster of about 2 cm, add water little by little and mix with the wooden stick to obtain a homogeneous and not very liquid composition.

Pour the obtained composition into the cup with the plasticine.

Put the cup aside, in the Art&Craft area, to dry. Clean up all the materials in order to have a free table to work at.

FOSSILS



STEP 1 REVIEW

A loop is a repetitive structure that executes a statement or a block of statements several times. A Loop can be infinite, meaning it never stops, or finite, which ends itself when a condition is met.

The rotation of the Earth around the Sun is an example of an infinite Loop. The spinning drum of a turned-on washing machine is an example of a finite Loop.

What other examples do you know?

Now, try to find some situations that can interrupt a Loop. In the case of the washing machine, we can mention the interruption of the water supply.

Come up with more examples.

10 min

ACTIVITY

Dinosaurs dominated terrestrial ecosystems for about 165 million years. They appeared on Earth about 220 million years ago, at the end of the Triassic period.

With the ClassVR solution, we will "travel" in time and space. We will discover the flora and fauna specific to the Cretaceous period, the last period in which dinosaurs existed. Open the ClassVR app, go to Search Subscription and type Cretaceous. Open and load The Cretaceous Period.

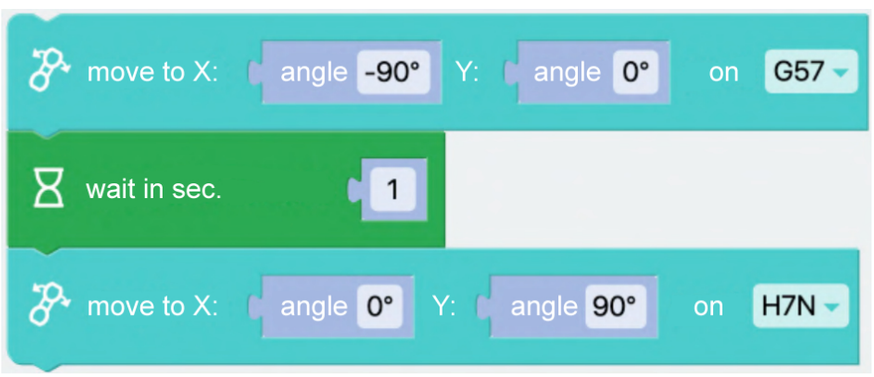
Describe the VR experience. What dinosaurs have you met?
Could you list the features of dinosaurs?

STEP 2 ONE HUB, MORE CONNECTIONS

You noticed that each Hub and robotic Fable module is inscribed with a unique code. The Fable Blockly program allows you to connect several modules to a single Hub. See the two examples below. Test them too! Notice the two connected Joint modules (G57 and H7N). Be careful! You may have other codes for the modules you have chosen. Keep them in mind and use them!

SEQUENCE 1

SEQUENCE 2



DID YOU KNOW?

The name "dinosaur" comes from the Greek words deinos (meaning "terrible") and saurus (meaning "lizard").

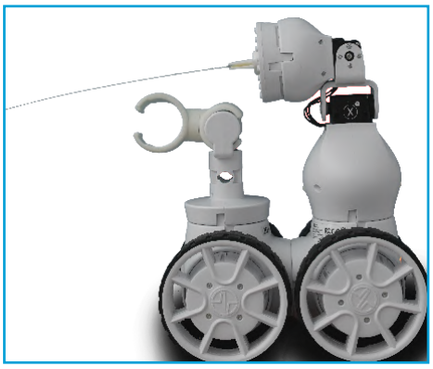
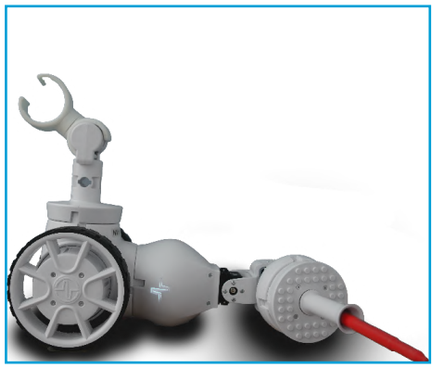
Richard Owen - a famous scientist and paleontologist from England - invented the word "dinosaur" back in 1841.

One of the largest known dinosaurs was the Argentinosaurus. It measured over 30 meters long and weighed approximately 100 tons.

Compsognathus - the smallest known dinosaur - measured 1 m long and weighed about 2.5 kg.

TEAMWORK ACTIVITY 20 min

Form multiple teams and build a dinosaur using robotic modules and Fable accessories. The dinosaur should be able to move. You can see some ideas below:

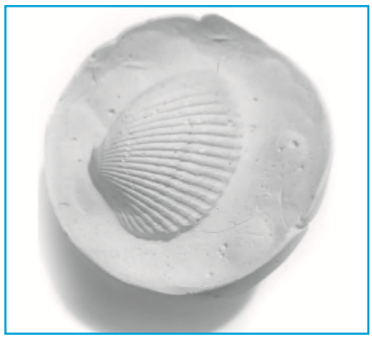





An even more interesting exercise involves 3D printing accessories and using Lego pieces in the construction of new dinosaur robots. Be creative and experiment with new shapes, new sizes, and new command blocks. Good luck!

ACTIVITY 5 min

Now that we're reaching the end of the lesson, I invite you to analyze the fossil you were asked to create and set aside. If the plaster is hardened, cut the cup and "discover" the fossil. If the plaster is still soft, do the following at home. Carefully remove the plasticine. If there are still traces of plasticine on the plaster, clean them with a brush. Wipe the fossil with a tissue.

Be a paleontologist, imagine a story about the true nature of the creature your fossil comes from. When and in what environment did he live? What are its features?

CONCLUSIONS HISTORY AND FUTURE

By combining several pieces of equipment into one assembly, you can give a robot/equipment new functions. By combining several Joint modules you can create a snake which can then be programmed. Modularity allows the combination of several elements and even the transfer of forces between them.

There are robots that have the ability to connect with each other in order to create new forms or respond to new situations/contexts.

DID YOU KNOW?

The word "fossil" comes from the Latin "fossus", which means "dug up". Fossils are the traces of past life on Earth.

The oldest fossils date back to 3.5 billion years ago, and for a fossil to be considered as such it must be at least 10,000 years old.

The oldest fossil ever discovered contains evidence of the presence of life forms, stromatolites, and dates back to 3.7 billion years ago.

Our planet is 4.5 billion years old.

REMEMBER!

The use of a single Hub to connect several modules is very effective, due to the fact that it enables us to control an assembly consisting of several modules from a single computer. By this, we can build and control increasingly complex machines.

Progress Check

FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Check your understanding of the motion commands included in the menu for the Joint module.
- Identify errors in default programs.

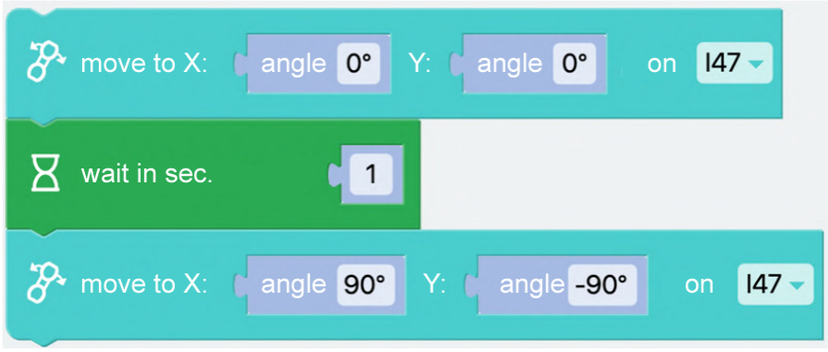
ACTIVITY 10 min

WHAT RESULT IS OBTAINED?

Place the Joint module on the base stand in a vertical orientation.

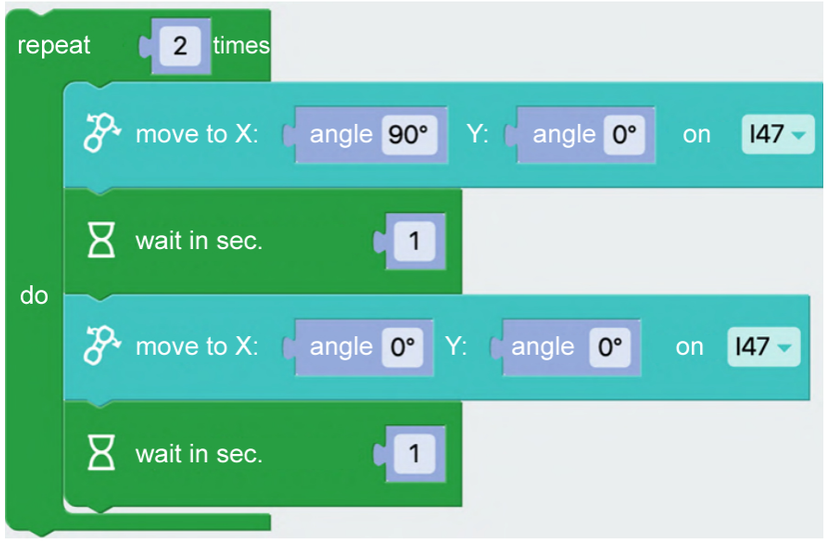
Before connecting the robotic arm to the computer, try to simulate the movements of the Joint module shown in the programs below. Test each sequence in the FableBlockly app.

SEQUENCE 1

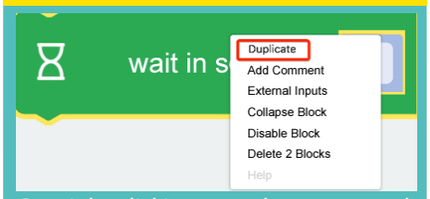


SEQUENCE 2

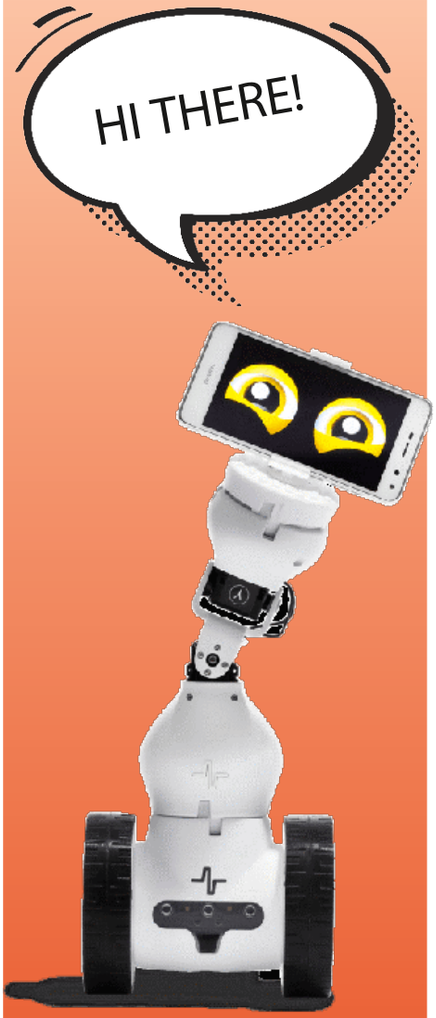
SEQUENCE 3



KEY INFO



By right-clicking on the command block, you will see what actions you can perform on it. The Duplicate command will make another identical block.



DID YOU KNOW?

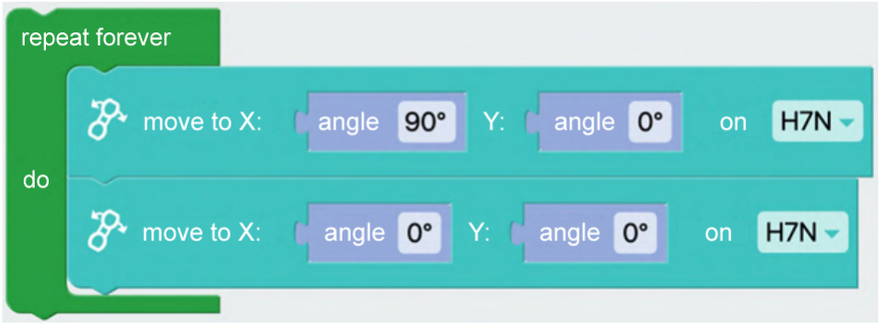
The expression "Quod erat demonstrandum" (Q.E.D) means "which was to be demonstrated" and is used in mathematical language, at the end of a mathematical demonstration.

ACTIVITY 10 min

FIND THE ERROR

In the following program, we want the X motor to perform a repeated movement, at time intervals of one second, from a vertical position, at a right angle (90 degrees). Explain the error and how you solved it.

SEQUENCE 1



ACTIVITY 10 min

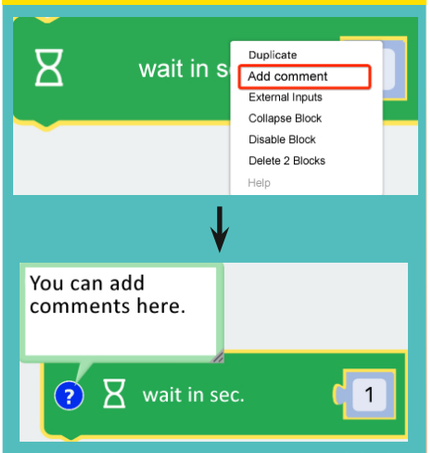
FIND THE ERROR

We need to create a program according to which the robotic arm performs two movements (left-right 90°) and returns to the initial position. Check if the program below meets these conditions.

Come up with your own program idea to solve the error you found. Test the solution in the FableBlockly app.

SEQUENCE 1

KEY INFO



The 'Add Comment' command helps you to take notes. It allows you to better organize yourself. You can delete the comment from the same place, using the 'Remove Comment' command. You can edit the comment by clicking on the question mark.

ACTIVITY 15 min

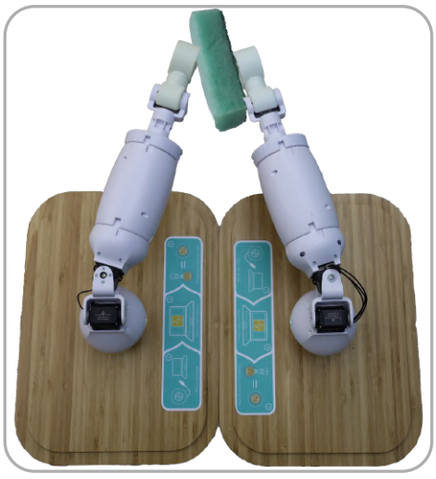
PROBLEM 1
THE ROBOT PAINTER

Help the painter to paint interesting shapes on a sheet of paper.

Using the Fable accessories and various tools of your choice from the Arts&Crafts area, create a brush and attach it to the Joint module. Write a program to simulate the movement of the hand (up-down, left-right, diagonal, etc.), and paint on the sheet of paper. Use lab accessories to place the sheet "in a standing position". At the end, prepare an exhibition of your works.

PROBLEM 2 (TEAMWORK)
THE ROBOT DISHWASHER

To wash the dishes, you need to design a program that consists of grabbing and lifting a dish sponge. Using two Joint modules and various accessories (either from the Fable kit or other tools created by you), program the robotic arms to complete the task, avoiding the sponge falling.



CONCLUSIONS **JOBS OF THE FUTURE**

In a very near future, everyone will be working with technology. Even if you will be a painter, architect, programmer or doctor, you will certainly use a lot of technology and maybe even specialized robots in your profession. Knowing how the technology around you works is a prerequisite for success.

DID YOU KNOW?

Industrial robots are machines that work in factories and execute a set of commands based on programs written by programmers. They can be reprogrammed to carry out new tasks and missions.

The first programmable industrial robot was created in 1954 by George Devol. This robot was a mobile arm that was later used in General Motors car factories (1961).

ACCESSORY IDEAS

Accessories from the Fable Robotics Kit

SUGGESTIONS

If you find the action of grabbing the sponge with the two robotic arms difficult, increase the volume of the object. For example, you can hold two sponges together. Why is it simpler this way?

Visual communication – 1-Step Lesson

LEVEL: **BEGINNER** **INTERMEDIATE** **ADVANCED**

FIELD ROBOTICS and PROGRAMMING
BIOLOGY / ARTS

LEARNING OBJECTIVES

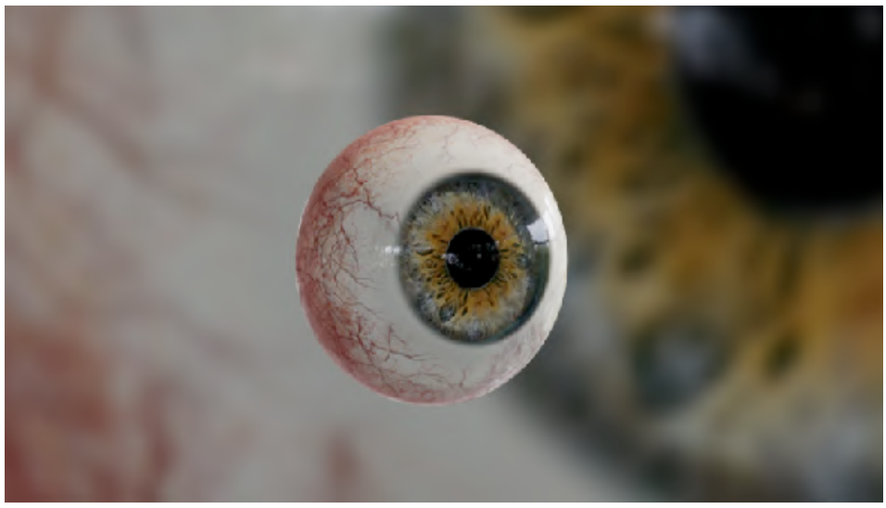
- Install the Fable Face app.
- Show expressions on the phone screen.

ACTIVITY 15 min

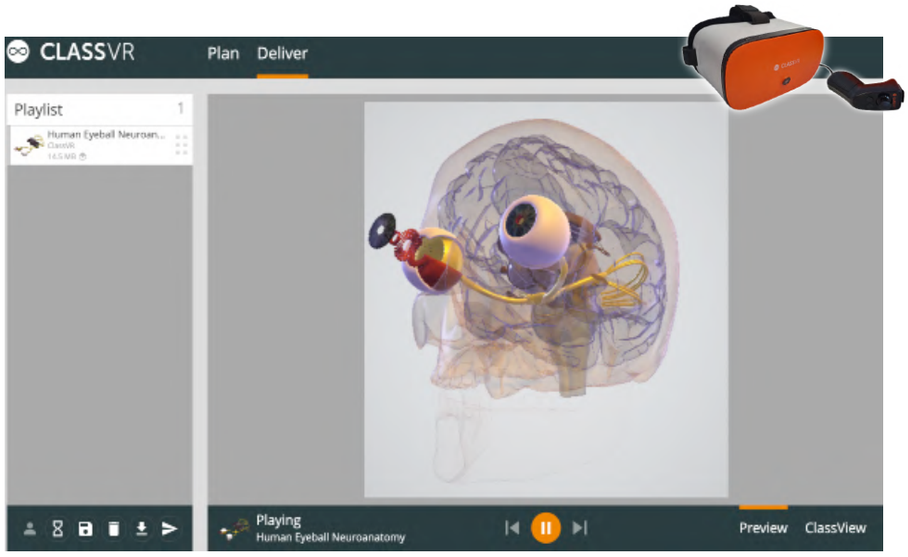
THE EYE

The eye is an organ of vision. The only organ more complex than the eye is the brain. Maybe you have green or brown eyes. Eye color is given by the iris, which is what you actually notice when you look at a person's eyes. Notice what color your colleague's iris is.

To study the structure and functions of the human eye, analyze the image of the visual organ in the 3D version. In this sense, access the information of the "digital 3D laboratory" available on the computer.



Open the ClassVR app, go to Search Subscription and type Eyeball. Open and load Human Eyeball Neuroanatomy.



DID YOU KNOW?

People do not see with their eyes, but with their brains. The eye is like a video camera that captures the image and sends it to the brain. If the eye were a real video camera it would have 576 megapixels.

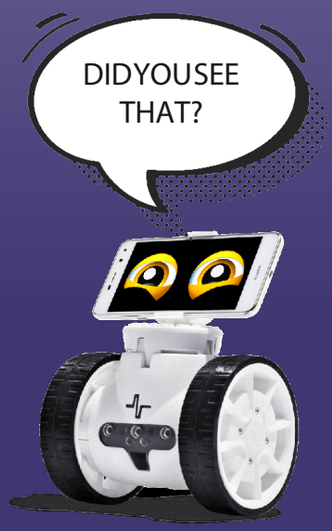
People can blink 5 times per second, and when they speak they blink much more often, reaching an average of 4,200,000 blinks per year.

DID YOU KNOW?

Owls have so large eyes that they cannot move them in the eye socket. As a consequence, their anatomy has evolved to give them greater mobility. The skull of owls is located on a single joint and they have 14 bones in the neck (humans only have 7), which is why they can turn their heads at impressive angles.

DID YOU KNOW?

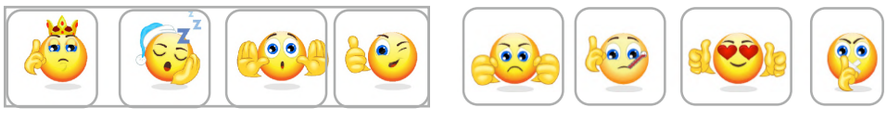
With the help of software, video cameras can recognize a person by facial analysis. Every human has a unique "pattern" of the face. This helps you, for instance, unlock your phone just by looking at it. Or rather... the phone is looking at you :). Also, each eye has a unique "pattern", that is, no two people have identical eyes.



ACTIVITY 5 min

We often use emojis to express our emotions and moods in writing. Today, with a single click, we can transmit emotions of joy, anger, sadness, etc.

Try to explain what emotion/mood the pictures below convey.

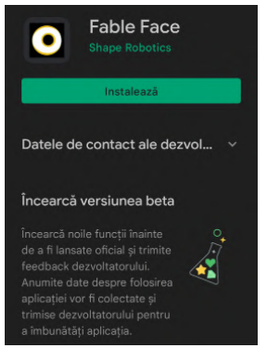


STEP 1 THE FABLE FACE APP

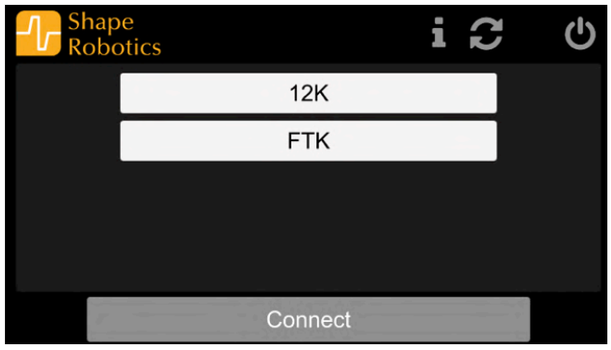
The Fable educational robotics ecosystem also includes the Fable Face app. Download the app on your phone and give your robot human features.

After installation you will be able to start the application.

INSTALLING



CONNECTING



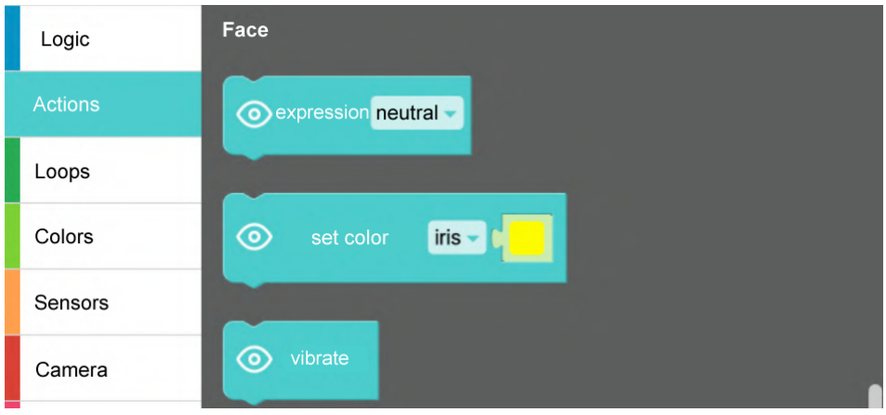
The Fable Face app will detect both your hub and the other currently connected hubs. Choose your code from the list (see the code on the back of the hub) and press the "Connect" button.

If everything went well, on your phone you will see two big eyes to be programmed from Fable Blockly (your computer).

ACTIVITY 10 min

In the "Actions" section of the programming menu in Fable Blockly, you will find the commands related to the "Face" of the robot.

Test all the commands in the Actions-Face menu. After pressing the Advanced Mode button, you will have access to even more commands.



CONCLUSIONS EMOTIONS AND ROBOTS

Perhaps the biggest challenge for a robot or smart piece of equipment lies in expressing emotions. Whether it is possible or not, if it will happen in a few years or in a few hundred years, mankind must be prepared for this moment.

INSTALLING

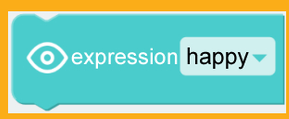
The FableFace app is available for both Android and IOS. The app has a friendly interface and an easy-to-use menu.

KEY INFO

CONNECTING

The Hub's unique code is written on its back.

NEW BLOCKS!



This command will display the phrase selected by the user on the phone screen. You have several options to choose from: happy, sad, angry, tired, surprised, etc.

This command allows you to "personalize" your robot's eyes, that is, to choose a color for its iris or eyelids.

With this command, the phone/tablet vibrates.

Wheels and Motion – 2-Step Lesson

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

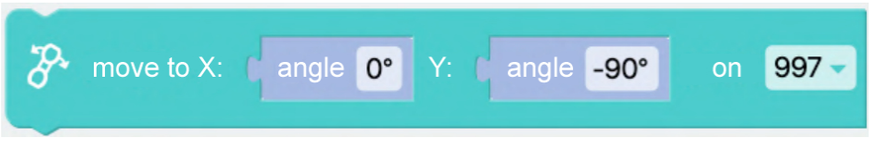
FIELD ROBOTICS and PROGRAMMING
MATH / ARTS / HISTORY / PHYSICS

LEARNING OBJECTIVES

- Connect a Spin module to the computer.
- Identify the motion commands for the Spin module.
- Program and move a Spin module in straight direction and in a 90-degree turn.

STEP 1 REVIEW

Analyze the program below and choose the image that corresponds to the program after running it.



ACTIVITY

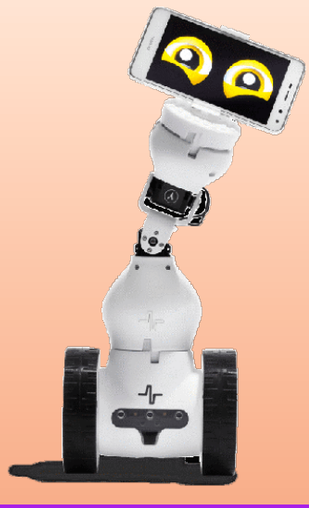
10 min

For this activity we need: four pencils, a plywood (or a notebook) 10x7cm, a wooden geometric figure (or a full pencil case), a spring dynamometer, a thin roll of paper tape, a roulette.

Place the piece of wood over the plywood placed on the table. Use paper tape to create a handle/hook as the one shown in the picture. Grab the dynamometer by the "handle" you created and drag to move it. Observe on the dynamometer what force is required to move it. Draw a table like the one below in your notebook and write down the value you get. Repeat the measurement and write it down one more time.

Feel out the force needed to move the plywood with the weight placed on top	Attempt 1	Attempt 2
No pencils under the plywood		
With pencils under the plywood		

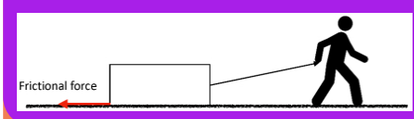
Observe what happens when you put four pencils under the wooden piece and try to perform the same movement with the dynamometer. What results did you get this time? How do you explain these differences?

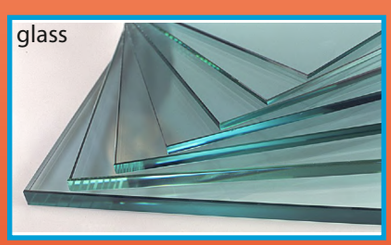


DID YOU KNOW?

The frictional force is the force that appears as a result of the interaction of two bodies, at the contact surface between them. During a movement, the force of friction opposes the movement, which means it slows it down.

The coefficient of friction depends on the material from which the objects are made.



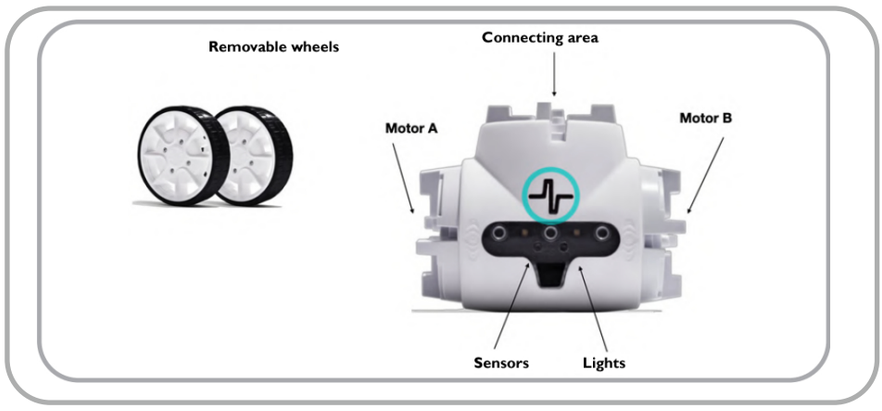


Repeat the experiment at home with your parents, but this time without pencils. Use the slide on the glass, then on the sandpaper.

STEP 2 SPIN MODULE

Use the image below to discover the components and functions of the Spin mode.

- Docking Area - allows Spin mode to be attached to other Fable modules.
- Motors A & B - Spin module motors. They can be ordered individually.
- Sensors - The Spin module is equipped with Proximity, Color, Light sensors.
- Lights
- Wheels – they are accessory components.

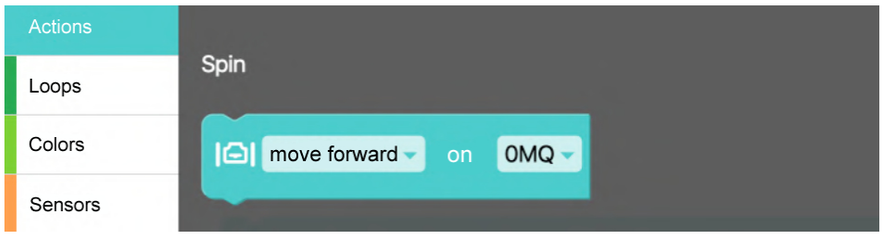


The Spin module is identified by a unique code (see the back of the module).

Once you set the same color on the Hub and Spin, you'll notice that in the Communication Area of FableBlockly the codes for each are mentioned.

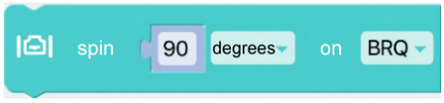
ACTIVITY 5 min

Program the Spin module to move forward for 5 seconds, and then backwards for 6 seconds. Create the program in such a way that the robot executes the specified commands at least 3 times. Use the Actions command from the menu.



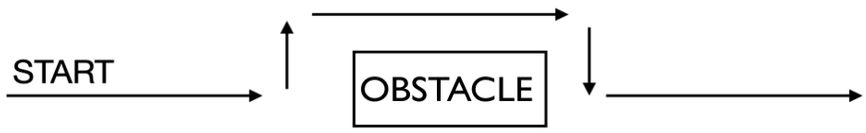
ACTIVITY 5 min

This command involves a right- or left-turning (n°) action from the Spin mode.



Program the robot to move according to the diagram below. You can use a pen, a book or an accessory from the Art&Craft area as an obstacle.

Next, create a larger pathway on the classroom floor and try to involve more obstacles. Program the robot to move according to the new route.

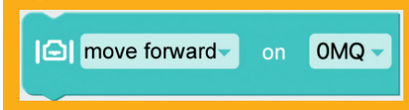


KEY INFO

CONNECTING

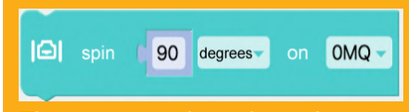
The unique connection code can be found on the back of the Spin module.

NEW BLOCKS!



This command makes the Spin module move forward/backward or rotate.

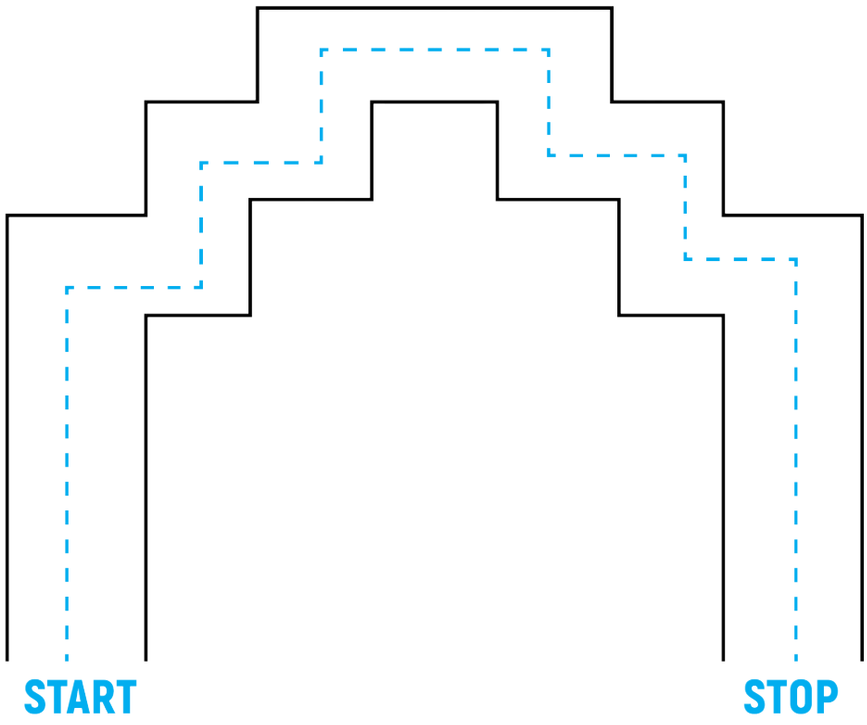
NEW BLOCKS!



This command makes the Spin module rotate. The measure of the angle can be modified.

ACTIVITY 10 min

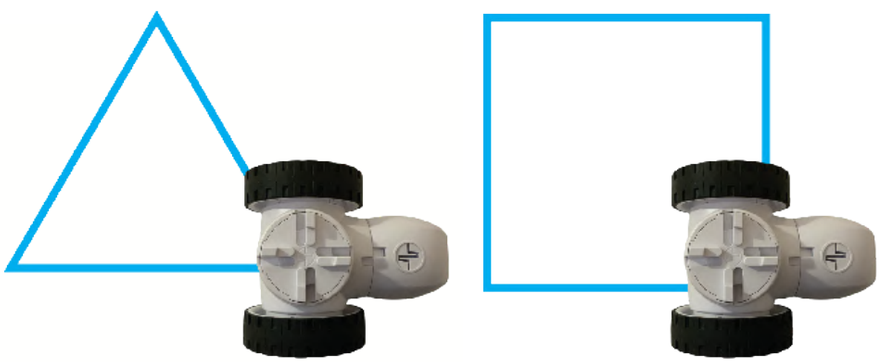
Use paper tape to create the path in the diagram below on the floor. Program the robot (using as few commands as possible) to move according to the created path.



ACTIVITY 10 min

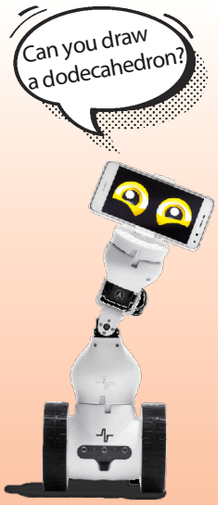
Attach a marker to the Spin module (equipped with wheels). You can do this using paper tape. Place the robot on a flipchart sheet so that, by executing the program you created, you get a triangle or square drawing.

Try to program the robot so that you get paths in the shape of a rhombus, pentagon, hexagon, etc.



CONCLUSIONS SIMPLICITY

Applying more force does not always solve a problem. As with the dynamometer example, testing new solutions can yield a simple, quick, and lower energy solution. The strength of the equipment also depends on the energy it consumes. A drone will drain the battery faster if it uses the maximum rotational power of the propellers. The same happens with electric cars, if you use the accelerator pedal to the maximum. As a programmer you will always think about how to make energy consumption more efficient. You will be surprised how many solutions you can find sometimes for consuming as little energy as possible.



DID YOU KNOW?

- The wheel is assumed to have its origin in ancient Sumer, Mesopotamia, the ancient territory of Dacia, 7,000 years ago.
- People used the wheel in horizontal position for pottery and to grind grain, and in vertical position for transport or for the development of other mechanisms (for example, water mills).
- It is assumed that the first wheels were built from wooden logs.
- In order to 'empty' the heavy interior of the wooden chariot wheels of Asia Minor, people invented the spokes (around 2000 BCE). They not only reduced the mass of the wheels, but also provided the necessary support for the wheels to not break so easily.

DID YOU KNOW?

- The marathon is a running sporting event with an official distance of 42.195 km, usually held on the road.
- The name of the event was given after the legend of the Greek soldier Pheidippides, a messenger who brought to Athens the news of the victory in the battle of Marathon, but the accounts of Herodotus question the historical truth of this legend.
- Most of the participants are amateur sportsmen, and every year over 800 such races are organized.

The Algorithm and the Traffic Light- 3-Step Lesson

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

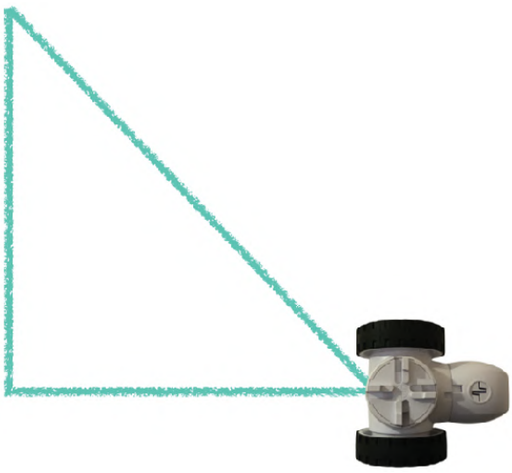
FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Teach the notion of algorithm.
- Algorithm creation exercises.
- Program a Spin module based on a custom algorithm.

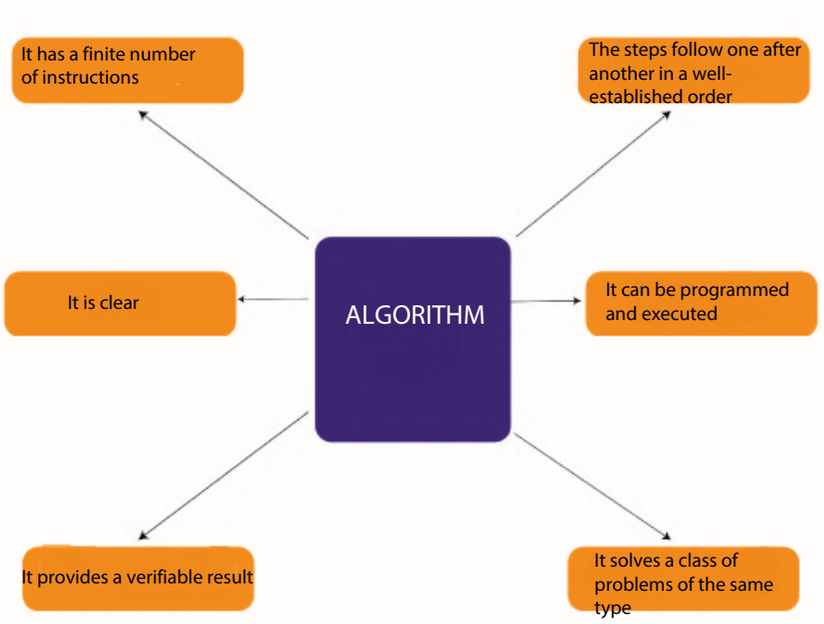
STEP 1 REVIEW

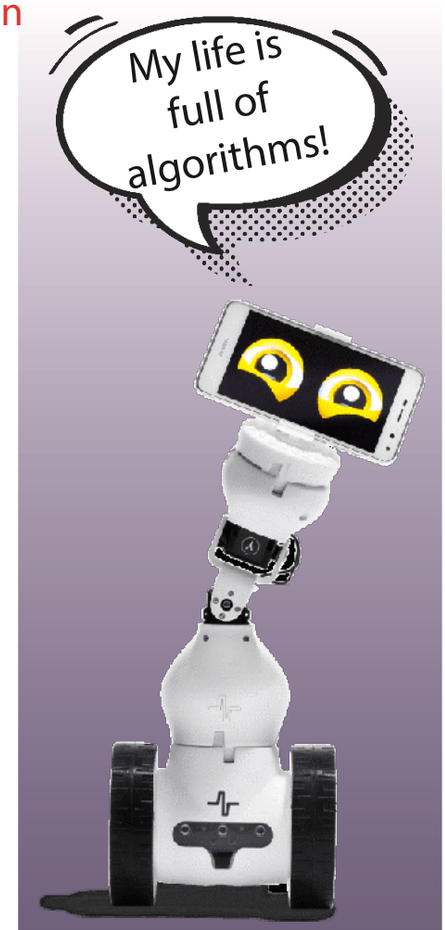
Tape the felt-tip pen to the Spin robot so that the top of the felt-tip pen can touch the flipchart. Program the Spin module to "draw" a triangle on a flipchart.



STEP 2 THE ALGORITHM

AN ALGORITHM is a set of finite instructions, which, carried out in a certain order, lead to a desired result.





ALGORITHM

Step 1: put on your socks
Step 2: put your feet in the shoes
Step 3: tie the laces
Step 4: when you get home, untie the laces
Step 5: slip your feet out of your shoes
Step 6: take off your socks

This algorithm is clear, has a finite number of instructions, leads to the same result, and gives a verifiable result. What else can you say about it?

ACTIVITY 10 min

The hub connected via USB to the computer has several colors. These colors can be changed not only by pressing the Hub, but also by commands in the program. In the Actions menu you will find the Light command.

Form teams of two to work with two Hubs. Program the two Hubs to act as a traffic light. One Hub will be for cars and the other for pedestrians. See the operation algorithm below:

- Green for cars (for 3 seconds) and Red for pedestrians
- Yellow for cars (for 2 seconds) and Red for pedestrians
- Red for cars (for 3 seconds) and Green for pedestrians (for 2 seconds)
- Red for pedestrians (for 4 seconds)

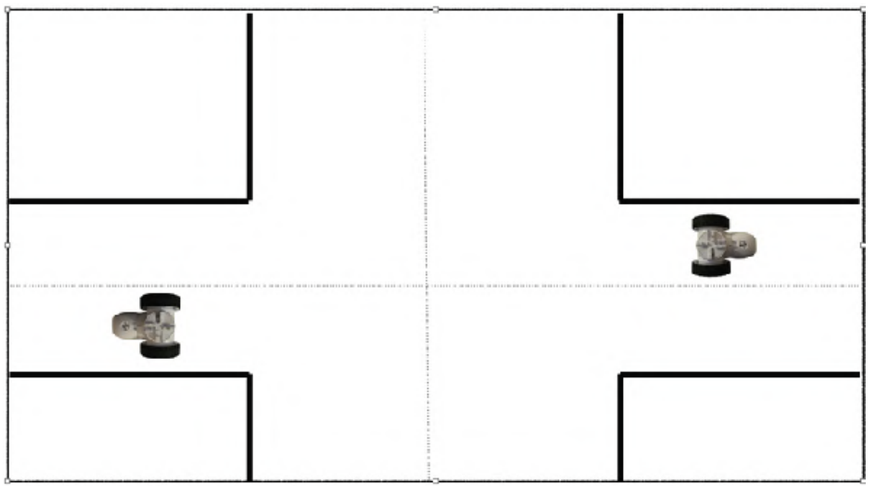
Note the times mentioned above. Suggest another solution to solve this problem.

ACTIVITY 5 min

Open the ClassVR app, go to Search Subscription, type Cycle and load The Water Cycle. Observe the path the water takes and write an algorithm about these activities.

ACTIVITY - TEAMWORK 5 min

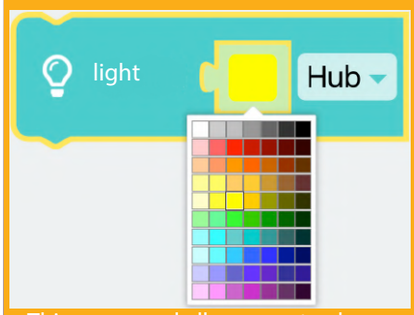
Team up with a colleague. Draw a route on flipchart sheets joined together and then program two Spin modules to move according to a pre-set algorithm. Use a single Hub and create your own motion rules.



CONCLUSIONS

Algorithmic thinking can help you prepare for a math test, plan a vacation, or offer a colleague a better solution for building a robot. Analyzing the task, choosing the tools and establishing the steps and stages are all part of a successful mindset!

NEW BLOCKS!



This command allows you to change the color of the Hub directly from the Fable Blocky app, while a program is running.

DID YOU KNOW?

The word "algorithm" originates from the name of the Persian mathematician Al-Khwarizmi (the first scholar of the Baghdad school). He is often called the "father of algebra".

DID YOU KNOW?

An algorithm is a set of simple instructions for solving operations. Algorithms are used predominantly in mathematics and computer science.

The Algorithm and the Morning Alarm - 4-Step Lesson

NIVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS/PROGRAMMING/ELECTRONICS

LEARNING OBJECTIVES

- Use commands from the Fable Blockly app's Logic menu.
- Write programs that use the If statement.

STEP 1 REVIEW

Write an operation algorithm specific to a traffic light. Red will be on for three seconds, yellow for one second, and green for five seconds. Program the Spin module to function according to this algorithm.

ACTIVITY

15 min

An alarm device is a piece of equipment that issues a warning when one or more conditions are met. For example, a fire alarm goes off when it detects smoke; and a gas alarm when gas is detected. What other alarm examples do you know and what conditions do they meet to trigger a warning?

Next, you will build an alarm that will detect the opening of a door. Here is the list of materials needed: clothes hook, aluminum foil, 9V battery, a battery adapter, and a buzzer.

Assemble the components according to the steps below, and finally, between the opening ends of the pliers, you can insert a thin sheet of paper.

DID YOU KNOW?

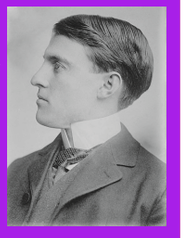
- Benjamin Franklin used the term "battery" for the first time, in 1748, to describe a group of glass jars charged with electrical charge.
- The Italian scientist Alessandro Volta invents the "voltaic cell" in 1800, which is considered to be the ancestor of electric batteries, because it transforms chemical energy into electrical energy.
- In 1802 was invented the electrical battery for mass production by William Cruickshanka.

REMEMBER!

BUZZER

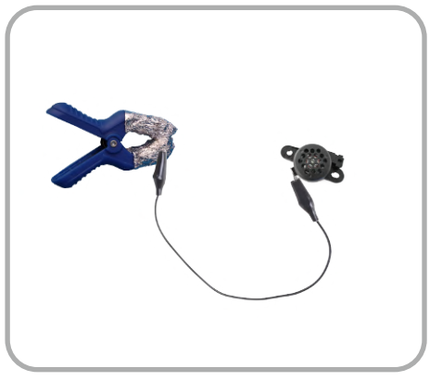
The buzzer is a small piece of equipment typically used in DYI (Do It Yourself) projects. It has the role of generating a sound when powered. The sound is produced due to the vibration of an internal membrane. In the electronic schematics you will identify the buzzer by this symbol.

DID YOU KNOW?

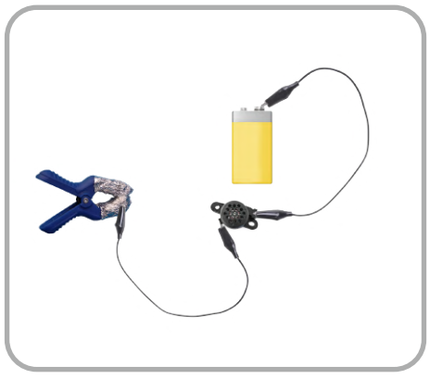


The buzzer is like a smaller horn. At the beginning of transport, bells or even trumpets with air balloons were used to alert traffic participants. The first invented horn was that of Miller Reese Hutchison, whose patent was registered in 1908. Hutchison was also associated with Thomas Edison.

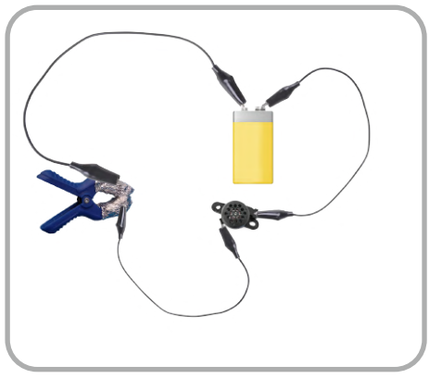
Wrap the ends of the pliers in aluminum foil, separated from each other



Connect one aluminum foil to a wire of the buzzer.



Connect the other cable of the buzzer to the battery.



Connect the other battery connector to the aluminum foil left free.

Notice that the buzzer activated itself, because the electrical circuit is "closed", that is, it is not interrupted. You can now insert a sheet of paper between the aluminum sheets and you will notice that the circuit is now "open", meaning it is interrupted, and the buzzer is no longer making any sound. The alarm goes off as soon as the paper sheet is removed. Where could you use such an alarm?

STEP 2 CONDITIONING

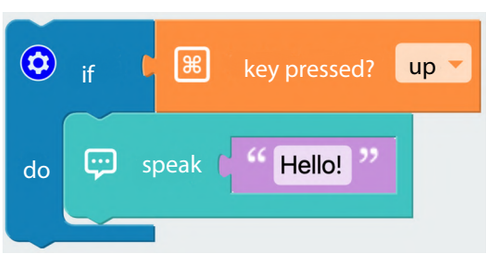
You noticed that every alarm needs at least one condition to be triggered. This is actually the idea of an alarm, to notify when an event happens. This check (to see if the event occurs) can be done endlessly, or only once. Could you give an example for each situation?

Regardless of whether this check is done endlessly or just once, one condition needs to be checked: whether the event has occurred or not. Or, in other words, if it is False or True.

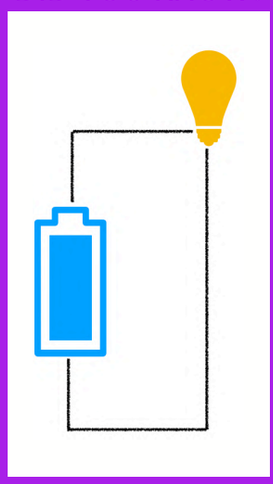
Example: If it is raining outside, we do NOT play basketball.
To the question "Is it raining outside?" can only be answered with YES or NO. The condition is or is not fulfilled, so the statement "It is raining outside" can be True or False.

ACTIVITY 10 min

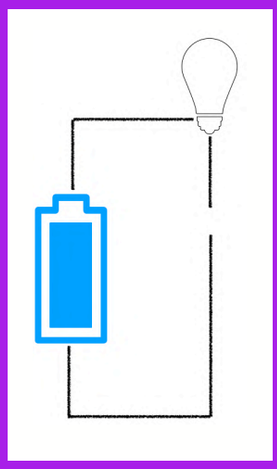
Open the FableBlockly app and write the following program. The two blocks (blue and orange) can be found in the Logic and Sensors menu.



DID YOU KNOW?



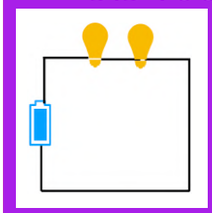
Closed circuit



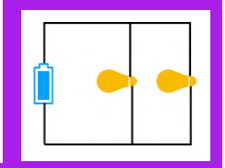
Open circuit

If the electrical circuit is continuous, it is called closed, because it allows current to flow. And if the electrical circuit is interrupted, it is called open.

DID YOU KNOW?



Parallel circuit



Series circuit

Series circuit - If one bulb fails, the entire circuit is open, the other bulb doe not light. Parallel circuit - If one bulb fail the rest of the circuit remains open, the other bulb remains lit.

A Christmas tree or a summer terrac light installation uses a parallel circuit.

Can you figure out why?

Run the program by pressing "Play". Can you hear the greeting?
Now hold down the "up arrow" key and run the program again. This time the greeting is heard, the command inside the condition being executed.

Can you explain why you didn't hear the greeting in the first variant? Complete the program so that you hear the greeting every time you press the "up arrow" key, without having to hold down the key from the beginning.

ACTIVITY 10 min

Place the Joint module with the color change button facing you.

Write a program that determines the movement of the robotic arm according to the conditions below:

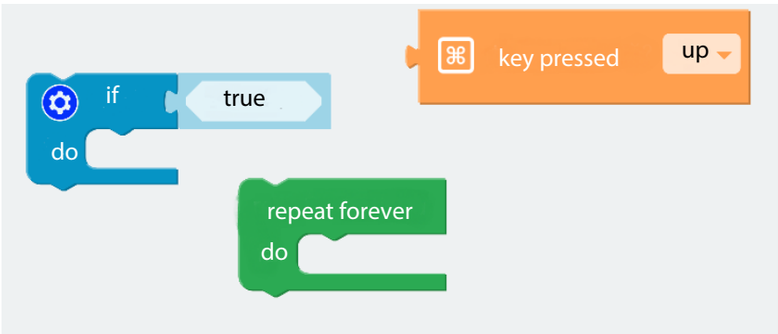
1. When pressing the "up arrow" key, make the Y motor move forward (-90°); and the X motor stand in the vertical/initial position.

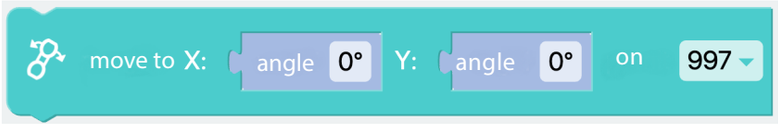
2. When pressing the "down arrow" key, make the Y motor move backwards, i.e. towards you (+90°), and the X motor stand in the vertical/initial position.

3. When pressing the "left arrow" key, make the X motor move to the left (+90°), and Y motor should stand in vertical/initial position.

4. When pressing the "right arrow" key, make the X motor move to the right (-90°), and Y motor stand in vertical/initial position.

Below are some examples of command blocks that you can use in this activity.

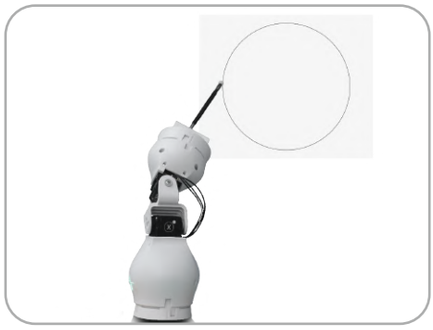




ACTIVITY 10 min

Write a program to enable the robotic arm to draw a semicircle on a sheet of paper fixed (upright) to a wall.

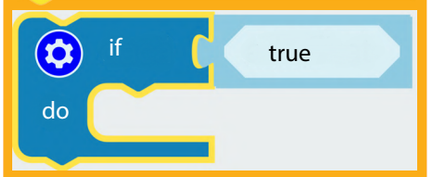
Build and mount on the Joint module a support that allows for the attachment and control of a marker.



CONCLUSIONS THE PAINTING ROBOT

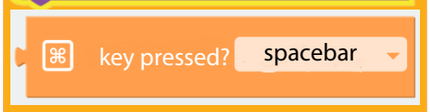
All alarm systems work based on checks, questions that you can answer with YES or NO, that is, True or False. Whether it's a simple alarm from a wristwatch or a complex system from a hydroelectric plant, it's the repeated check questions that control the alarm system. There are, of course, also used sensors that take input data from the environment in which they are located.

NEW BLOCKS!

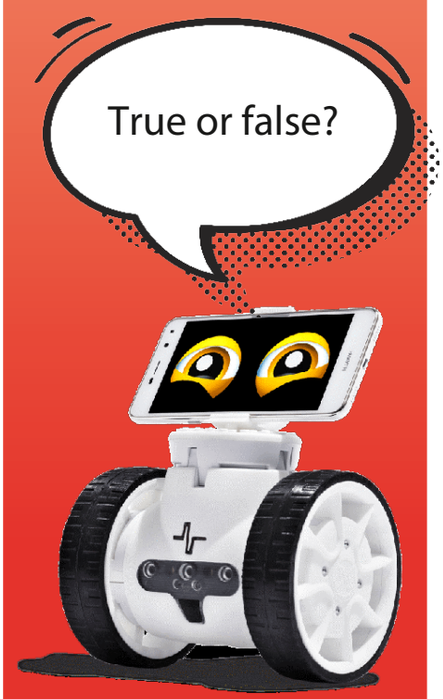


This command is waiting for a condition to be met. As soon as the condition is met, the commands inside the If block are executed. Here you can have one or more commands.

NEW BLOCKS!



This command checks if a key is pressed, thus which means that its truth value is true. If the key is not pressed at the time of verification, its truth value is false. You can choose which key to be checked.



Winter Conditions - 3-Step Lesson

LEVEL: **BEGINNER** **INTERMEDIATE** **ADVANCED**

FIELD ROBOTICS and PROGRAMMING
GEOGRAPHY/ARTS

LEARNING OBJECTIVES

- Use multiple conditions in a single decision structure.
- Programming exercises with decision structures.

STEP 1 REVIEW

Use Fable accessories or 3D print your own to create a hammer. Use a Joint arm for this too. Now program the robotic arm to react according to the following conditions:

- when pressing the A key, the hammer rises to a vertical position
- when pressing the D key, the hammer descends to 90 degrees (motor X)

ACTIVITY 15 min

Program a Spin module so that you control its movement either from the directional keys (forward, backward, left, right) or by pressing the "W/A/S/D" keys. Find a solution to be able to stop the Spin module whenever needed.

Add this block inside the IF structure, before the motion command. Note that inside the conditional structure, you can add more commands. These will be executed on a command-by-command basis.

Use a maze board connected to the Joint module and control the metal ball with the keys so that you go through the maze as fast as possible.

STEP 2 HOW CAN YOU LIVE IN AN IGLOO?

According to the dictionary, an igloo is a "hut made of blocks of ice and snow, built by the Eskimos in the polar regions". Arctic peoples know that there is nothing more reliable than igloos, and if they are built correctly, then at a temperature of -40°C outside, it can be +20°C inside. How is this possible?

Inside the small house, the human body emits heat, similar to a small radiator. Warm air rises because it is lighter than cold air, and due to the spherical shape of the hut, the warm air begins to circulate evenly. The walls and floor of the igloo are built of compacted snow, meaning it is made of 10% frozen water and 90% air. Snow is an excellent thermal insulator. Some igloos are equipped with an exhaust hole at the top, and people can even make a fire inside to keep warm.

ACTIVITY 5 min

Open the Class VR app, go to Search Subscription and type Igloo Hotel Norway to see what a modern igloo looks like. Observe how these constructions are made. How do you think light gets inside? Could you make a fire inside to keep warm? Could you improve such a construction?

DID YOU KNOW?

Although it seems impossible, you can build a house with all the walls facing south.

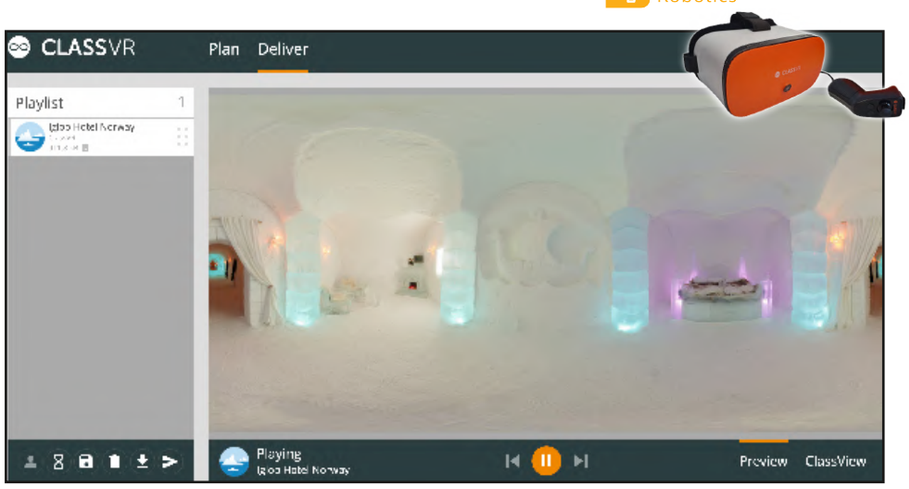
Any idea how this could be done?

DID YOU KNOW?

About 10,000 years ago, in China and the Middle East, people used to build their roofs with clay.

In Bermuda, people build their houses with stepped roofs.

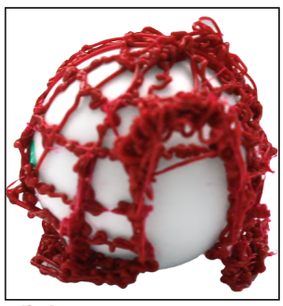
In Norway, people use turf is also for the construction their roofs.

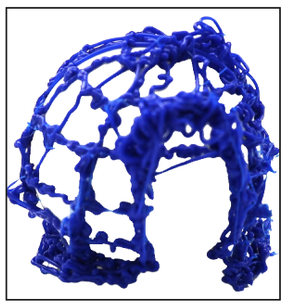


10 min

ACTIVITY

Use the 3D pencil to build a support structure for a miniature igloo. Discuss with your colleagues about how you can do this using as few resources as possible. Try different ideas and compare the results.





10 min

ACTIVITY

You are the driver of a snow plow. You are tasked with clearing an area of snowdrifts "modeled" out of crumpled sheets of paper.

Build a snow plow using the Spin module, the "beaver tail" and the "plow" accessories from the Fable set.

Program the Spin module in FableBlockly so that you can control it to remove all the snowdrifts from the previously defined area. Please note the following conditions:

- when you reverse, the snowplow emits a sound to signal its presence. Use the Musical Notes command from the Actions menu for this action.
- the snow plow only moves forward when the "up arrow" key and the P key are pressed simultaneously.

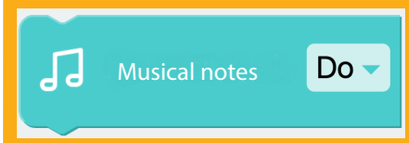
CONCLUSIONS **INTELLIGENT MACHINES**

Today we can see autonomous tractors, agricultural drones for sowing, monitoring and spraying crops, as well as autonomous cars. In the future, it will be absolutely normal to see self-driving cars clearing the street or machines washing the sidewalks. Even the trucks can be autonomous or commanded remotely from a control center. They all work based on repeated questions that a programmer asks in the code.

DID YOU KNOW?

- The largest amount of snow in a single snowfall ocurred in Alaska (1952), with a snow deposition of 24.75 meters.
- The largest snowflake measured 38 cm wide and 20 cm thick (1887, USA).
- Artificial snow cannons were invented in 1950.

NEW BLOCKS!



The command involves playing a specific sound on the computer.

DID YOU KNOW?

- The longest song in the world is Symphony of the Crown, performed by Earthena, and has a duration of 48 hours, 39 minutes and 35 seconds.
- The shortest song in the world belongs to the band called Grindecore Napalm Death (duration=1.316 seconds) and has only four words.

Progress Check

FIELD ROBOTICS and PROGRAMMING

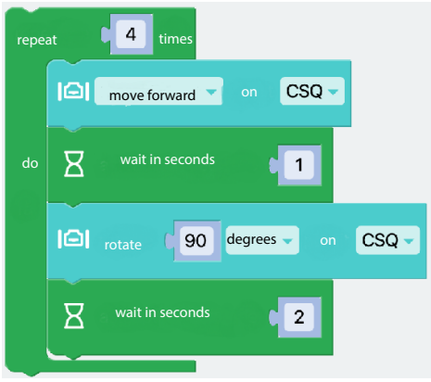
LEARNING OBJECTIVES

- Identify the result of a predefined program.
- Identify errors in examples and correct them.

ACTIVITY 10 min

WHAT IS THE RESULT?

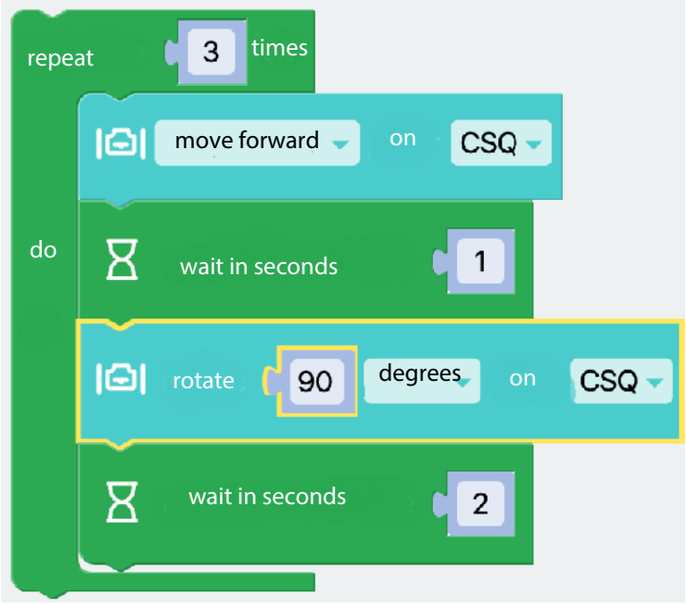
Analyze the images below and draw the path of the robot for each individual program on your notebook. Afterwards, enter the commands into FableBlockly, play each program and check if you drew the path correctly. You can also check by accessorizing the Spin module with a colored marker.



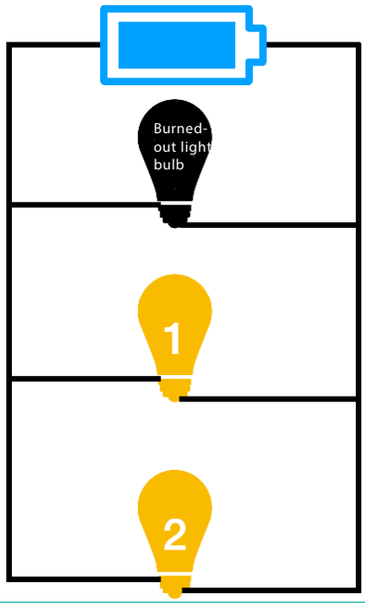
ACTIVITY 5 min

FIND THE ERROR

A driver wants to drive a route in the shape of a square.
Checks for errors in the program he created. What does the correct version look like?



REMEMBER!



In this circuit, bulbs 1 and 2 are on or off?

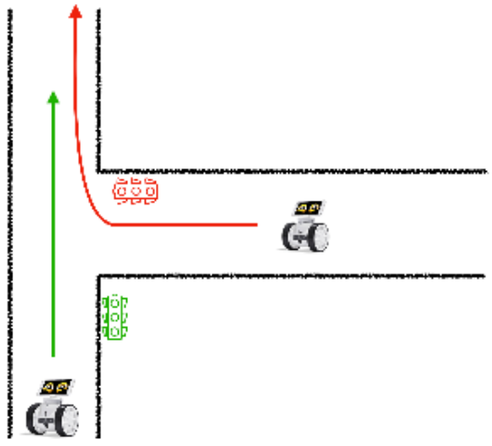
ACTIVITY 15 min

Notice the intersection in the picture. The two Spin modules move as indicated by the arrows. Write an algorithm for each module so that the two move without meeting at the intersection. Based on the algorithm, write a program in the Fable Blockly application, additionally meeting the conditions below:

- uses a single Hub connected to the computer, for the two Spin modules
- changes the color of the Hub to green while a module crosses the intersection

Write an algorithm for each traffic light so that two Spin modules heading to the intersection at the same time do not meet. To test the created algorithm, use two Hubs connected to different computers. Pay attention to times and colors to avoid traffic jams or other unforeseen road events.

After testing the algorithm, program two Spin modules to move towards the intersection, respecting the established rules.

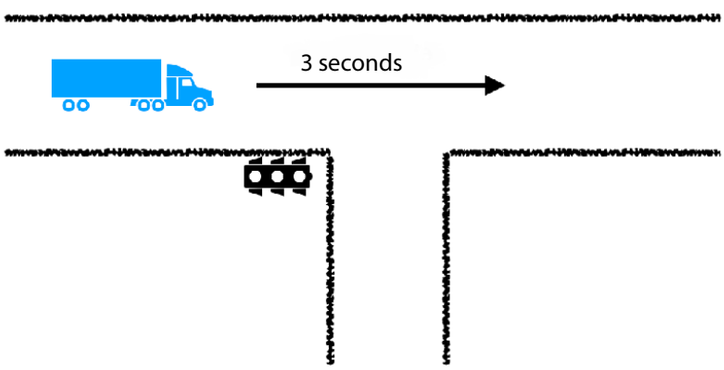


ACTIVITY 10 min

SOLVE THE PROBLEM

An autonomous truck is at an intersection, in front of a traffic light that is not working. A human operator must control crossing the intersection, as the on-board computer can only actuate the truck if it "sees the traffic light". Write a program that allows crossing when the following conditions are met:

- When pressing the W and E keys simultaneously, the truck moves forward for 3 seconds and then stops.
- Pressing the "space" key at any time will stop the truck immediately. You can check yourself by applying the program on a Spin module.



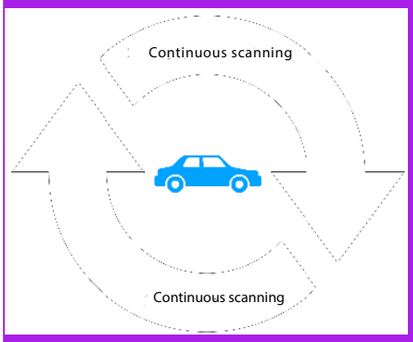
CONCLUSIONS ERROR IDENTIFIER

It can often be faster to spend time identifying errors in a program than to start with it from the beginning. The same happens with programs written by you, because you can follow a code more closely. This can be a job for those who excel at attention and following workflows. Would you like such a job? Do you think you would do better if you checked the functionality directly in the program or by observing the behavior of the equipment executing the code at the same time?

DID YOU KNOW?

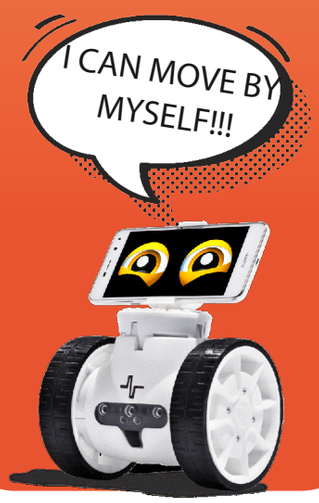
- The first traffic light in human history was a gas-powered model and was installed in London on December 10, 1868.
- In 1908, the first world rules for road signaling were established in the framework of an international conference.
- The first electric traffic light was invented by James Hodge and was installed on August 5, 1914 in Cleveland, Ohio.

DID YOU KNOW?



Self-driving cars work based on collecting information from sensors installed on the car or accessed from other sources. Based on this data and with the help of an Artificial Intelligence software, the car's software makes decisions to control the movement.

A self-driving car is constantly scanning its surroundings and calculating possible situations that are about to happen.



If It's Not True, Then It's False? - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
COMMUNICATION

LEARNING OBJECTIVES

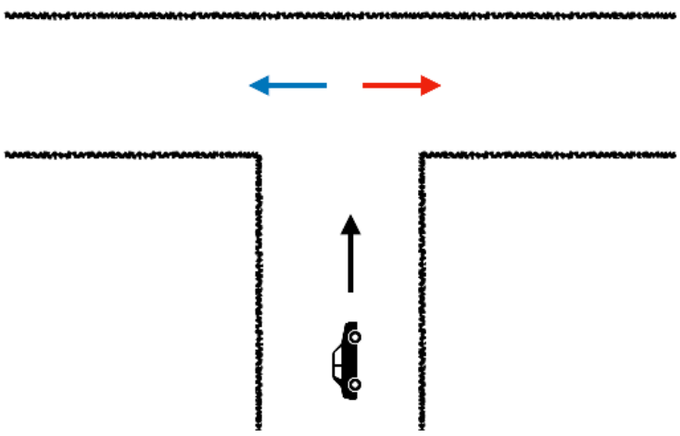
- Program Spin and Joint modules in a conditional structure.
- Use the If/else extension command.

STEP 1 REVIEW

Program the Joint robotic arm to perform a left movement when the A and S keys are pressed simultaneously, and a right movement when the S and D keys are pressed simultaneously.

STEP 2 MORE CONDITIONS

INTERSECTION

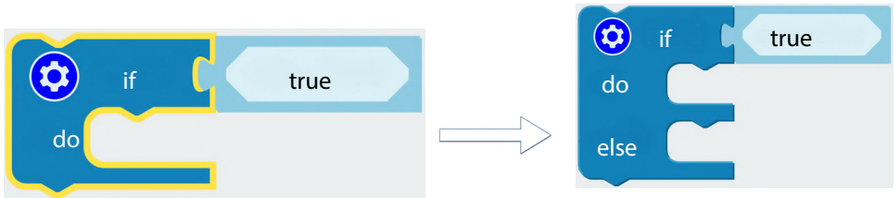


In the intersection shown in the picture, a car heading toward the center of the intersection has the option to turn left or right. These commands could be solved with two conditionals. If you pull the steering wheel to the left, you will turn left. And if you pull the steering wheel to the right, you will turn right.

Can you identify another solution? For example, as long as you don't turn left and want the movement to continue, it means you will turn right. There is no other option. In this case you can say you are turning left, otherwise you are turning right. This command, for English programming, sounds like this: IF/ELSE. IF = on condition that, and ELSE = otherwise. In this mode, the program will execute either the first command or the second command. It is understandable that both cannot be executed, one excluding the other.

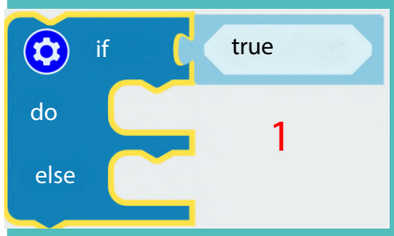
For programming Fable robotic modules, the IF command block can be modified to allow this new choice as well. In the Romanian Fable interface, IF/ELSE are written if/else.

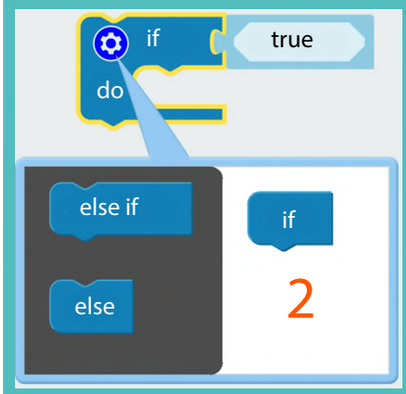
Open the Fable app, and from the Actions menu take the IF command. By pressing the gear wheel you will expand the menu of this command and you will be able to "drag" the command differently, from the left side to the right side.

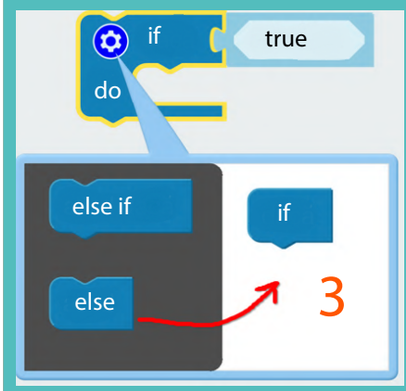


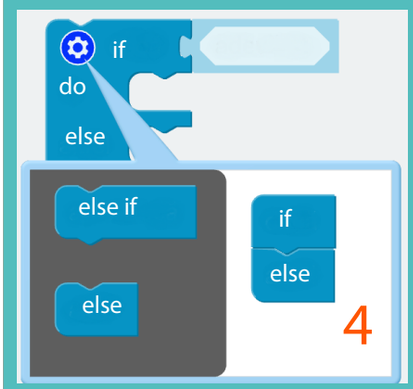
REMEMBER!

Here's how the 'If' command expands





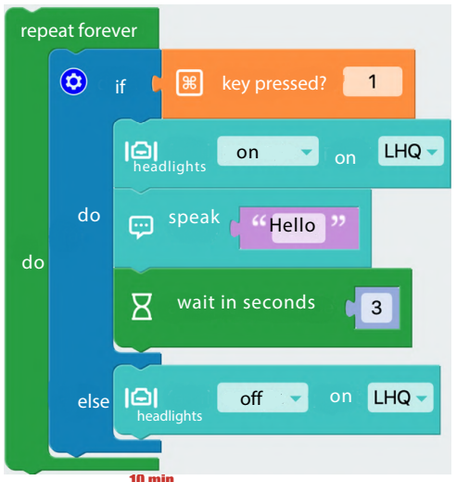




This block is visible in Advanced Mode and allows speed control for the movement of the Joint module's motors.

ACTIVITY 5 min

Analyze the following program and determine how the robot behaves when you press key 1 and what happens if no key is pressed.



ACTIVITY 10 min

The SOS signal is a standard distress signal to ask for help. Using Morse code and Fable robots we can transmit this message in two ways: acoustic (sound) or light signals. Program a Spin module to transmit the SOS text in Morse code, visually.

Use the command to turn the lights on and off. Use the pause between transmissions, marking the times at which the light is not on.

ACTIVITY 15 min

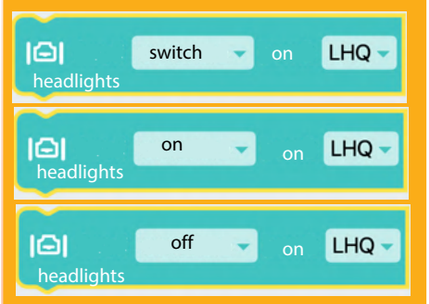
Using Morse code build and transmit to other teams a three-word sentence. Program the Spin module to transmit the same message through light signals. Checks if the message sent was received correctly. Did errors occur during the performance of the task? How did you solve them? Describe three situations in which Morse code can be helpful.

ACTIVITY 10 min

Place the maze board on a Joint module, together with the metal ball. Using keystroke detection, control the robotic arm from the keyboard to move the metal ball along the path.

The speed can be set if you switch to Advanced Mode from the Fable menu. After this Setting, in the Actions/Joint menu you will find the command that allows the motors to move at a speed defined by you. Use if/else commands. In this situation, is it easier if you expand or not the command with the else condition?

NEW BLOCKS!



ON AND OFF HEADLIGHTS

This command allows control of the Spin mode lights.

This control refers to "turning on, off, switching". Switching means going from on to off one action at a time.

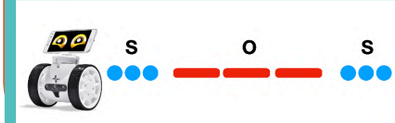
REMEMBER

MORSE CODE

It was created in 1830 by Samuel Morse. The code was created to aid in remote communication.

A	•—	N	—•
B	—•••	O	———
C	—•—•	P	•——•
D	—••	Q	——•—
E	•	R	•—•
F	••—•	S	•••
G	——•	T	—
H	••••	U	••—
I	••	V	•••—
J	•———	W	•——
K	—•—	X	—••—
L	•—••	Y	—•——
M	——	Z	——••

1	•————	?	••——••
2	••———	!	—•—•——
3	•••——	.	•—•—•—
4	••••—	,	——••——
5	•••••	;	—•—•—•
6	—••••	:	———•••
7	——•••	+	•—•—•
8	———••	-	—••••—
9	————•	/	—••—•
0	—————	=	—•••—

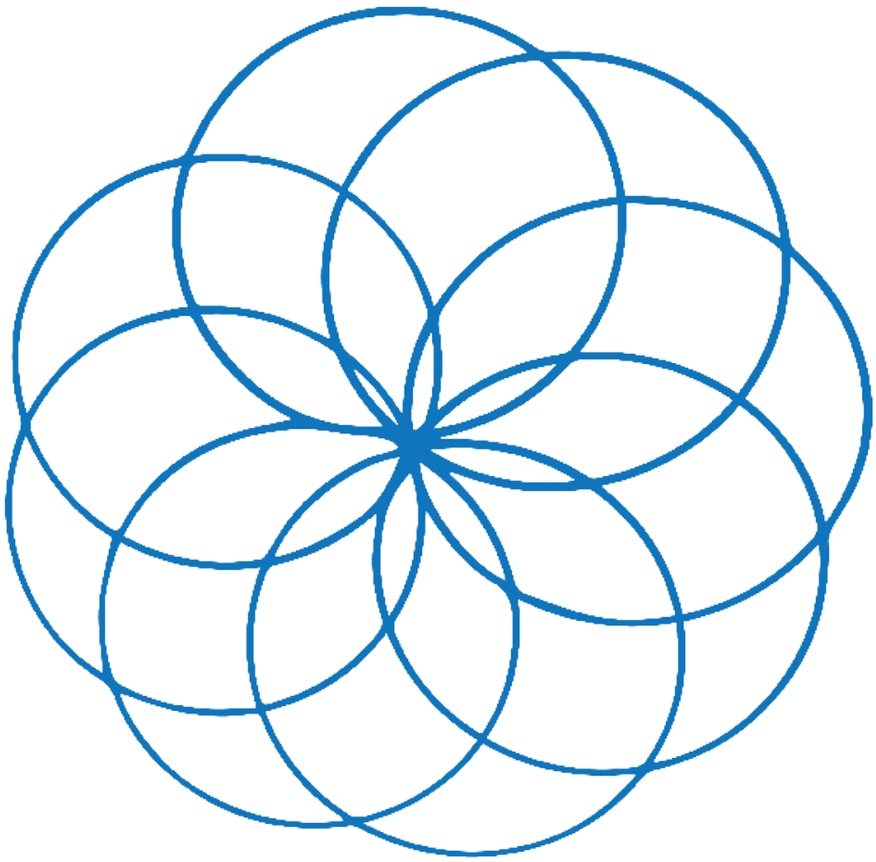


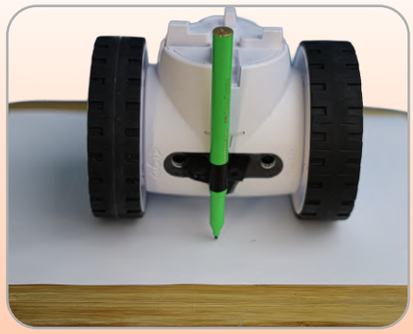
ACTIVITY

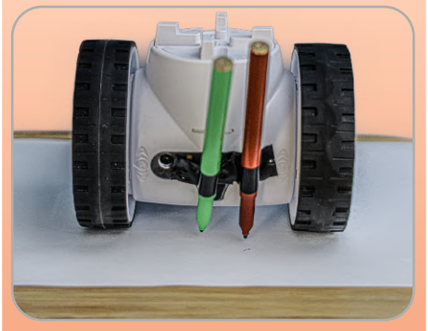
10 min

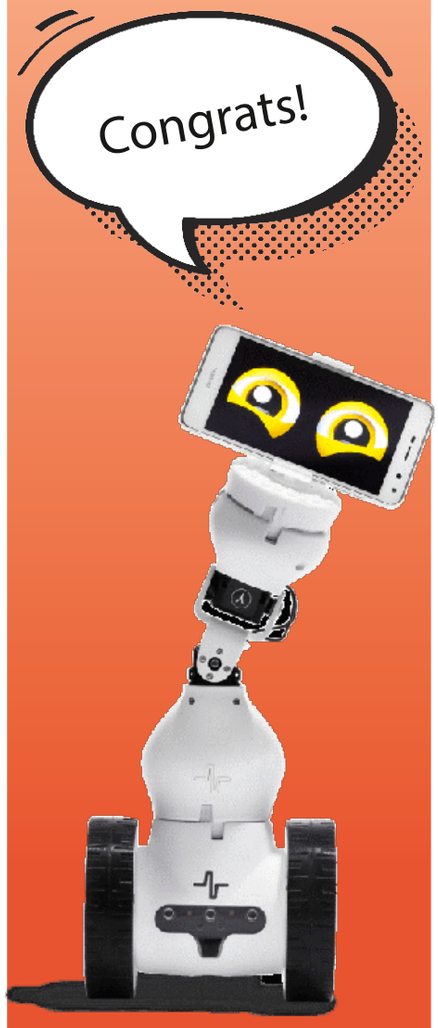
Use a Spin module, a flipchart sheet, paper tape and a marker.

Look at the drawing below. Tape the marker to the Spin robot so that the tip of the marker touches the paper. Program the module to mimic the drawing. You can control the drawing activity manually (by pressing keys) or automatically (the program will execute the necessary commands by itself).









NEW BLOCKS!

SPEED CONTROL

This command allows movement at a certain speed. This facilitates a more precise control of the motors.

This command is available in Advanced Mode.

CONCLUSIONS YES OR NO?

A condition consists of two parts: a hypothesis and a conclusion. When you write "If", you state the hypothesis, and the execution part is the conclusion. Conditions help you control what the program does. A condition in programming can only have a True or False result. Try to get by in school for a day using only YES or NO answers.

Flowchart and conditions - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Distinguish the constituent elements of a flowchart.
- Create a flowchart for controlling the Fable robotic arm.

STEP 1 REVIEW-ALGORITHM

Create a program to draw a right triangle by means of a Spin mode.

ACTIVITY 10 min

AVOID THE OBSTACLE!

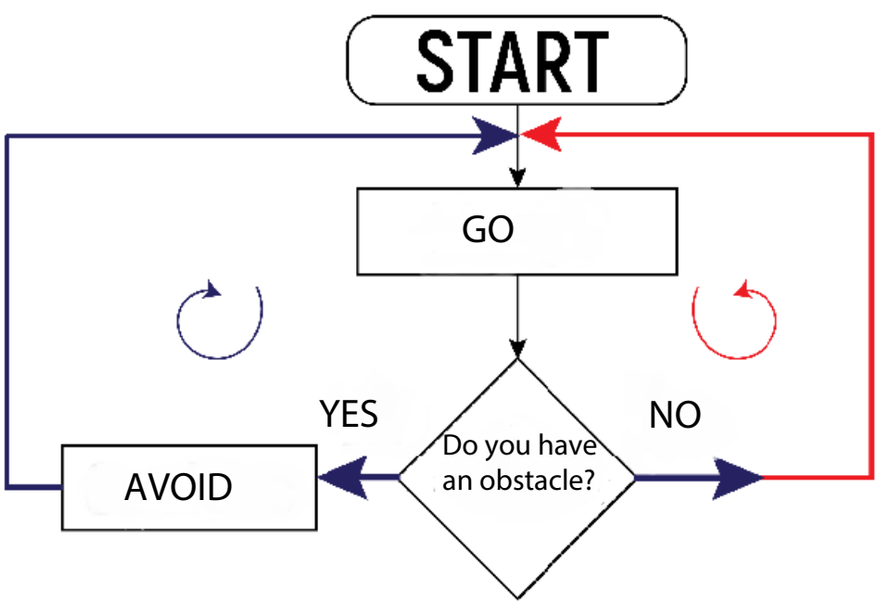
On a white sheet of paper, write an algorithm that allows a robot vacuum cleaner to always move forward. If an obstacle appears in front of it, the robot must be able to bypass it. Identify the moment when the vacuum asks if there is an obstacle.

STEP 2 FLOWCHART

A flowchart is the graphical representation of an algorithm. This is similar to a mind map and is built from top to bottom.

In the construction of the flowchart, you will use the following graphic elements: oval, rectangle, rhombus. There are other graphic elements that can be part of the building process, but for now you will only use these three.

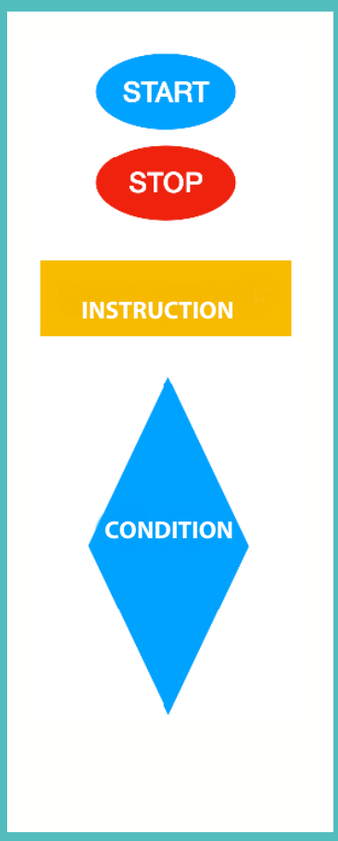
FLOWCHART FOR THE ALGORITHM
ROBOT VACUUM CLEANER

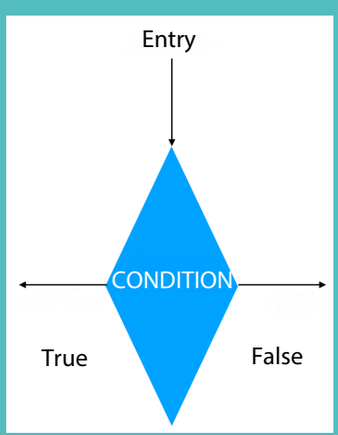


Notice that the graph block for the condition has one input (gets the information from the previous block – Move to) and has two possible outputs, YES or NO. This block is a conditional block, that is, it waits for the program to make a choice. The links between blocks are called branches.

REMEMBER!

GRAPHICAL ELEMENTS FOR THE FLOWCHART





DID YOU KNOW?

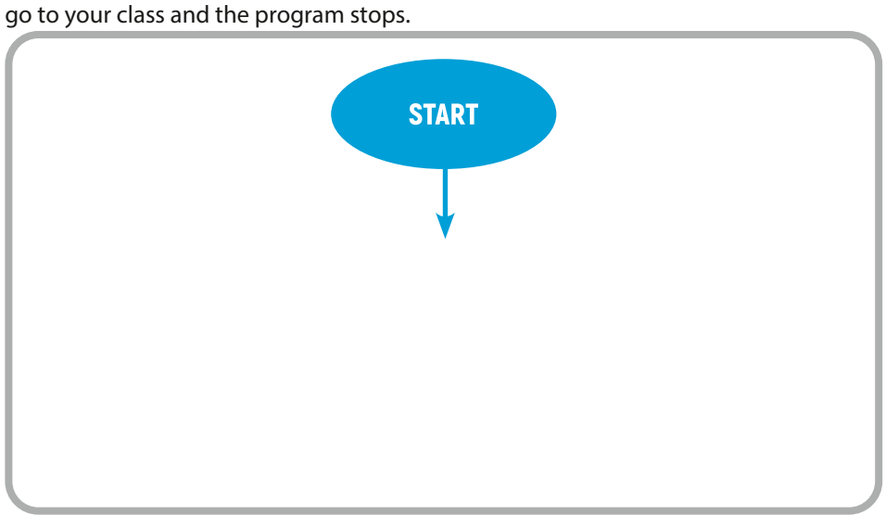
Image Source: Wikipedia
Sursă foto: Wikipedia

In 1860, the first vacuum cleaner for carpets appeared.
In 1905, in England, the first portable vacuum cleaner was created.

ACTIVITY 10 min

In your notebook, draw a flowchart for the following situation:

You go to school. A classmate asks you if you go out to play with him in the schoolyard. If it's raining outside, you suggest going to the library, and if it's not raining outside, you stay and play outside, in the schoolyard. After 10 minutes, you go to your class and the program stops.

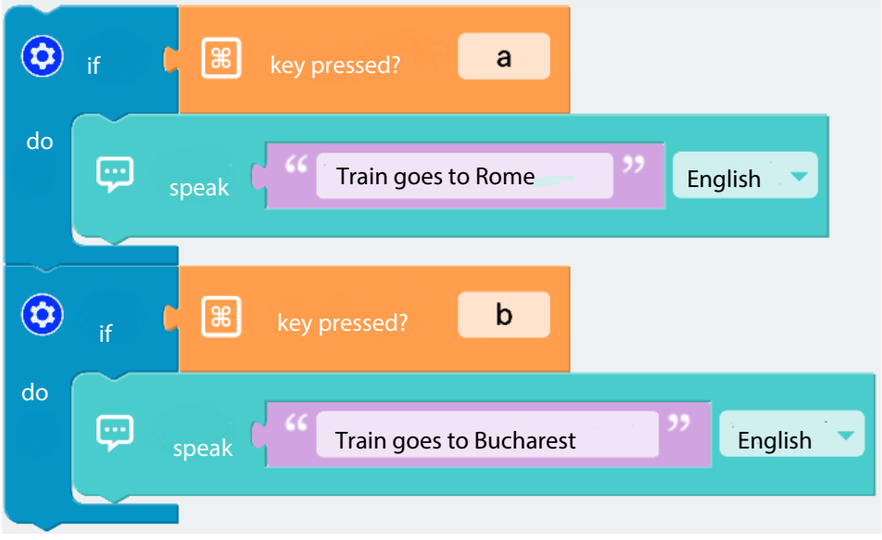


STEP 3 KEYBOARD COMMANDS

Follow carefully the programs below and, for each of them, draw in your notebook the flowchart according to which they work. Open the FableBlocky app and test each program to see the result.

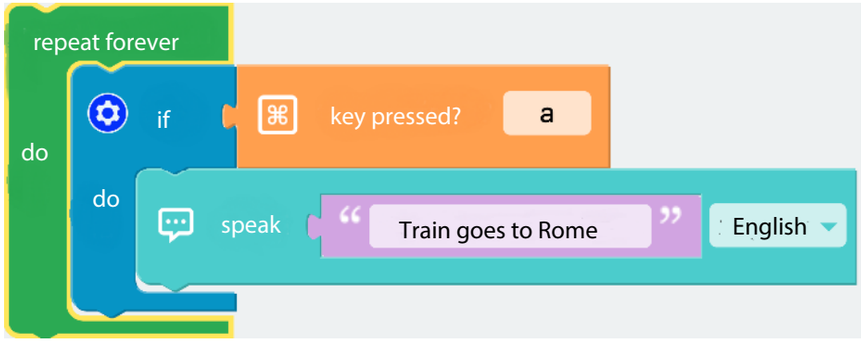
VARIANT 1

In which direction is the train announced if the A key is pressed?



VARIANT 2

What happens if you press the A key? Why was the "forever loop" used?



DID YOU KNOW?

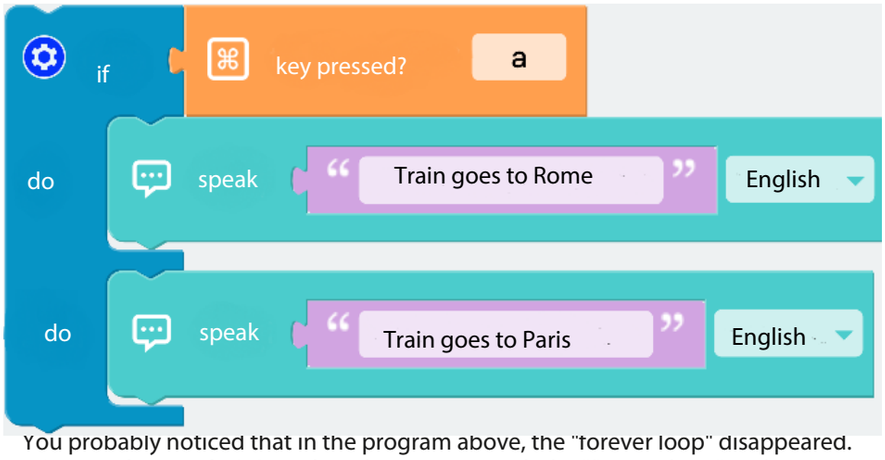
"Mille viae ducunt homines per saecula Romam" – "A thousand roads will always lead people to Rome" refers to the fact that goods and travelers always left and returned on the same 29 access roads.

Rome is called the "city of seven hills" and is one of the few cities in Europe that survived World War II relatively unscathed.

VARIANT 3

Complete the program so that it looks like the one below. See what happens if:

1. You hold down the A key and run the program
2. You do not press any key and run the program



You probably noticed that in the program above, the "forever loop" disappeared. You're wondering why? Complete the program with the "forever loop" and see what happens.

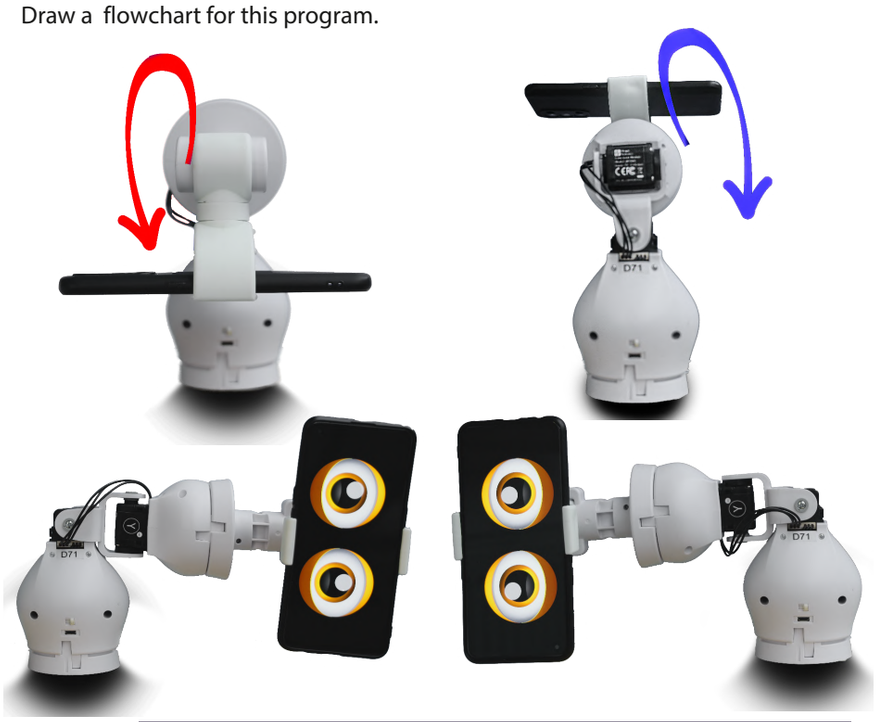
Discuss the obtained results with your colleagues.

ACTIVITY 10 min

Using the Joint module, build a program that performs the following actions:

- when pressing the "up arrow" key: it leans forward
- when pressing the "down arrow" key: it leans back (towards you)
- when pressing the "left arrow" key: it leans to the left
- when pressing the "right arrow" key: it leans to the right

Draw a flowchart for this program.



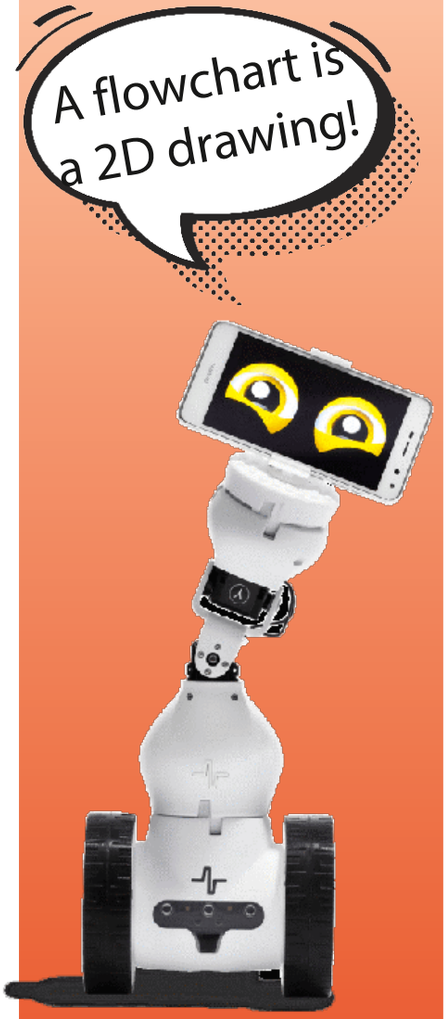
CONCLUSIONS ORGANIZATION

Starting a task by drawing is normal for a programmer or product designer. Many jobs require planning actions in the form of flowcharts. A flowchart also helps you a lot in identifying errors in the operational flow.

Try to make a flowchart for the things you are planning to do during the weekend.

REMEMBER!

Flowcharts are used for software development but also for creating workflows. Such a scheme details a way of approaching a problem, being also an analysis tool. In a flowchart there must be at least one path that starts from START and ends at STOP. What would happen if it wasn't like this?



Sensors and Earthquakes - 3-Step Lesson

LEVEL: **BEGINNER** **INTERMEDIATE** **AVANCED**

FIELD ROBOTICS and PROGRAMMING
ELECTRONICS/SOCIAL RESPONSIBILITY

LEARNING OBJECTIVES

- Define the notion of sensor
- Construction of a motion sensor
- Program the color sensor in the Spin module

STEP 1 REVIEW

A robot vacuum cleaner turns on by itself and begins to work. It will continuously walk and vacuum. When it encounters an obstacle, it goes around it and continues moving, and if it detects a step, it immediately rotates 180° and continues moving. Draw a flowchart for this vacuum cleaner.

ACTIVITY

5 min

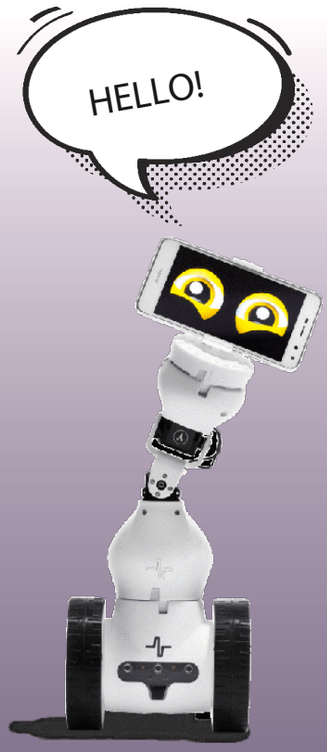
Using the materials shown in the pictures, assemble a device as in the example below. Set the device aside, you'll come back to it later to complete the activity.




STEP 2 ABOUT EARTHQUAKES

An earthquake is a strong and sudden movement of the Earth's crust. This movement can be vertical, horizontal or torsional (twisting) of the Earth's crust.

The severity of an earthquake is measured by the damage it causes and the manner and force with which it occurs. There are several scales for measuring seismic intensity, but the most used in Europe and the US are the Mercalli scale and the Richter scale. The Mercalli model measures the damage produced, while the Richter scale measures the amplitude of ground motion.



Mercalli Scale	
I	Not felt
II	Weak
III	Felt
IV	Light
V	Moderate
VI	Strong
VII	Very strong
VIII	Severe
IX	Violent
X	Intense
XI	Extreme
XII	Catastrophic

Richter Scale
I 2 to 3 degrees
II 3 to 4 degrees
III 4 degrees
IV 4 to 5 degrees
V 5 to 6 degrees
VI 6 degrees
VII 6 to 7 degrees
VIII 7 degrees
IX 7 to 8 degrees
X 8 degrees
XI 8 to 9 degrees
XII greater than 9 degrees

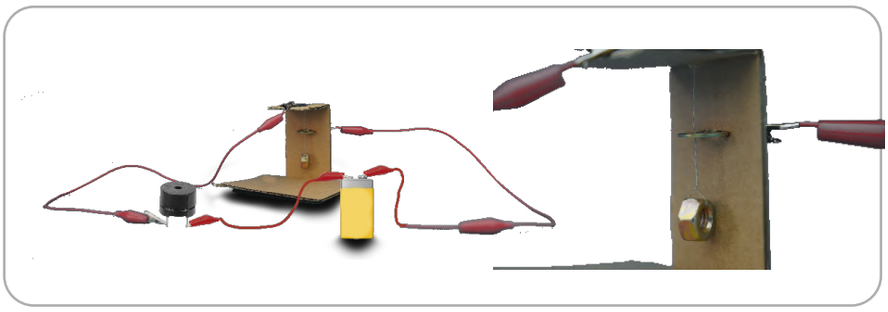
ACTIVITY 10 min

SEISMOGRAPH

According to the dictionary, a seismograph is a device that graphically records, automatically, the moment, duration and intensity of seismic movements. This way, you can analyze how an earthquake unfolded.

Complete the project started in the first part of the lesson with some new elements, as shown in the example below.



Start the circuit and move the whole assembly. Notice that every time the thread touches the nut, the buzzer makes a noise.

Where do you think you can use this motion detection system?

STEP 3 SENSORS

A sensor is a device that takes in information from the environment, analyzes it, and then performs an action. For example, a smoke sensor detects smoke to then trigger a fire alarm. A gas sensor detects a leak and cuts off the gas supply. Come up with other examples of what other sensors you know, how they are triggered and what actions they produce.

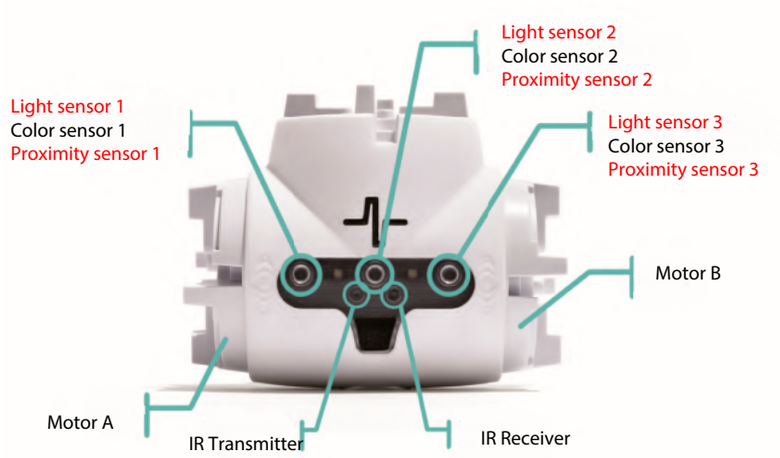
ACTIVITY 15 min

COLOR SENSOR

This type of sensor detects a color using light. The sensor sends light to an object, and by analyzing the returning ray, the ray rejected by the object, the sensor can detect what color it is. The color sensor is extremely useful in the sorting process. For example, we can sort ripe tomatoes that are ready for consumption.

Come up with some examples too. In what situations can such sensors be useful?

Placement of sensors on the Spin module



REMEMBER!

For more information about earthquakes, visit the link: https://nutremurlacutremur.ro/campanie.htm

REMEMBER!

MAN-MADE SENSORS

automatic braking

NATURAL SENSORS

orca on the hunt

REMEMBER

The color sensors on the Spin module are RGB sensors and can detect a color at a maximum distance of 3 cm. For better detection, the Spin module will turn on its white light.

DID YOU KNOW?

For more information about earthquakes, and to see the latest earthquakes in the world, you can go to https://earthquake.usgs.gov/

ACTIVITY 10 min

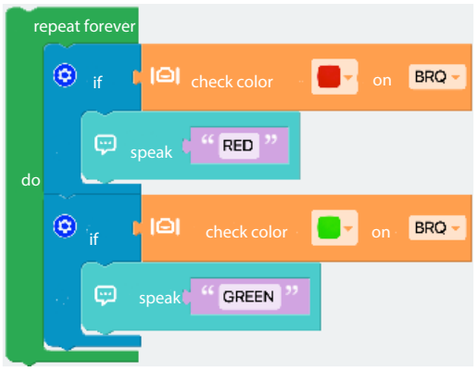
COLOR DETECTION

Take a white sheet of paper and two markers, one red and one green. Cut out two rectangles and color small parts of them. Here is an example:

The Spin module has three color sensors, placed below the logo. Open the Fable application and write the following program.

Next, place the colored sheets one by one in front of a color sensor and run the program. Keep in mind that you are using a sound command, so the computer volume needs to be turned up to be able to hear it.

Can you rewrite the program so that the color detection is done every 3 seconds and therefore not continuous?



ACTIVITY 10 min

ERRORS

Take a sheet of paper and color a few clearly defined areas, to then detect them with the Spin module. With the help of plasticine, hold the colored sheet so that it stands straight like a wall. Now program the Spin module to come towards your wall and announce what color it encountered. Notice what types of errors can occur depending on the color you use. You can use, for example, several shades of a color, one at a time. Why do you think errors can occur in such situations? How could they be avoided or solved?

EXTRA ACTIVITY

Program the Spin module to:

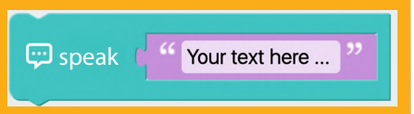
- always move forward
- turn 180° if it detects red color
- turns right 90° if it detects green color

Suggest other ways of using the color sensors on the Spin module.

CONCLUSIONS COLOR

Color detection is used by "line follower" robots to move. They have the color sensors oriented towards the floor and can identify the colored bands on it. Such robots are used in warehouses to move shelves, but also in hotels or hospitals, with the role of information and guide, moving on colored lanes.

NEW BLOCKS!



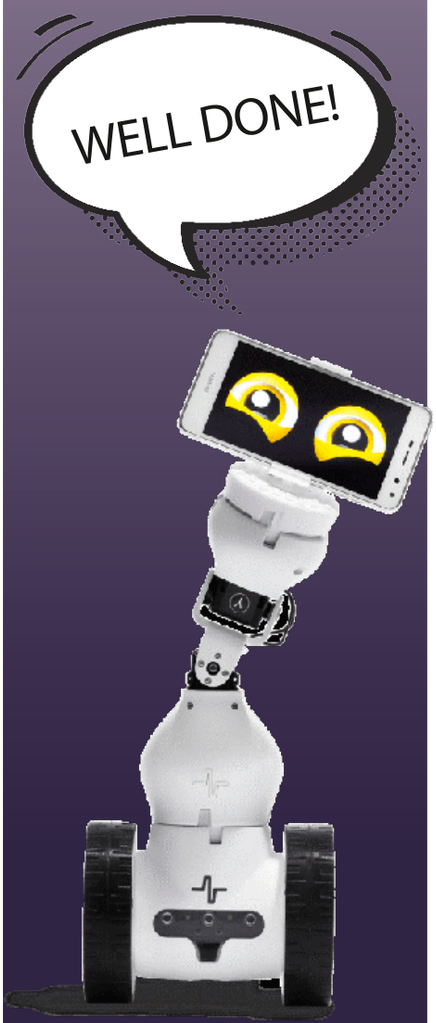
BLOCK - SPEAK

This command consists in the fact that any text written in the "box" will be "read" and implicitly will be heard on the computer.

NEW BLOCKS!

COLOR SENSOR

This command block involves detecting the color of the object in front of it.



Real Life Situations - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
REAL PROBLEMS/MATHEMATICS/GEOGRAPHY

LEARNING OBJECTIVES

- Programming the color sensor on the Spin module.
- Identifying solutions for the problems shown.

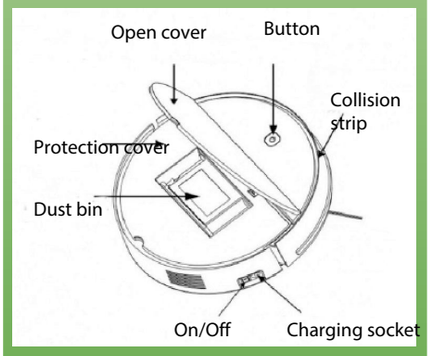
STEP 1 REVIEW

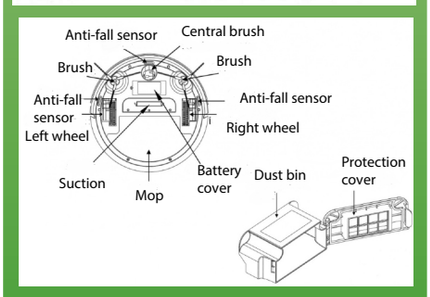
Using colored papers, program the Spin module to detect and pronounce the colors it encounters along the way.

STEP 2 THE VACUUM CLEANER ROBOT

A robot vacuum cleaner is meant to replace the manual vacuum cleaner and the person who uses the latter. The robot vacuum cleaner starts itself, cleans by itself, announces if it encounters errors during operation and can recharge itself. Let's see what are the main components of such equipment:

- The vacuum pump "absorbs" the dirt inside.
- Two wheels required for movement.
- Independent wheels that facilitate the completion of 360° turns. The same role is fulfilled by the wheel attached to the Fable Castor mode.
- Rotating side brushes: they have the role of collecting dirt in the area of the walls.
- Rotating main brush: collects dirt from the central area.
- Mop (optional): its role is to wipe the floor.
- Optical switches: are used to detect frontal obstacles.
- Gyroscope: absolutely necessary for orientation; this allows the on-board computer to track the robot's position at all times.
- The Lidar sensor measures distances to obstacles, by even making a 2D map of the room. This sensor can tell the difference between a wall and a chair.
- Stair detection sensors are IR (infrared) light sensors that measure distances, downward.



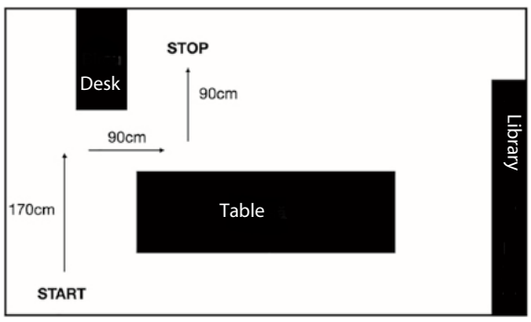


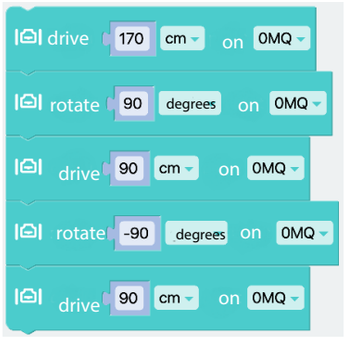
DID YOU KNOW?

The first robot vacuum cleaner was made by Electrolux in 1996 (Trilobite model)

ACTIVITY 10 min

With the help of a pencil and a white sheet, make a 2D map of the room you are in. Imagine that you can see the room from above and place on your map every element that can be an obstacle for a vacuum at floor level. Open the Fable app and write a program to allow a Spin module to move at least 5 meters across the room based on the map you drew. For this, use a roulette to measure the distances between the obstacles. See the example below.

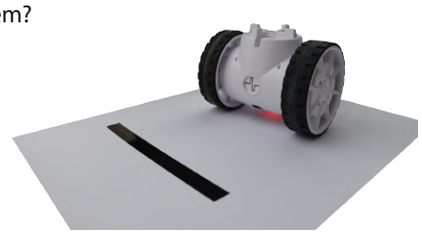




ACTIVITY 10 min

Starting from the example of the robot vacuum cleaner, we know that there are situations where the robot is not allowed to enter a certain area. Using sensors, the robot vacuum cleaner either avoids obstacles or stops. Program the Spin module to move in a straight line, and when it encounters a black line marked on the floor, the robot has to stop.

What challenges did you encounter in accomplishing this task? How did you manage to solve them?

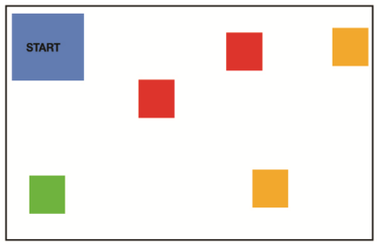


ACTIVITY 10 min

Create a space with four well-defined edges ("walls") using colored tape. Program the Spin module to continuously move in this space, but without leaving the bounded perimeter.

ACTIVITY 15 min

Create a space with four well-defined edges ("walls"). Mark some colored areas inside the bounded perimeter (you can use colored paper squares). Program the Spin module to move continuously inside the delimited space, and upon detecting the colored area the robot has to stop for three seconds and announce the identified color. When you press the spacebar, the robot will search for the place where it started, and when it finds it, it stops.



CONCLUSIONS COLOR DETECTION

Color detection can help you for guidance and moving along a specified path, but also for delimiting a perimeter and making sure that a piece of equipment does not leave a certain area. Such robots can be used in warehouses or in various outdoor motion tests. In a hospital, the "line follower" robots can lead you to a specific medical department. They follow the colored lines, and with the help of proximity sensors they can avoid collisions.

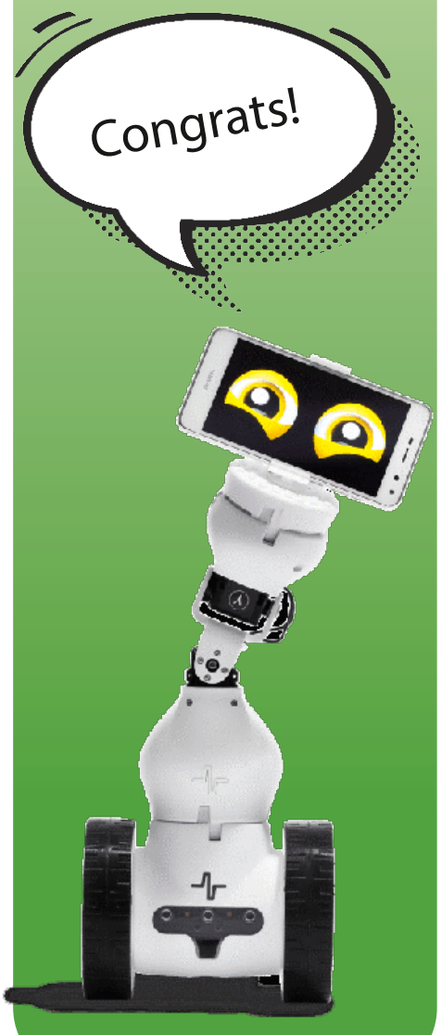
REMEMBER!

PAY ATTENTION TO THE POSITION OF THE SENSORS!

Sensors are oriented forward.

Sensors are oriented downward.

Sensors are oriented downward.



The Sound Sensor - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE AVANCED

FIELD ROBOTICS and PROGRAMMING
ANATOMY

LEARNING OBJECTIVES

- Identifying the functional role of a sound sensor.
- Detecting the noise level with the help of a microphone.

STEP 1 SOUND

Any disturbance (mechanical energy) propagated through a material medium in the form of a wave is called sound. The human ear "feels" air vibrations with frequencies between 20Hz and 20kHz, but there are situations where some people can hear even beyond these values. Vibrations in the air are picked up by the eardrum and then "translated" into electrical signals to be interpreted by the brain.

ACTIVITY 10 min

DOES SOUND REALLY TRAVEL?

To perform this activity, you need cling film, a polystyrene bowl and a paper as light as possible (a napkin, for example).

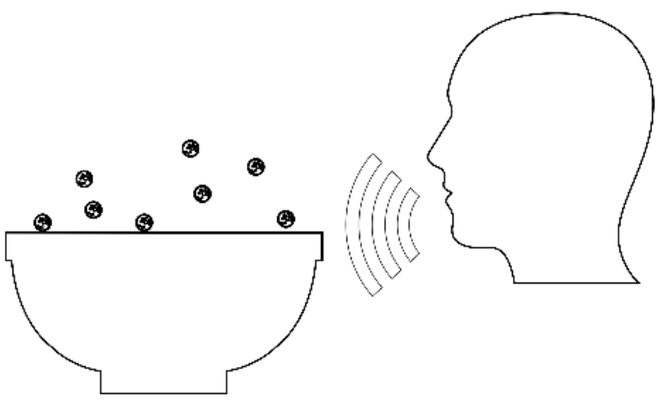
Cover the bowl with cling film without creating creases. Make small paper balls and place them on top of the cling film. Basically, you've just built an "ear" or a "microphone" (both work similarly). Now, with your mouth closed, without blowing air through your nose into the bowl, try to make as loud a "buzz" as possible at the edge of the bowl. You will notice that the balls will start "dancing". In fact, they will jump all over the place because the cling film vibrates due to the sounds you make.

What conclusion can you draw from here?

MATERIALS REQUIRED

CLING FILM OVER A BOWL

PAPERS ON TOP OF THE CLING FILM



INFO

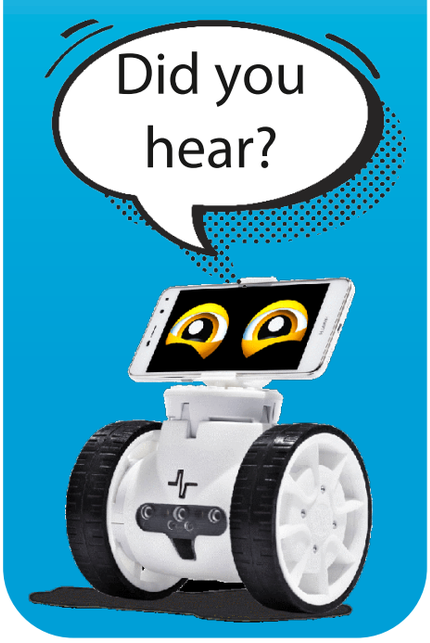
SONAR: underwater telecommunications equipment, containing elements for the emission and reception of sound waves and used for the detection of underwater objects.

ECHOGRAPHY: technique for exploring the living structures of organisms with the help of ultrasound reflection.

REMEMBER!

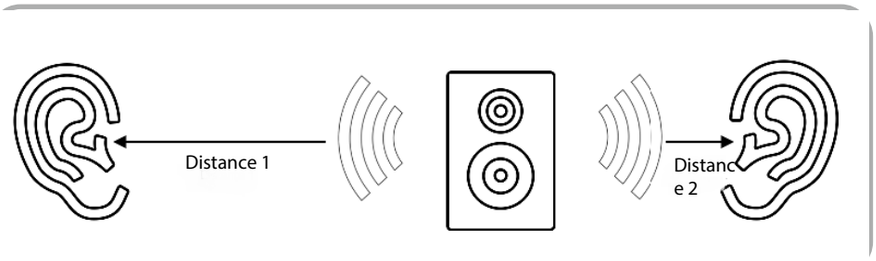
PLAY

Sound detection is used in many situations. For example, the sonars on ships and submarines detect the bottom of the sea or the ocean, but also underwater obstacles. Fishing vessels use sound to detect schools of fish. Ultrasound can "see" inside your body, and that also with the help of sounds.



STEP 2 SOUND DETECTION

Our ears act like a radar that picks up sounds coming from multiple directions. We are even able to localize these sounds, due to the distances and positioning of the sounds to each ear.



ACTIVITY 10 min

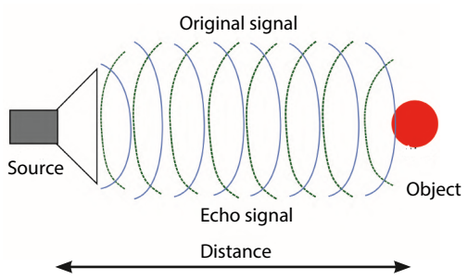
Close your eyes and cover one ear. A colleague claps his hands. Open your eyes and say who did it. Due to the fact that one ear is covered and does not "pick up" the sounds well enough, there will be errors in detecting the source of the noise. What happens when you do the same experiment without covering your ears? How long did it take you to figure out who clapped this time?

STEP 3 SOUND SENSOR

In conclusion, we could say that the ear is a "receiver" of sounds. Humans receive sounds with frequencies between 20Hz and 20 KHz, while dogs can hear up to 50 KHz and dolphins receive sounds with frequencies up to 160 KHz.

Like animals that detect obstacles with the help of sounds, robots do the same with the help of sound sensors. That is, sound is emitted, it travels, finds an obstacle, and returns, just like an echo. By measuring the return times, we figure out how far the obstacle is.

There are several types of sound sensors. Some of them have a very thin sheet, called a membrane, which vibrates when is "hit" by sound waves. As soon as it detects a vibration, the sensor "translates" this movement into electrical signals in order to be able to transmit them to a computer and use them in the program. Such a sensor is actually a microphone.



ACTIVITY 1 min

In the images below, which animals use echolocation?

DID YOU KNOW?

Sound cannot be heard in space, sound cannot travel through a vacuum. There are no molecules there for the sound to make them vibrate.

The speed of sound in air is over 300 m/s. The exact value depends on the outside temperature.

Sound travels four times faster in water than in air.

DID YOU KNOW?

Absolute hearing or perfect hearing is the ability to recognize or reproduce musical notes perfectly, without external influence.
Mozart, Chopin, Bach and Beethoven could compose arrangements for symphonies in their minds and were able to quickly recognize passages that sounded false to the ears.

REMEMBER!

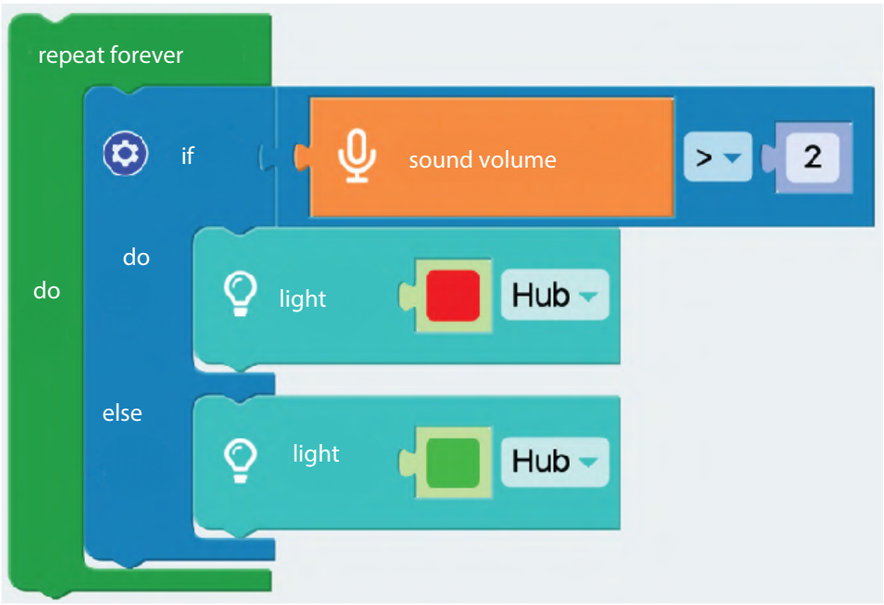
ECHOLOCATION

It is a method by which some organisms orient themselves in the surrounding environment with the help of ultrasounds reflected by obstacles. The word comes from the Greek language: ēchō = echo, sound; + laina locare = to localize.

ACTIVITY 10 min

THE NOISE METER :)

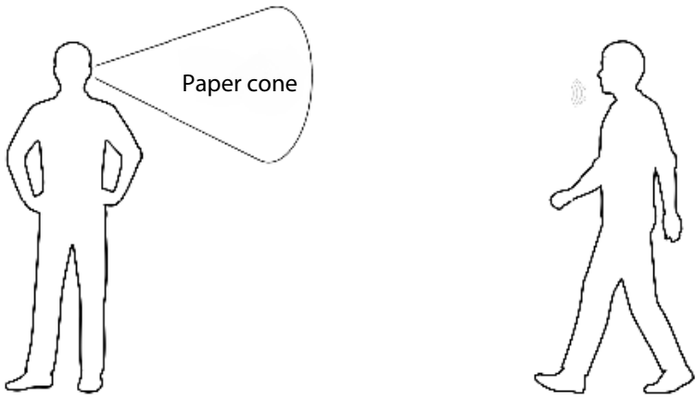
In this activity you will use a sound detection command and a comparison block. Because the sound detection will be done by the microphone, make sure the headset microphone is functional and can be used. Open the Fable Blockly app and write the following program. Run the program and identify how the Hub light changes from green to red and vice versa. Replace the comparison value to test new variants. Where could you use such a "noise meter"?



ACTIVITY 10 min

BIGGER EARS

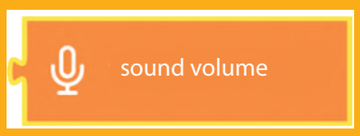
For this activity you need an A3- or A2-sized sheet of paper and scotch tape. Roll the sheet so that you form a cone, but leave a space of about 3cm diameter towards the top. At the other end, open the space as much as you can, then glue the edges so that the cone remains fixed and cannot change its shape. Go outside, in the school yard, put the cone to your ear and notice the differences in sound detection. Now you can also hear weaker and more distant sounds. You can ask a colleague to stand at a distance and clap their hands more and more slowly. Repeat the same without the paper cone. What differences do you notice?



CONCLUSIONS SOUND DETECTION

Sound sensors are found in many pieces of equipment. The car alarm can detect a broken window or a loud noise. That's why sometimes when it thunders you hear car alarms going off. Ultrasonic sensors can measure distances, and medical equipment uses sound to analyze the inside of the human body.

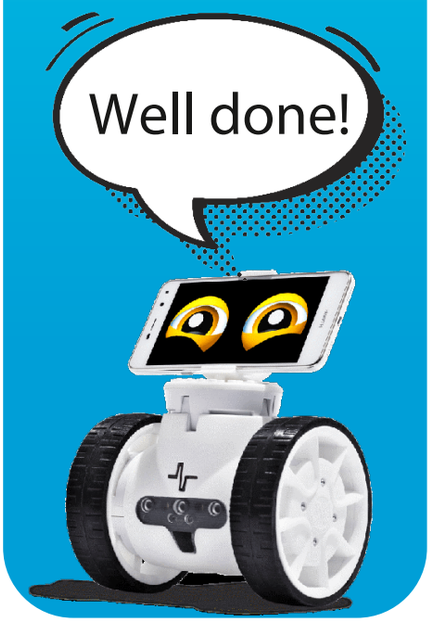
NEW BLOCKS!



This control block "reads" the noise level through the computer's microphone.

This command block allows the comparison of two values, numbers.

The antenna "listens" for signals from space. It has a diameter of 70 meters and is located in Australia.
Photo: nasa.gov



Light Sensor - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE AVANCED

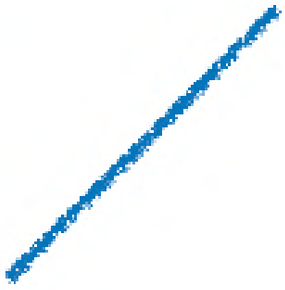
FIELD ROBOTICS and PROGRAMMING
MATHEMATICS

LEARNING OBJECTIVES

- Identify the functional role of an IR sensor (infrared).
- Detect noise level using an IR sensor.

STEP 1 REVIEW

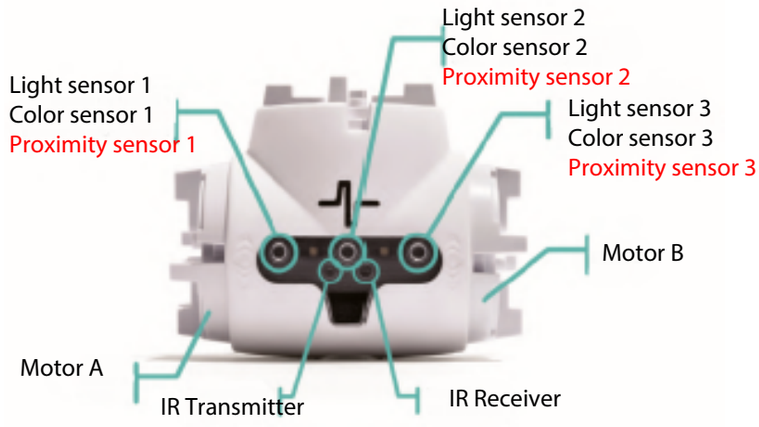
Program the Spin module to continuously move forward on the surface of a flipchart sheet, and upon detecting a blue line drawn on the sheet, the robot has to stop moving and turn on its headlights for 5 seconds.

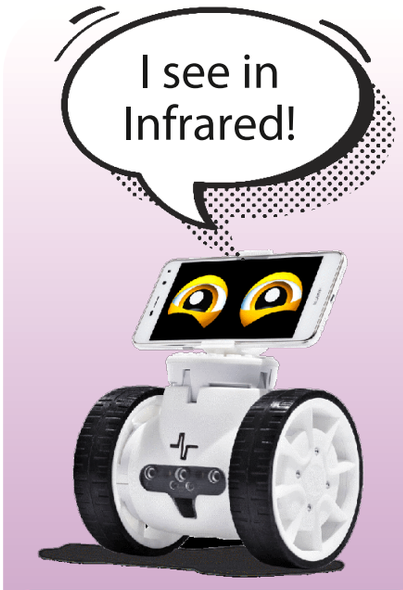


STEP 2 USE OF PROXIMITY SENSORS

Proximity sensors measure the distance to a nearby object without touching it. This distance can be measured using sounds or an infrared light. Regardless of the chosen option, the sensor needs a transmitter and a receiver.

Notice the image below. How many sensors are shown?





REMEMBER

INFRARED LIGHT

Infrared light is beyond the human visible spectrum, with wavelengths between 800-900 nanometers. Humans do not see this light, but perceive it as heat. Humans can see light with wavelengths between 350-780 nanometers. Values are approximate, not exact.

REMEMBER!

PROXIMITY

You say that an object is in your proximity if it is in close contact to you. When you pay with your contactless card (without inserting it into the POS), you need to bring it close to the POS in order to complete the payment. That is, your phone needs to be in the proximity of the POS in order to be detected.

REMEMBER!

POS TERMINAL

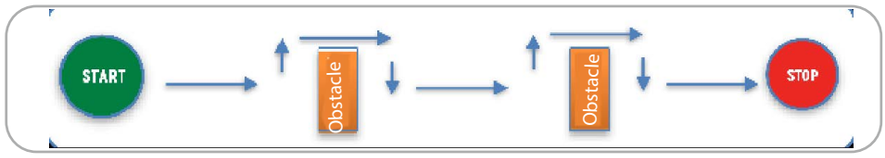
POS: Point Of Sales. It is a device that can receive, process, store and transmit card payment information.

ACTIVITY 10 min

AVOIDING OBSTACLES

Build a path similar to the one in the picture. Arrange various obstacles on the floor (books, cork blocks, bowling pins, etc.)

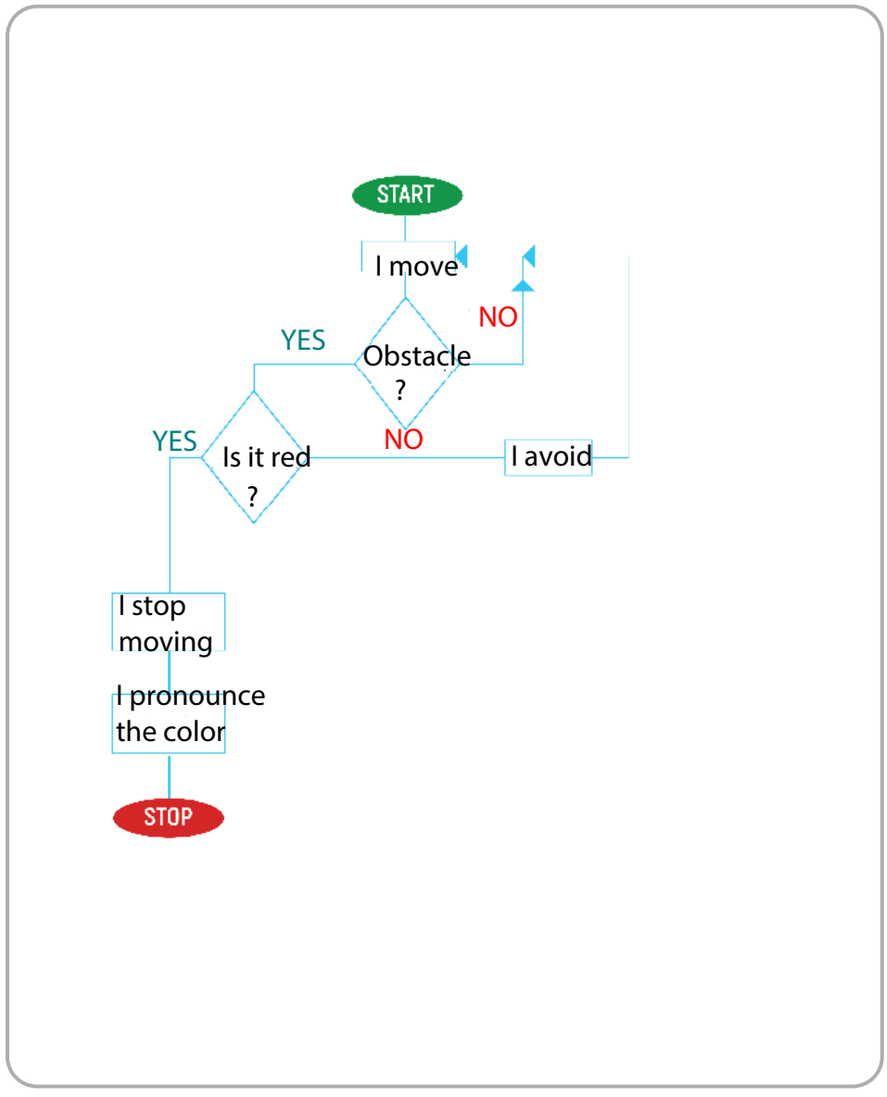
Write a program in FableBlockly that should allow the Spin mode to start moving forward, detect the two obstacles, and avoid them, according to the diagram below. From the Sensors menu, use the "Obstacle in the Proximity" detection command.



ACTIVITY 5 min

DOUBLE DETECTION

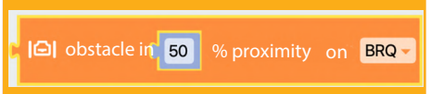
You noticed that the Spin module is able to detect a color, but at the same time it can also detect an obstacle. That means you could make him behave differently depending on what color the obstacle in front of him is. However, for a double detection you need a double condition. Analyze the flowchart and identify what behavior a robot following this algorithm will have.



After analyzing the flowchart, answer the following questions:

- What does the robot do if it does not encounter an obstacle?
- What does the robot do if it encounters a blue obstacle?
- What does the robot do if it encounters a red obstacle?

NEW BLOCKS!



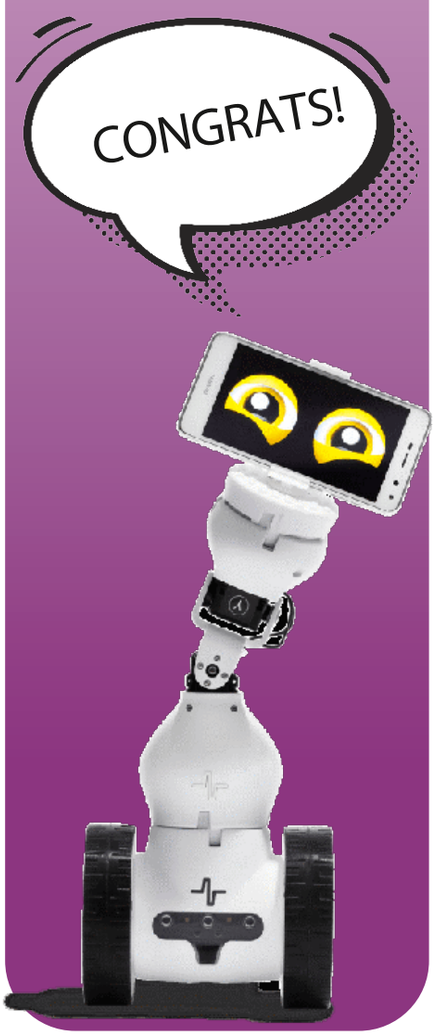
OBSTACLE DETECTION

This block "reads" the distance of an object from the robot using infrared light.

REMEMBER

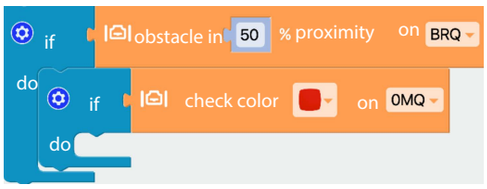
PROXIMITY SENSOR

It measures the distance as a percentage. A smaller percentage means a larger distance, and a larger percentage corresponds to a smaller distance. In this reasoning, you realize that 100% means right next to the sensor, in the closest position.

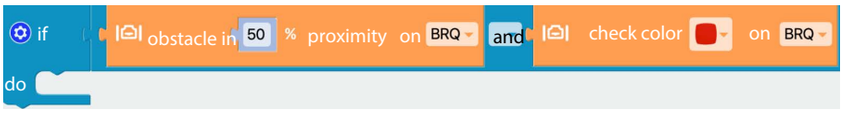


Îln this case it was necessary to use a double condition. For this situation, it can be written in two ways:

VARIANT 1



VARIANT 2



In the second case, a logical "AND" was used. The condition will be true if both detections are true. If one of them is not true, none of the statements inside the "IF" are executed.

You have in the table a breakdown of the effect of a logical AND:

DETECTION 1		DETECTION 2	RESULT
true	**AND**	true	Condition met
true		false	Condition not met
false		true	Condition not met
false		false	Condition not met

ACTIVITY 10 min

Taking into account the information in the table, build and run a program for each individual situation:

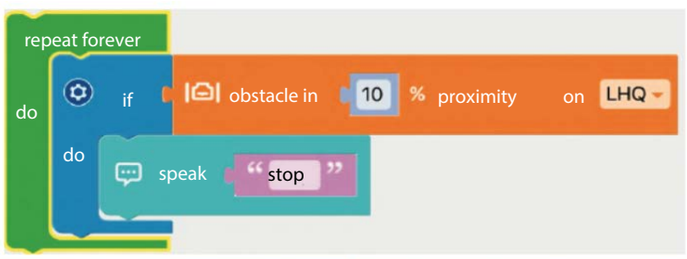
VARIANT 1

The robot stands still. If there is a green obstacle, the Hub lights up in green color.

VARIANT 2

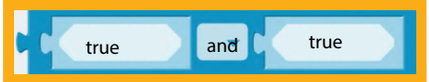
The robot stands still. If the sound from the computer's microphone is greater than 2 and the robot sees the color red, the robot should say "red". Test each program before moving on to the next.

Open the Fable Blokly app and create the following program. Change the detection percentage (by default it is 10%), run the program and write down in the notebook the distance from which the robot performs the object-detection action. Use a ruler to make the measurements.



Percentages	Distance measured in centimeters
10%	
25%	
50%	
75%	
100%	

NEW BLOCKS!



This command block checks if both conditions are met. This is a logical operator.

DID YOU KNOW?

A sensor can connect directly to a computer or a Wi-Fi network.

Sensors can be classified into Active and Passive. Active sensors need an external signal, an energy source, which means they are energy consumers, just like distance measurement sensors (radar). Passive ones directly generate a response, such as light sensors (photoresistor).

TYPES OF SENSORS

In which areas are used the sensors in the list below?

- temperature
- proximity
- infrared
- ultrasonic
- light
- gas
- smoke
- alcohol
- touch
- color
- humidity
- pulse
- inclination
- radioactivity
- pressure
- motion

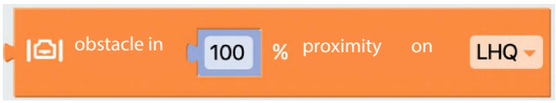
ACTIVITY

10 min

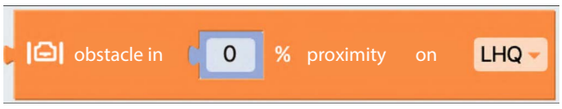
Open the FableBlockly app and write a program to allow the Spin module to move forward to the first obstacle encountered. Obstacle detection will be done using the proximity sensor. Upon detection of the obstacle, the robot will stop, perform a 180° rotation and continue on its way.

Use multiple detection time values by changing the percentage.

What do you notice when you use 100% obstacle detection?
Can you explain why this happens?



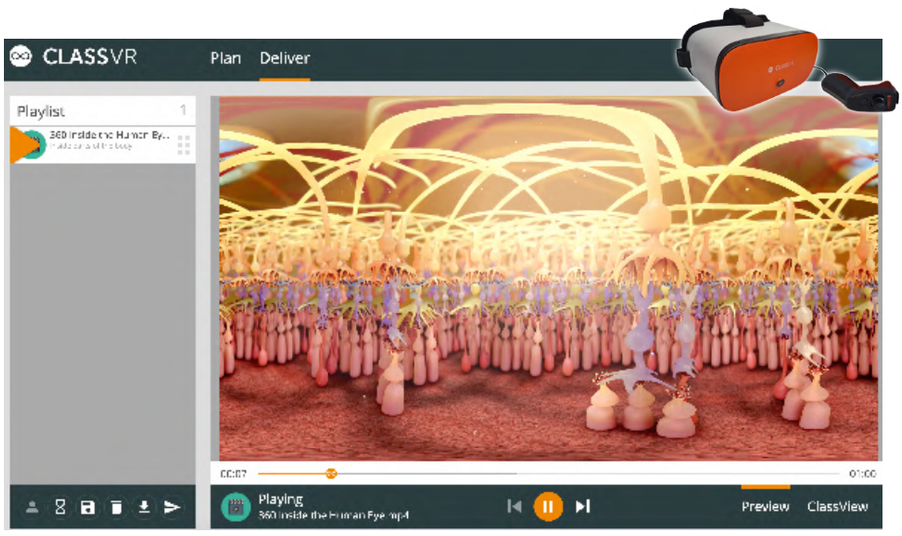
What do you notice when you use 0% obstacle detection? Can you explain why this happens?



VR ACTIVITY

10 min

Open the Class VR app and access the file titled 360 inside the Human Eye. mp4. Notice how light is used so that you can see things in front of you.



CONCLUSIONS

INFRARED

Infrared radiation is used in many situations, not only in calculating distances. For example, with the help of this radiation you can remotely detect the radiation emitted by a body and transform this radiation into an image. This technique is used in medicine, construction, chemical industry and is called thermography. Through thermography, builders can identify areas where a building "loses" heat and can figure out exactly where a building needs additional insulation.

REMEMBER

PROXIMITY DETECTION

This type of detection is used in many electronic systems. The fact that your phone knows when it's "brought to your ear" and turns off its light means that it is using a proximity sensor. Contactless payments are also possible due proximity sensors. The metal detector also works with the help of such sensors. Automatic screen brightness adjustment and "line follower" robots are other examples of equipment that use proximity sensors.

The colors we see in the image are actually "translations" of the wavelength of light. Blue is for 3.4μm, green for 4.6μm, and red for 12μm.

Logical Operators - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE AVANCED

FIELD ROBOTICS and PROGRAMMING
MATHEMATICS/SOCIAL RESPONSIBILITY

LEARNING OBJECTIVES

- Program the sensors on the Spin module.
- Use the AND, OR, NOT logical operators.

STEP 1 REVIEW

Analyze the program above and say what action the robot will perform for each situation.

Detection 1	Detection 2	Robot says
It sees red	A key is pressed	
It sees green	Spacebar is pressed	
It sees red	Spacebar is pressed	
It sees blue	X key is pressed	

STEP 2 ABOUT THE SORTING PROCESS

To sort means to choose, arrange or distribute goods, products or other materials by categories, taking into account certain specific elements (size, color, utility, quality, etc.)

If, for example, you have bricks of the same shape, same material and same weight, but of different colors, you will be able to organize them, sort them according to color.

You have probably heard frequently about garbage sorting. We all know how to separate metal from paper or plastic from glass. The sorting process is followed by the waste recycling process, i.e. processing it so that it can be reused.

Household Waste

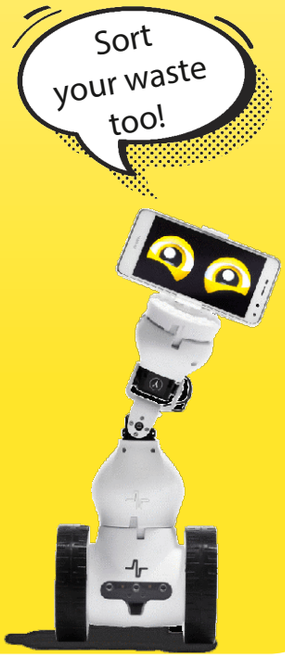
Glass

Plastic and PET

Metal

Paper and cardboard

Color code
for waste sorting bins.



ACTIVITY 10 min (TEAMWORK)

Go through each option below and note the number of students that fit the requirement.

VARIANT 1

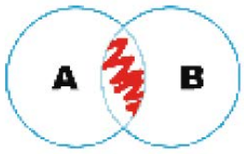
The students who are wearing at least one white or black piece of clothing stand up. How many students stood up?

VARIANT 2

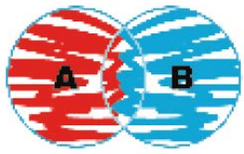
The children who are wearing a white and red article of clothing stand up. How many students stood up?

VARIANT 3

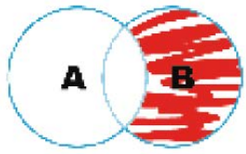
The students who do not have white clothes stand up. How many students stood up?



AND



OR



NOT

In the first figure, the common elements are taken, those that are in both set A and set B.

In the middle figure, elements are taken from either set A or set B.

In the last figure, elements of set B are taken, and no elements from set A.

STEP 3 PROGRAMMING WITH LOGICAL OPERATORS

As you saw in the previous lesson, there are situations when you need more than one condition to be met to make a decision.

Let's consider the following example:

Mihai: - Hello, Andrei! There's a cycling competition this weekend. I have already entered the competition, would you like to go with me?

Andrei: - Sure, please give me more details.

Mihai: - Saturday morning we leave by car for Moara Vlasiei, the place where the final stage of the competition takes place. I hope it doesn't rain, because the organizers said that the event will only take place if two conditions are met: the road through the forest must be dry, and the temperature must be above 15 degrees.

Andrei: - Okay. See you in the morning. I hope the weather is good!

If you were Andrei and drew a flowchart with the information transmitted by Mihai, what would it look like?

You notice that there is a double condition here, the dry road and the temperature above a certain value. Both conditions must be met. In such situations, you need to use logical operators. They allow the construction of expressions starting from the possibility of true/false answers.

In the previous activity you had a visual identification of the three situations. The logical operators are: AND, OR, NOT. In the previous lesson you worked with AND, and now you will see the other two operators at work.

Open the Fable Blockly application and in the Actions menu identify the logical operators. For the NOT operator you need to enter Advanced Mode.

With the help of logical operators, you can make more complex decisions inside your program.

DID YOU KNOW?

WASD

This key combination is very often used by gaming enthusiasts. One explanation for their choice is that they are further away from the right hand, which works on the mouse. Of course, for those who are left-handed, this is no longer as good a choice, these players preferring the IJKL variant. What keys do you use when you play and use the keyboard?

DID YOU KNOW?

Cycling is a sport practiced with bicycles that involves covering a route in the shortest time.

Cycling dates back to the end of the 19th century.

The longest cycling route is 6200 km long and crosses 8 countries.

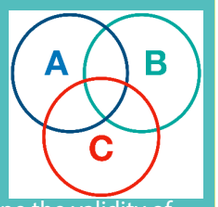
REMEMBER

The set is one of the most important concepts of modern mathematics. A set is a collection of well-defined and distinct objects.

The set of natural numbers is denoted by N

The set of integer numbers is denoted by Z

The set of rational numbers is denoted by Q.



The Ven-Euler diagram is the most widely used form of graphical representation of sets, being able to very easily determine the validity of interferences by graphical representation.
With the help of this diagram you can quickly see the meetings, intersections or complementarities of the sets.

ACTIVITY 10 min

THE DOUBLE CONTROL FOR THE ROBOTIC ARM

VARIANT 1
Program Joint mode actions/movements according to the conditions listed below:

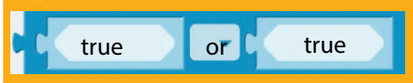
If W and "up arrow" keys are pressed simultaneously, the arm tilts forward.
If S and "down arrow" keys are pressed simultaneously, the arm tilts towards you. If the A and "left arrow" keys are pressed simultaneously, the arm tilts to the left.
If the D and "right arrow" keys are pressed simultaneously, the arm tilts to the right.

VARIANT 2
Program Joint mode actions/movements according to the conditions listed below:
If one of the W or "up arrow" keys is pressed, the arm tilts forward.
If one of the S or "down arrow" keys is pressed, the arm tilts towards you.
If one of the A or "left arrow" keys is pressed, the arm tilts to the left.
If one of the D or "right arrow" keys is pressed, the arm tilts to the right.

VARIANT 3
Program Joint mode actions/movements according to the conditions listed below:

If the "up arrow" key is pressed, the arm tilts forward.
If the "up arrow" key is not pressed, the arm tilts back (towards you). Use the NON command block here

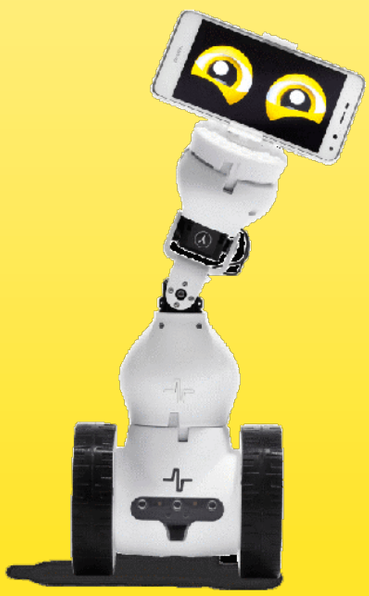
NEW BLOCKS!



This command block checks if at least one of the conditions is met, i.e. its truth value is true. This is a logical operator.

This command block checks if this condition is not met, i.e. its truth value is untrue. This is a logical operator.

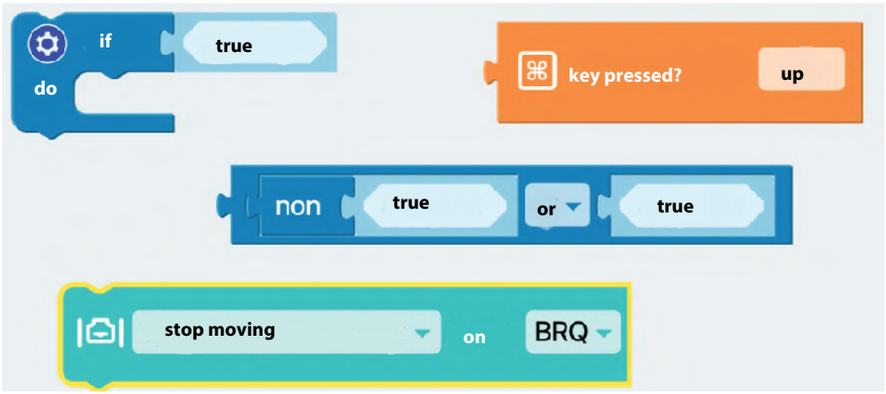
Detection 1		Detection 2	Result
true	OR	true	Condition met
true		false	Condition met
false		true	Condition met
false		false	Condition not met



ACTIVITY 10 min

BETTER CONTROL FOR THE SPIN MODULE

Write a program to be able to control the Spin module from the keys (forward, backward, left, right). Add a new function, which is to stop if no button is pressed. Use the logical operators and blocks suggested in the image below.



CONCLUSIONS MULTIPLE CONDITIONS

Autonomous machines, agricultural drones, have in their operating programs many conditions that they identify and fulfill. Multiple checking is part of the programming technique. It is also part of many systems that check with each other and duplicate in functions. A road tunnel with ventilation, for example, can announce a danger (trigger an alarm) if the sensors detect a slightly increasing amount of carbon monoxide and at the same time detect a malfunction of the ventilation system. In this situation, different alarms can be triggered, for a higher degree of risk.

Solving Problems - 3-Step lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
MATHEMATICS/SOCIAL RESPONSIBILITY

LEARNING OBJECTIVES

- Programming Joint mode using logical operators
- Using color sensors.
- Building a sorter by colour criteria.

STEP 1 REVIEW

Program the Joint robot to meet all the conditions below:

VARIANT 1

- If one of the w or up arrow keys is pressed, the arm tilts forward.
- If one of the s or down arrow keys is pressed, the arm tilts towards you.

VARIANT 2:

- If the up arrow key is pressed, the arm tilts towards you.
- If the up arrow key is not pressed, the arm stands upright. (Use the command block NON).

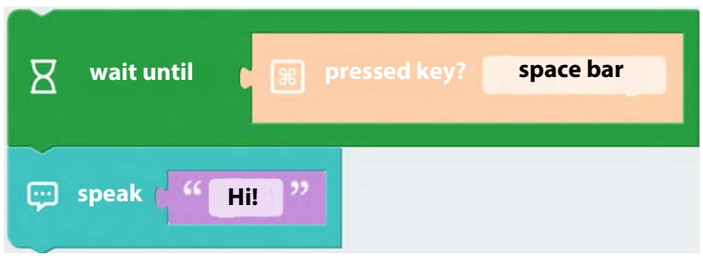
STEP 2 WAIT COMMAND

Sometimes you have to wait until something happens. If a colleague asks you to wait until they've collected all their notebooks to go home together, your activity algorithm has just received a new command: wait until.

In the Fable Blockly app you find this command too, as in any other block-based command. The command puts the code that follows it on hold until the wait condition is met, i.e. the information in the orange area becomes true.

Find this command in the Loops menu. By default you have the space key for detection, but you can choose another key on the keyboard.

Open the Fable Blockly app, write and test the following program:



NEW BLOCKS!

The command puts the code that follows it on hold. It moves to the next command block as soon as the chosen key is pressed. You can choose other keys, not just the space key.

STEP 3 ROBOTS HAVE BOSSES TOO

Sorting by color can be very useful in factories. If a robot paints a part in a light shade of green, it should paint all parts that pass by in the same shade. But even robots can make mistakes, errors that they may or may not report. And to make sure things are right, other robots check the results. For the example above, another robot checks the shade of green, automatically marking which products do not meet the original requirement and which products are sent back for re-painting or an interim stage. Such checks, by color, are found in many places.
Even in factories that make tiles, earthenware, sanitary ware. You wouldn't want to order a white sink and bathtub, and have them come one white and one gray (or maybe only half painted) because of a robot that didn't follow the algorithm. Can you imagine other places where sorting by color, or size, or shape is necessary?

Where can you find automaticsorting	Why sorting is being made?	How is this sorting made?
Egg packing line	To separate them by size	Using sieves with holes of different diameters

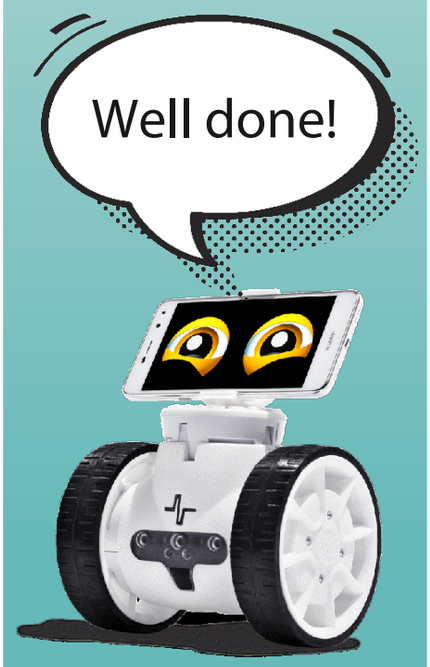
TEAM ACTIVITY 20 min.

SORTING MACHINE

You will have to build a machine that sorts styrofoam balls by color. If they are one color it will push them to the left, and if they are another color it will push them to the right. Here are the materials needed:

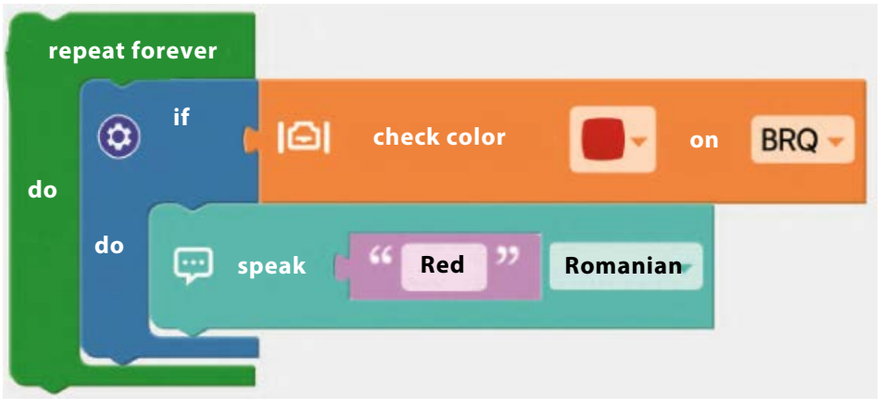
DID YOU KNOW?

Many industries use sorting in their operations. Even seeds are automatically sorted by color. Potatoes can be sorted by thickness. And if you want something even more interesting, there are automatic machines that crack nuts and separate the kernel. One of the methods used for nuts is a simple air jet, which can separate the kernel from the shell after the nut is cracked. But also vibrating screens are used for walnuts, so that the kernel separates from the shell and falls into another container.



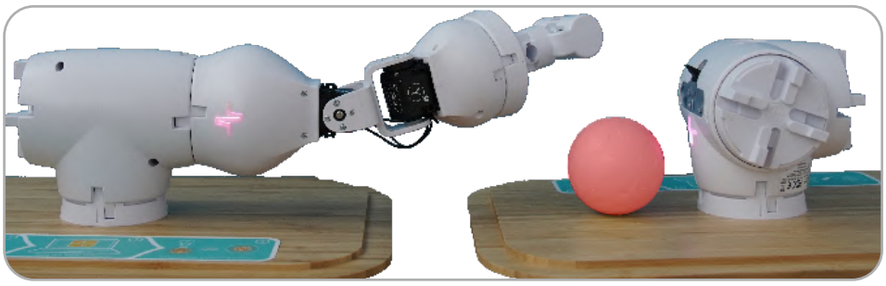
Choose one or two more teammates, because the project is more complex. Together you'll be able to experiment with different building and working ideas.

The first step is to take two styrofoam balls and color them, and then test whether the Spin module can recognize them. Here is the program to help you with this test.



The next step is to build together a machine, using a Spin module and a Joint module, that detects the ball, recognizes what color it is and moves it left or right.

Here's an idea for a build, but this is just one of many that can be built. Look for other functional ideas, you may find one even simpler than this



During programming and testing, try to make a clear distinction between obstacle detection and color detection. Because it is more efficient to read color only when you actually have an obstacle in front of you.

Also use the new command you learned today, wait until.

- How did you find the new work assignment?
- What challenges did your team face?
- How did you solve the problems that arose?
- Exchange impressions with colleagues from other teams.

CONCLUSIONS SORTING

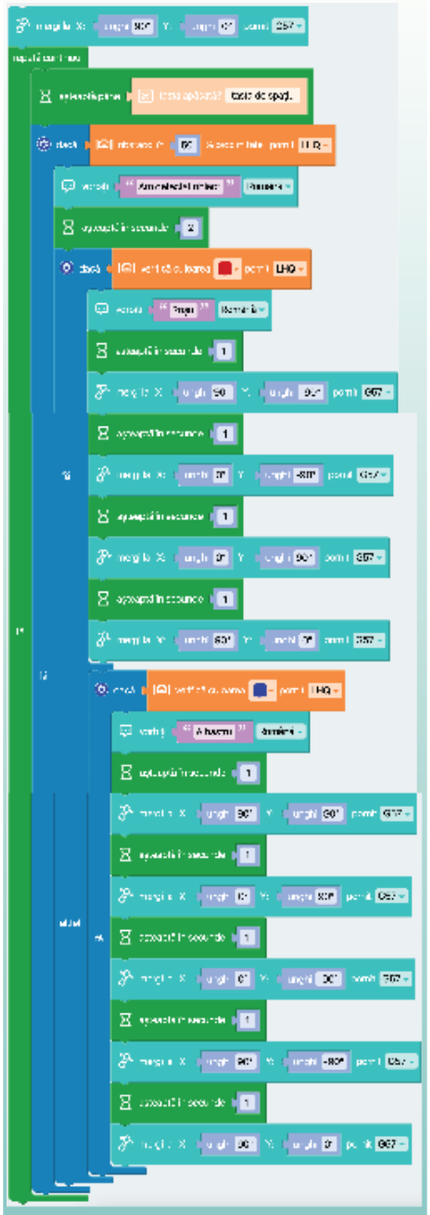
Sorters can be manual or automatic, depending on the mode of operation. In the shop you see apples, potatoes, eggs, sorted by size.

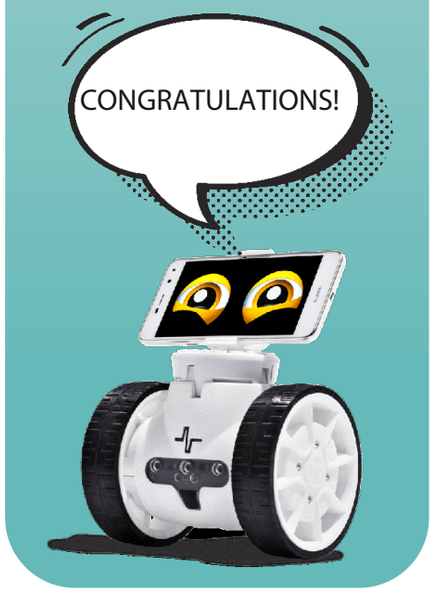
Automatic sorters can even remove products that don't meet manufacturing standards, so that the final products comply.

What other examples of sorting can you come up with?

Here is one way to solve the problem.

Find another way to solve it





Variables - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
MATHEMATICS/ECONOMICS/HISTORY

LEARNING OBJECTIVES

- Creating a variable.
- Setting an initial value for a variable.
- Changing the value of a variable during a program run.

STEP 1 REVIEW

Open the Fable Blockly app and write a program to use the wait until command. Explain why this command is so useful.

ACTIVITY 10 min.

BUILD STORAGE CRATES!

Use a 3D pencil to build a storage crate. Start by building the base of the crate in the shape of a rectangle 5 cm long and 2 cm wide. Pay attention to detail, try to build the side edges, handles, maybe some decorative elements.

Put the crate away, because you will use it later in this lesson. What strategy did you adopt to achieve the strongest possible construction?

STEP 2 SOME THINGS CHANGE ALONG THE WAY

Have you ever thought that a meter never changes its value?
It is always 100 cm or 1,000 mm, i.e. it has a constant value. As an international unit of measurement, the meter has the same value no matter where or how it is used.

As an exercise of imagination, think of a situation where two countries have different lengths for a meter. What problems could arise?

At the same time, you are surrounded by things that change very often or even continuously. For example, the length of a day and night or the length of your fingernails are values that change all the time. In these situations you say you have encountered a variable. That is, something that can change its value over time. Think about other variables around you. What would a world in which these variables become constant, i.e. do not change over time, be like?

STEP 3 HOW DOES A VARIABLE LOOK LIKE?

It has a name, because you need to recognize it and use it. It's of a certain type, because you need to know who you're working with, what kind of values you hold.
A variable is also defined by a value, because it's always changing, changing its value.

REMEMBER!

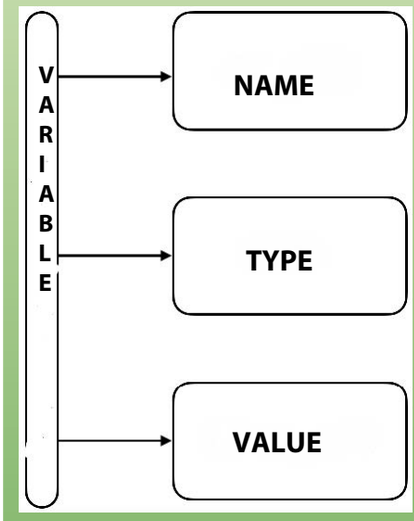
CONSTANT

A constant does not change its value over time. The meter as a unit of measurement in the International System is a constant.

REMEMBER!

VARIABLE

A variable changes its value over time. Some examples of variables: hair length, temperature, height.

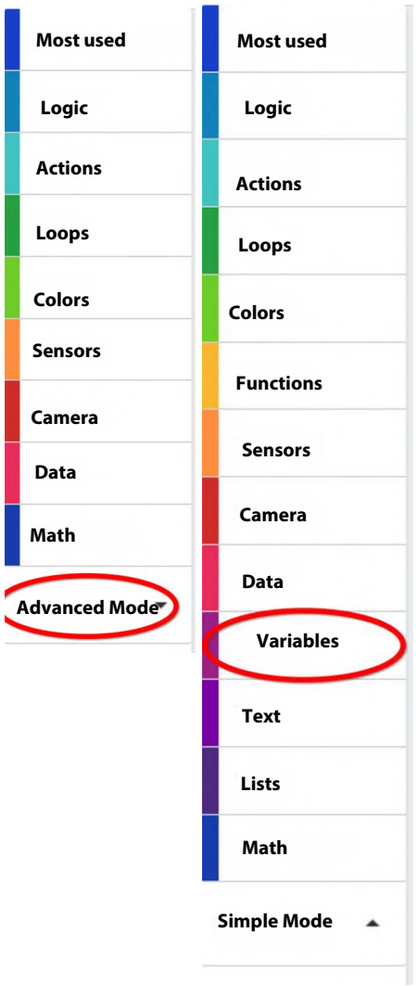


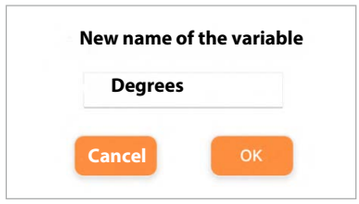
Variables are distinguished by name and can be given different values. Decide what you could store in the newly created crate and label it. At the moment, the default value is zero (nothing stored), but this value can be changed. But how?

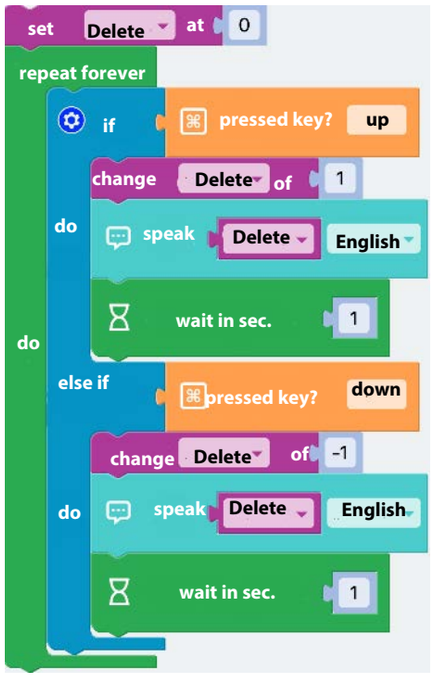
ACTIVITY 10 min.

VARIABLES IN PROGRAMMING

Go to "Advanced Mode" in FableBlockly. Notice in the main menu a new chapter, "Variables". Create and name your own variable.







Let's look at the new commands one by one:

Your variable needs an initial value. How many erasers do you have in you crate at the beginning? You can change the initial values according to your needs.

Each time you put another eraser in the crate, you change the value, the total number of erasers. You do the same when you remove an eraser, with the only difference that then you change it by -1.

DID YOU KNOW?

In ancient Mesopotamia, 10,000 years ago, scribes and salesmen used calculators. The cone, sphere and flat disc were used to represent measurements: small, medium and large. This was how various quantities were calculated.
Photo source: mathigon.org, credits University of Pennsylvania

NEW BLOCKS!

This command sets a numeric value for your variable.

This command adds one unit to the existing value. If the variable has a value of 5, after this command it will have a value of 6. You can also change the value by minus. If you change it to -1, it subtracts one unit from the value of the variable.

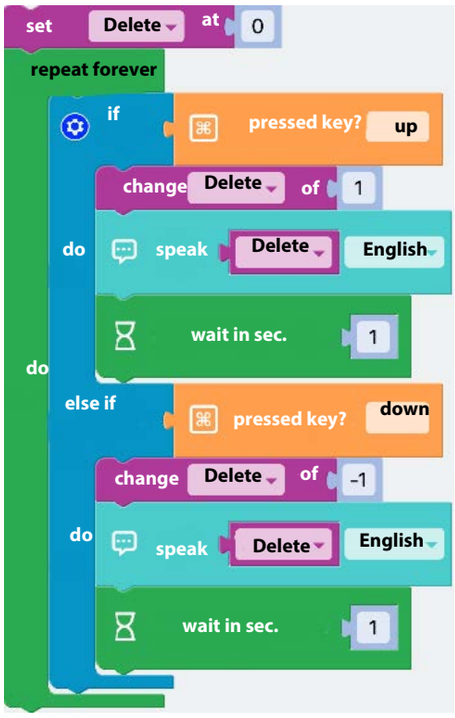
This command uses the value that the variable has at the time of reading in the program.

REMEMBER!

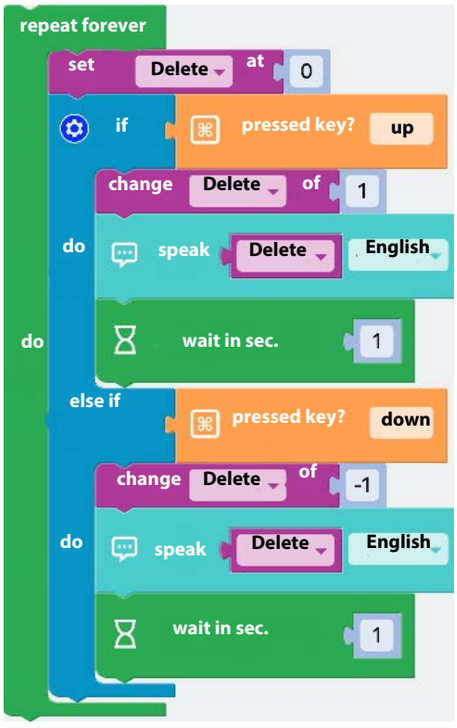
VARIABLE

The concept of variable is found in physics, mathematics, chemistry, computer science. Be careful how you relate to a variable because it is important to analyse all the data in a problem.
The number of leaves on a tree can be a constant for a certain time interval or fixed for the time you are reading this text. But the number of leaves on a tree can also be a variable, if you relate to the whole calendar year. Certainly some leaves, if not all, will fall and so their number will change many times.

Open the Fable Blockly app and build the following program. Test the program and identify the role of the variable and how it changes.



But what do you think happens when the program is written this way? Explain the changes made. Is this new version of the program useful?



ACTIVITY 5 min.

Write a program that counts every time an obstacle appears in front of a Spin module.

CONCLUSIONS VARIABLES

You work with variables every day, so often that you don't even notice it. At the store, at school, on the football or basketball court. Scoring is also a variable, life is a continuous mix of variables.

DID YOU KNOW?

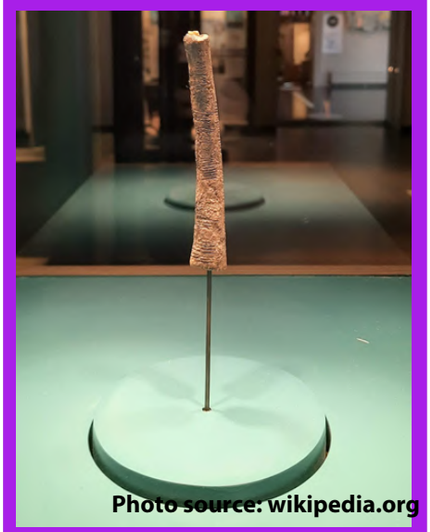
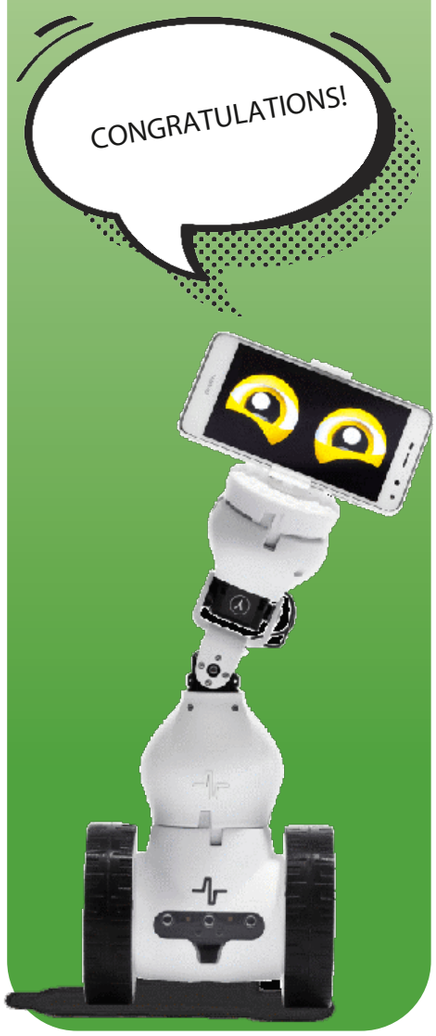


Photo source: wikipedia.org

The Ishango bone is a bone tool and possible mathematical object, dating from the Upper Palaeolithic period. Linear scratches on the bone would seem to have helped with mathematical calculations.
The Ishango bone is on display at the Royal Belgian Institute of Natural Sciences.



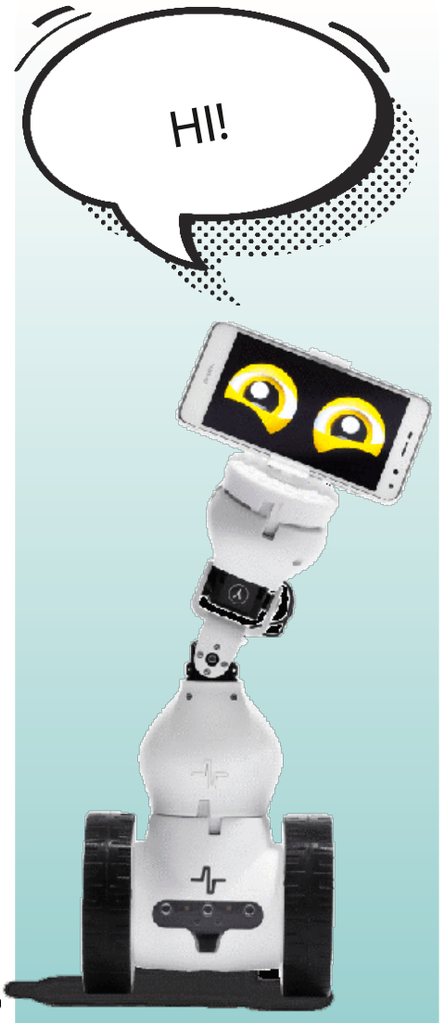
Time, a Variable - 2-Step Lesson

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
MATHEMATICS/ECONOMICS/HISTORY

LEARNING OBJECTIVES

- Deepening the work with variables.
- Creating programs that use variables.
- Identifying errors.



STEP 1 REVIEW

Remember what a variable is. List the variables you discuss every day at school, at the shop, at home.

Now, create a program in FableBlockly that contains a variable with an initial value of 10. When you press the "up arrow" key, the variable will increase by one, and when you press the "down arrow" key, the variable will decrease by one. In what situations could you use such a program?

ACTIVITY 10 min.

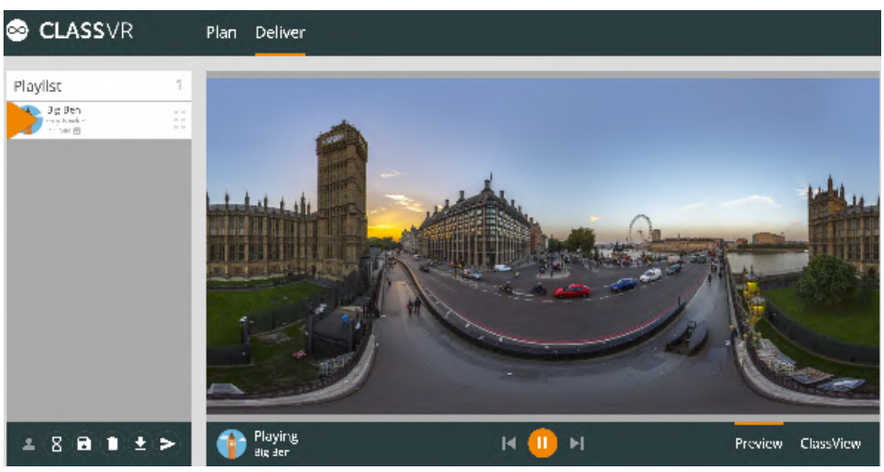
VISITING LONDON...

Open the Class VR app, go to the Subscriptions section and type in the search box: Big Ben. View the content using the VR headset. Big Ben is the world's largest (four-sided) bell clock and the third tallest clock tower in the world. The clock was commissioned on 31 May 1859.

Here are some curiosities about Big Ben:

- Big Ben weighs 13.7 tonnes.
- The hour hand is 2.7 meters long and the minute hand is 4.3 meters long.
- At the base of each face of the tower is the inscription:

DOMINE SALVAM FAC REGINAM NOSTRAM VICTORIAM PRIMAM



Tell us what caught your attention on this VR trip.

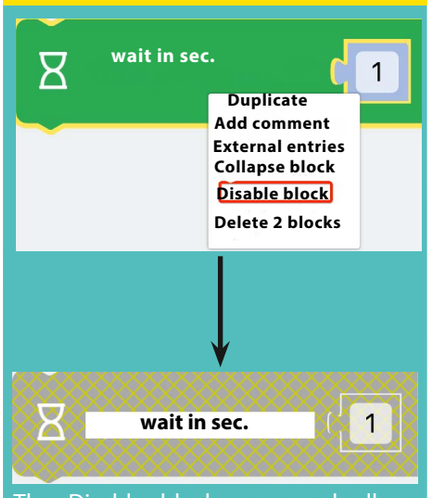
STEP 2 MACHINES COUNT/CALCULATE TOO...

When I say machines, I don't mean cars, I mean machinery, equipment.

The washing machine knows how to count. The microwave even "boasts" this ability - when it counts, it displays seconds on the screen. The electric oven has a timer to turn off the heat or to let you know the cake is ready.

Can you find other equipment that "know how to count"?
What does it take for them to count?

REMEMBER!



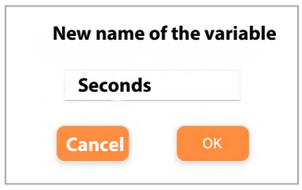
The Disable block command allows you to keep the block on the screen but without it being taken into account when running the program. You can restore it to its original state from the same place with the Allow block command.

ACTIVITY 15 min.

STOPWATCH

According to the dictionary, a stopwatch is "a precision instrument operating on the principle of a clock, allowing time to be measured to fractions of a second". The stopwatch is used to determine the results of sports competitions, for example. In what situations do you use the stopwatch on your phone?

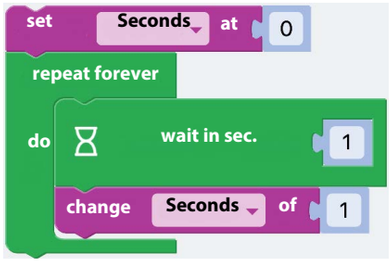
I suggest you use the command blocks in the FableBlockly app to count the seconds. To do this, you will obviously need a variable representing time. The initial value of the variable will be zero, and over time this variable will change.



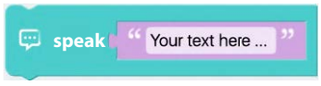
Are you ready to start counting? After an affirmative answer, the following question arises: how do I know a second has passed? The answer is very simple and can be found in the Loops section: "wait a second".

What you're about to do is count down the seconds, just like a stopwatch. So you need a loop to make the seconds go by: wait a second, start again, wait a second, start again...

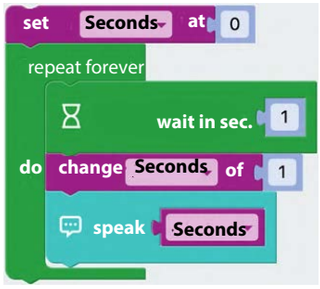
Once you've solved the passing of the seconds, you still have to solve counting them. This is done using the variable you created at the beginning, the variable "Seconds". After each second you will change the value of the variable, i.e. add one second. Here's what the program looks like after this change.



If you run the program you will notice that in this configuration you cannot see or hear how many seconds have passed. To hear them, use the "Speak" sound command

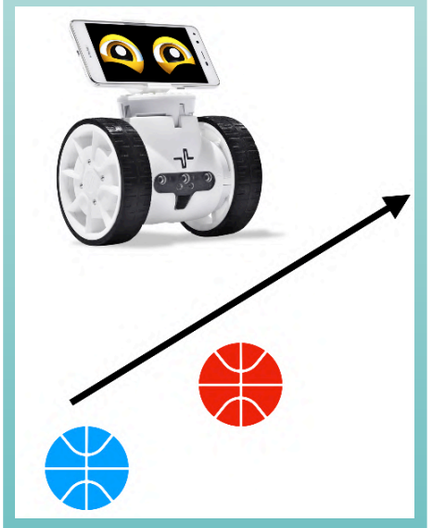


Your program now looks like this. To hear the seconds tick by, you will enter the "Seconds" variable.



DID YOU KNOW?

Originally, the stopwatch was called a chronograph. In Greek "chronos" means time and "graph" means writing. N. Mathieu Rieussec created a stopwatch for King Louis XVIII in 1821, as His Majesty was fond of horse racing. Rieussec's mechanism was the first to become commercially available. The first "medical watch for measuring the pulse" was created by Samuel Watson (1860). It was fitted with a lever, which when pressed stopped the watch.



It programs a Spin module to detect a colored ball passing in front of it and count these passes. Use a red and a blue ball and count them separately.

Start the program and the stopwatch on your phone at the same time. What do you notice? Because of the pronunciation of the second, the program no longer calculates the seconds correctly, because it "loses time" in order to "talk". It moves on to the next command after it has finished "talking", and you can see this very clearly when counting seconds, when longer words are spoken: fifteen, twenty-seven...

Your stopwatch works, the count is consecutive, but you'll still have to deal with the problem of "timing" with the actual seconds. Use the Hub's color change to show the passing seconds. You can light the Hub red for one second and blue for the next. Experiment with other ideas.

ACTIVITY 10 min.

Open the Fable Blockly app and build a program that contains a variable with a larger initial value, for example between 10 and 20. Over time, the value of the variable will decrease by 1 each time the "down arrow" key is pressed. When the variable reaches zero, the program will send an audio message about this.

Make a flowchart for this program.

ACTIVITY 5 min.

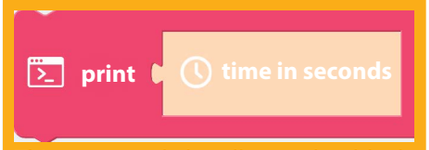
Analyze the following program and identify the result of its execution. What do you think the following program does?

CONCLUSIONS TESTS

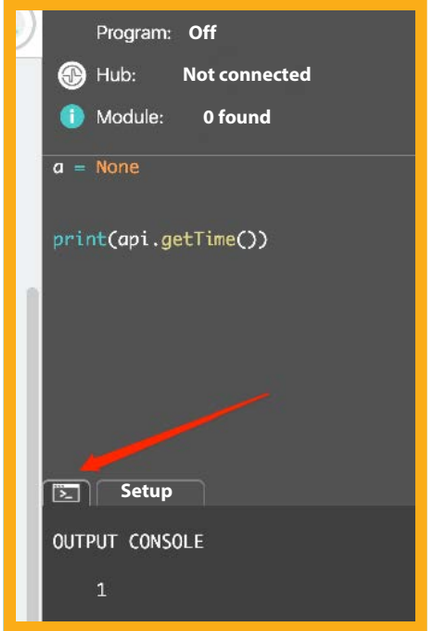
Always check the functionality of the program. As you saw with the first stopwatch, from a programming point of view things seemed to be taken care of. During use, problems arose that you didn't expect, the voice "ate time" and the timer was not accurate. There are several possible fixes, but the most important is to figure out this error that occurred, and the easiest way is to test, test, and test.

Here's a workaround, using the output console in Fable Blockly. In the Data menu, you'll find the Print command.

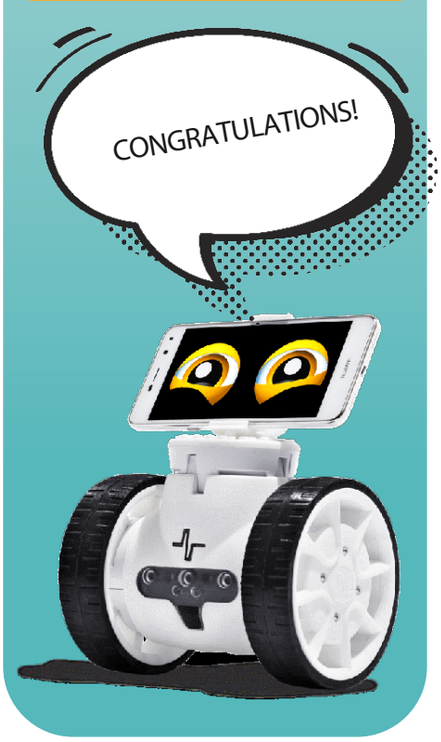
NEW BLOCKS!



This command also allows other blocks to be inserted, such as a variable. Modify the previous program, and instead of hearing seconds, set it to display seconds. You will see the result in the Output Console. Use the new command block for other displays as well.



This command block allows data to be displayed in the output console of the Fable Blockly app.



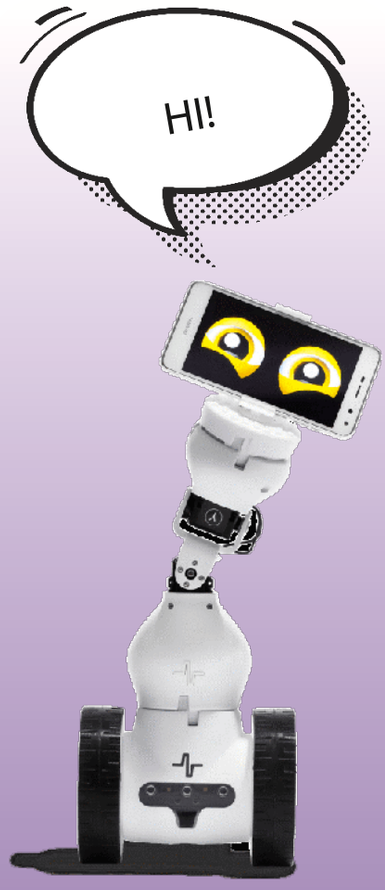
Inspection Robot - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

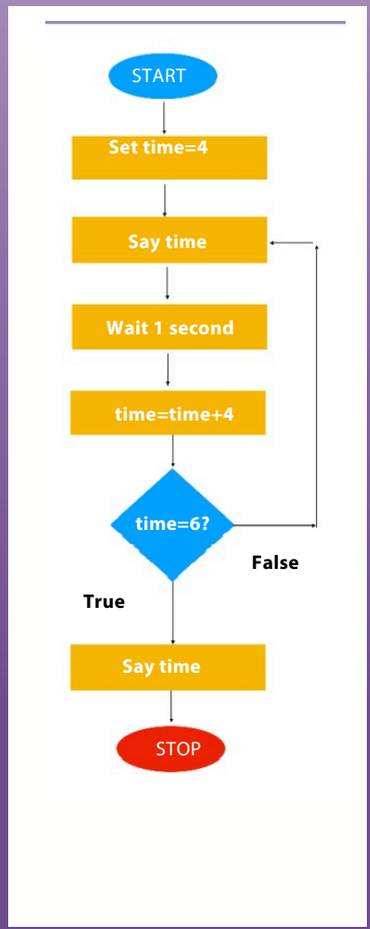
FIELD ROBOTICS and PROGRAMMING
PHYSICS

LEARNING OBJECTIVES

- Building an inspection robot.
- Programming the inspection robot to perform the tasks outlined.



To help you, follow this flowchart too:



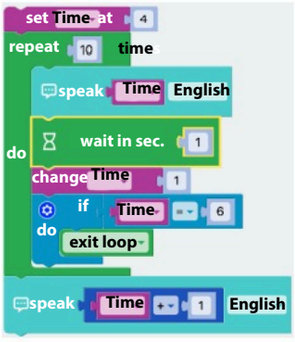
STEP 1 REVIEW

Open the Fable Blockly app and build a program that allows a Spin module to move forward continuously using an infinite loop. When an obstacle occurs, the Spin module will stop moving using the "exit loop" command. Count the obstacles encountered too.

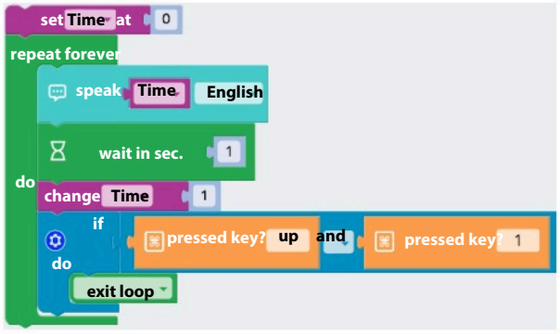
ACTIVITY 5 min.

Describe step by step what the programs below do.

OPTION 1

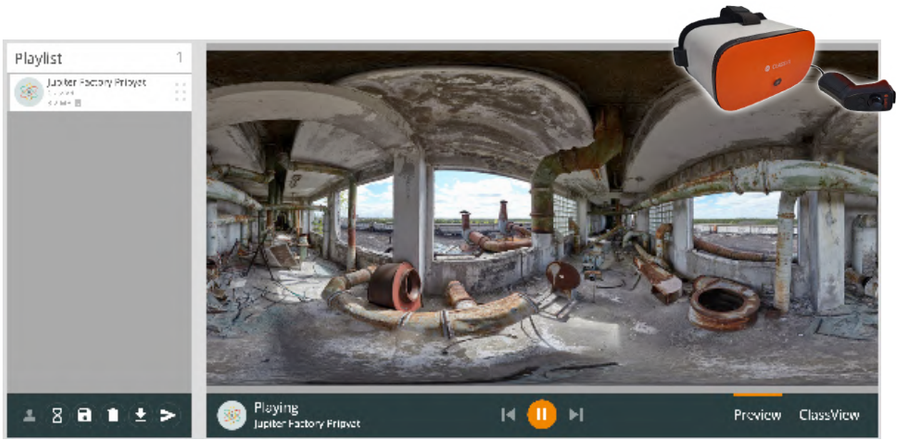


OPTION 2



STEP 2 NUCLEAR ACCIDENTS

Open the Class VR app, go to the Subscriptions section and type in the search box: Radiation. You'll find several materials ready, open the one called Jupiter Factory Prypat. View the content using the VR headset.



The Chernobyl nuclear accident is regarded as the worst accident in the history of nuclear power. According to Wikipedia, the Chernobyl accident "injected 400 times more radioactive material into the earth's atmosphere than the Fukushima accident, several times the amount of radioactive material corresponding to the Hiroshima and Nagasaki bombs". What did you find most interesting about your visit to Prpyat? Do you think people will ever be able to live there again?

ACTIVITY 5 min.

Open the Class VR app, go to the Subscriptions section and type in the search box: nuclear. You will find several materials ready, open the one called Nuclear Power. View the content with the VR headset.

Nuclear power has such a high yield that people thought at first that energy would be produced in huge quantities and be free, and cars and planes would be able to use it. This was around 1940. Building such plants was neither cheap nor easy. The most nuclear reactors in the world were built between 1970 and 1985, with more than 400 in total. In addition to power generation, some countries have also built nuclear bombs.

The risks of working with nuclear power can be very high. Radioactive waste from these plants must be stored in special places for thousands of years so that it does not harm human health or the environment.

STEP 3 INSPECTION ROBOTS

In the event of a nuclear accident, people cannot be sent to contaminated areas, and robots can be used to do this. Inspection robots can check, collect and transmit information, and sometimes even fix the problem. An inspection robot can, for example, figure out if a tap needs to be turned off because it is malfunctioning. And if it is equipped with the necessary accessories, it will even be able to turn off the tap and report that it has executed the command(s).

In what other situations might the use of inspection robots be useful?

What exactly would a robot do in the situation you described?

DID YOU KNOW?

Italian physicist Enrico Fermi's research contributed to the construction of the world's first natural uranium and graphite nuclear reactor (2 December 1942, Chicago)

REMEMBER!

ABOUT THE NUCLEAR POWER PLANT

A nuclear power plant is a very complex facility that produces electricity from heat. Heat energy is produced by nuclear fission reactions inside the nuclear reactor. These reactions are continuously maintained. The heat emitted by a nuclear reactor is then used to turn water from liquid into vapor. In turn, the steam pushes and rotates the blades of a turbine connected to the electricity generator. The fuel used for nuclear reactions is natural uranium.

ABOUT MATTER AND ATOMS

Matter is made up of atoms. Rocks, water, air... everything is made of atoms. These, in turn, combine to form molecules. An atom consists of a nucleus surrounded by electrons. The nucleus is very heavy and the electrons are very light.

Here you can find detailed material about the Cernavoda nuclear power plant in Romania. https://www.nuclearelectrica.ro/cne/wp-content/uploads/sites/2/2022/05/PLAN-DE-URGENTA-Ghid-personal-pentru-locuitorii-din-zona-CNE-Cernavoda-1.pdf

Here you can find more information on radiations: http://www.anpm.ro/ce-sunt-radiatiile

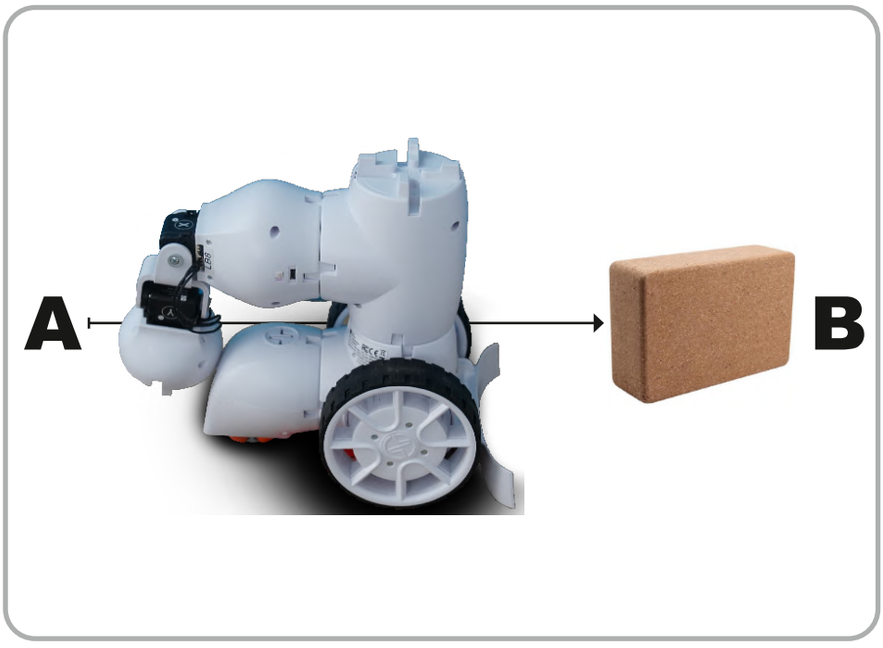
TEAM ACTIVITY 20 min.

BUILD AN INSPECTION ROBOT

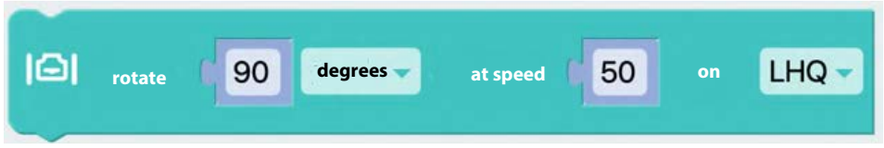
Materials needed per team: flipchart sheet, red crayon, a cork block/light object that can be used as an obstacle, a Spin module, a Joint module, Fable accessories, individually created 3D printer accessories (optional).

What will the robot do?

- The robot moves from point A to point B, following the red line on the flipchart.
- On detecting obstacles on the route, the robot will signal acoustically (voice or sounds) and remove the obstacle. The sound is emitted from the computer, so make sure you have the buzzer turned up a bit so you can hear the sounds.
- The robot will draw the "+" sign where the obstacle was.
- The robot will switch to manual control and the team will bring it back to the start.



Experiment as a team with the effect of the following commands. Which of the blocks would you find useful in programming your own inspector robot?



CONCLUSIONS SPEED

The Spin module allows the two motors to rotate at different speeds. The ability to control each motor brings great advantages. At the same time, keep in mind that the speed must be matched to the load. For example, a very high speed can cause a sensor to miss a color. Why? Things happen too fast.

REMEMBER!

SPIN MODULE

For better control of the wheels attached to the Spin module, use the Advanced Mode in the Fable Blockly menu and try the new commands in the Actions menu.

NEW BLOCKS!

This block allows you to rotate the Spin module by giving you the ability to set the spin angle and speed at which to make this movement.

This block allows you to set a speed for each wheel separately. If the value is positive, the wheel rotates in one direction, and if it is negative, it rotates in the other direction.

Guide Robot - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING ARTS

LEARNING OBJECTIVES

- Creating a robot to act as a guide.
- Programming the robot to recognize places and play audio material.

STEP 1 REVIEW

Open the FableBlockly app and write a program that consists of playing a musical note every time the "a" key is pressed. The possible number of presses is five, and if this number has been "exhausted", the robot will play an audio message. Play the program and explain in what real-life situations it would be useful.

As the sounds are computer-assisted, make sure the volume is turned up and you can hear what the program will run. Use the Music Notes command in the Actions menu.

STEP 2 GUIDE PROFESSION

According to the dictionary, a guide is "a person who accompanies a group of tourists or visitors, giving them the necessary explanations".

According to the Government Decision 305 of 2001 in Romania, a tourist guide, for the purposes of this Decision, is a person who leads and guides a group of tourists or visitors, giving the necessary explanations about the places visited, and who ensures that the contracted tourist program is carried out in the best possible conditions.

The document can be studied here: https://legislatie.just.ro/Public/DetaliiDocument/27394.

The categories of guides used in tourism activity in Romania are:

a) local guide, providing tourist assistance on a limited territory;

b) national guide, providing tourist assistance on the national territory and abroad;

c) specialised guide for certain segments of tourist services.

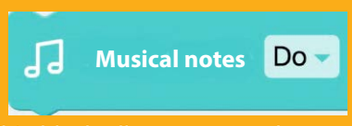
ACTIVITY

5 min.

Open the FableBlockly app and select the Advanced Commands work mode. Practice the "speak" command using texts in multiple languages.

Here are some examples:

NEW BLOCKS!



This block allows you to play a note from the musical scale. The sound is played by the computer.

DID YOU KNOW?

Source: Wikipedia

Guido d'Arezzo is the inventor of the modern musical notation system.

TEAM ACTIVITY 30 min.

ASSIGNMENTS OF A GUIDE

The task of today's lesson is to build and program a Guide Robot. It should be able to introduce students from another school visiting your school the advantages of studying in your school, accompany them on a short excursion along a particular route, convey various emotions to the new students... to perform the duties of an informed and friendly guide.

Form three teams to create your school's Guide Robot. First, I suggest you spend a few minutes making a plan. Here are some helpful questions

1. What does a student feel when he arrives at a new school?
2. What does a student look for when looking for a new school?
3. What information would you present to your potential colleague?

Write down the answers to these questions. You will need them throughout the making and programming of the robot;

The next step is to determine the tools and tasks to be carried out by each team:

TEAM 1
3D PEN

- Using the 3D pen make small representative constructions for your school.

The Guide Robot will give the "constructions" as a gift to the new students.

TEAM 2
FABLE ROBOTS

- Build a robot that can be controlled from the keys. It will drive new students to several classes in the school.
- At each point of interest, at the press of a key, the robot will talk about that place.

TEAM 3
ART &CRAFT

- Using cardboard, textiles, markers, sequins... create the outfit of the Guide Robot.

Next, each team starts building its own project. To make the project more complex, you can make the robot recognize certain colors and start a narrative for each color. For example, when it "sees" blue, tell a story about the school library.

STEP 3 GUIDE ROBOTS

Robots have also been used in the hotel, café and restaurant industry for many years. Their functions include acting as an Information Point, giving information and even holding short conversations in several languages. They then specialize in specific tasks. Some robots can drive you to your hotel room after you've checked in, while others can even carry your luggage. In a restaurant, you can be waited on by a robot. The tasks are diverse and are growing in complexity. Don't expect all robot guides to look like a human. Depending on the role it has to perform, each robot has its own construction, optimal for the task

If you were to build a robot to work in a school cafeteria, what would you want it to look like and what tasks would be interesting for it to perform? Write these things down in your notebook and draw a model of your robot.

Use the 3D pencil to draw the shape of your robot!

CONCLUSIONS INFORMATION POINT

Info Points were widespread in the 1990s. They acted as a guide, providing information visually and sometimes in an audio-visual way. Now they have lost their usefulness as phones and apps have taken over the role of guide.

This robot is used in the hotel industry and in shopping malls. It is produced by the Keenon company in Shanghai.

Pepper is a robot produced by the Tokyo company Soft-Bank Robotics Corp. The robot can be used in many industries and is also suitable for the role of a guide in the hotel industry.

DID YOU KNOW?

The word "hospitality" appeared before the use of the word tourism. Hospitality comes from the Latin "hospes", which includes the words guest, host and stranger. And the word tourism in Romanian comes from French (tourisme) and Italian (turismo).

DID YOU KNOW?

The world's oldest travel agency was founded by Briton Thomas Cook in Leicestershire in 1841, and his first organized trips were by train, persuading the Midland Counties Railway Company to use trains for tourist purposes.

Guide Robot, Part II - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
ROAD SAFETY EDUCATION

LEARNING OBJECTIVES

- Designing a humanoid robot to perform a range of functions:
- Talks
- Moves
- Expresses emotions

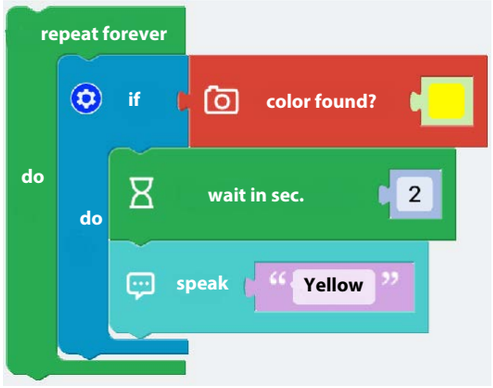
STEP 1 USING THE WEBCAM

In the main menu of the FableBlockly app you will find the "Camera" section. This category contains several commands, and all of them use the webcam present on your computer: "take photo, color found, motion detected, video menu". For the "show image" command, go to the Advanced menu mode.

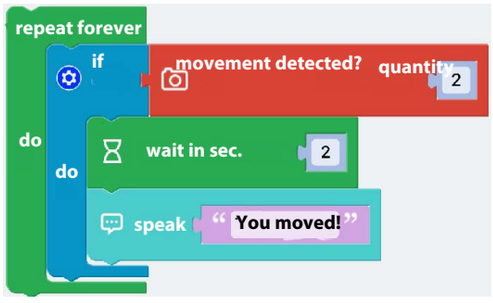
ACTIVITY 10 min.

Observe the program sequences and explain what the program will do in each case. Enter and render each program in FableBlockly. Can you complete the list with new explanations after you have seen each program "in action"?

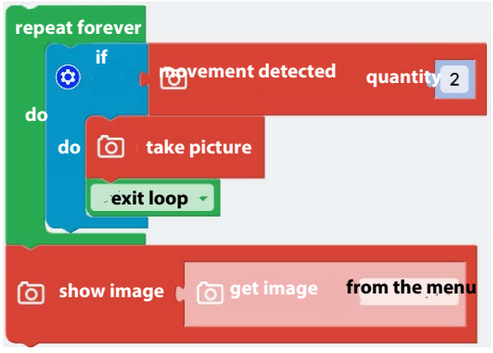
VARIANT 1 1



VARIANT 2

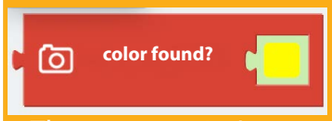


VARIANT 3



NEW BLOCKS!

This command consists of taking photos with the webcam installed on your computer.



The computer's webcam identifies certain colors in images.

The webcam on the computer detects movement and helps determine the degree of sensitivity.

The command will display the image that the webcam on your computer captures using various filters.

This command will display the captured image on the Fable Blockly application screen. Find this block in the main menu, Advanced Mode.

STEP 2 HUMANOID ROBOT

ACTIVITY 10 min.

A robot can come in many shapes and sizes. Many industrial robots are shaped like an arm. Why? Because their creators aimed to create a tool that would perform the functions of a human arm (gripping, pushing, holding, selecting...) only much stronger and more reliable. So a factory robotic arm can handle a paint gun or a welding machine. A robotic arm can even tighten a screw to close a housing. A robotic arm can handle very heavy objects or even tiny things. Find other uses for a robot arm.

Human-looking robots are called humanoids.

ACTIVITY 25 min.

JOBS FOR HUMANOID ROBOTS

Build the humanoid version of the Fable robot. You can use various tools in the Art&Craft area to create an outfit for the humanoid robot that, for example, works as a front-office in a hotel.

So what is this humanoid robot supposed to do?

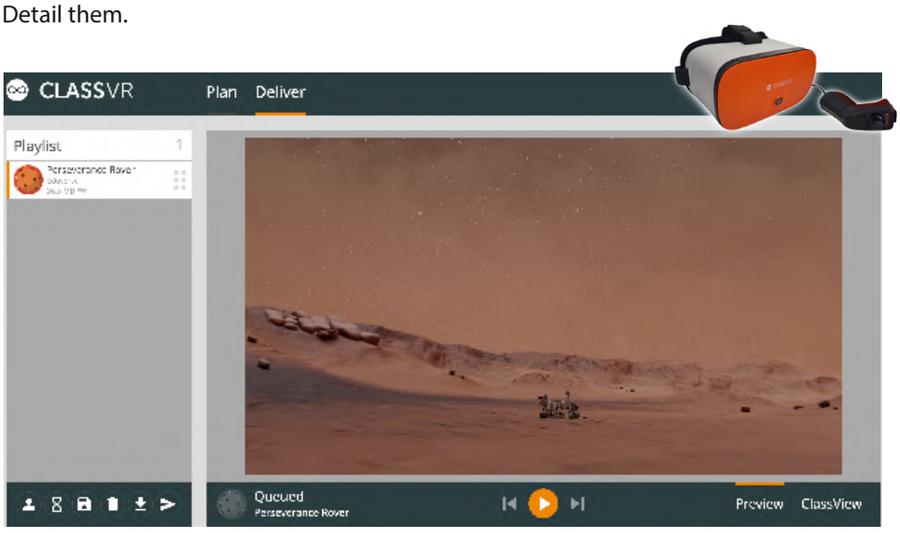
- use non-verbal and verbal language to greet customers
- move forward to guide them to the restaurant
- convey more emotions during the conversation
- go back to the reception to give customers a flyer with a map and other tourist information.

Create and run the program in FableBlockly. What challenges have you encountered? What solutions did you find? What other jobs could humanoid robots "own"?

ACTIVITY 5 min.

Open the Class VR app, go to the Subscriptions section and type in the search box: Rover. You will find several materials ready, open the one called Perseverance Rover. View the content using the VR headset.

Have you noticed how this Rover is built? If you were designing a robotic arm for your next Mars mission, what other actions would you want it to be able to perform? Detail them.



CONCLUSIONS ROBOTS HELP

Robots come in many shapes and sizes. Have you ever wondered if a humanoid robot would be more easily "accepted" for household chores, instead of a robot with a totally different shape? Would a humanoid robot be more limited in function or the opposite? Could it take over some of your tasks?

How do you think it would be better?

REMEMBER!

ROBOTIC ARM

The Perseverance Mars rover has a robotic arm. With this arm he can use tools like a human. It can bend, tilt or extend to use tools. The tasks can be many, for example he can use a microscope to analyze the composition of rocks and soil, or abrasive equipment to grind rock to expose new layers. The arm is 90 cm long and has three joints, just like a human. It has five motors.

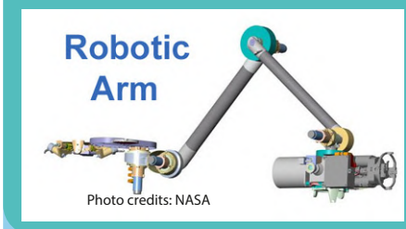


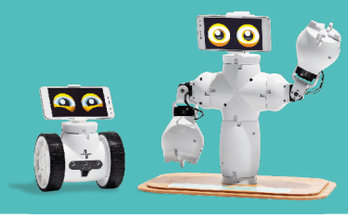
Photo credits: NASA

DID YOU KNOW?

The Perseverance rover "brushes its teeth". The Rover's robotic arm has an attachment to clean its tool or rock grinder so it removes debris before the next grinding action.

REMEMBER!

Robots can perform many tasks and come in many shapes and sizes. Both shape and size are determined by the task they are required to perform. For example, in a machine factory there are many robot arms because they handle tools (paint gun, welding machine, drill) more easily. In a warehouse there are many platform robots, i.e. robots with wheels that can carry packages from one place to another. They don't need arms, they need wheels. Educational robots are smaller, talk and sometimes express emotions.



Can the Sound be Seen? - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Using the webcam in the Fable Blockly app.
- Using sound detection.
- Viewing a sound detection graph.
- Creating an alarm system.

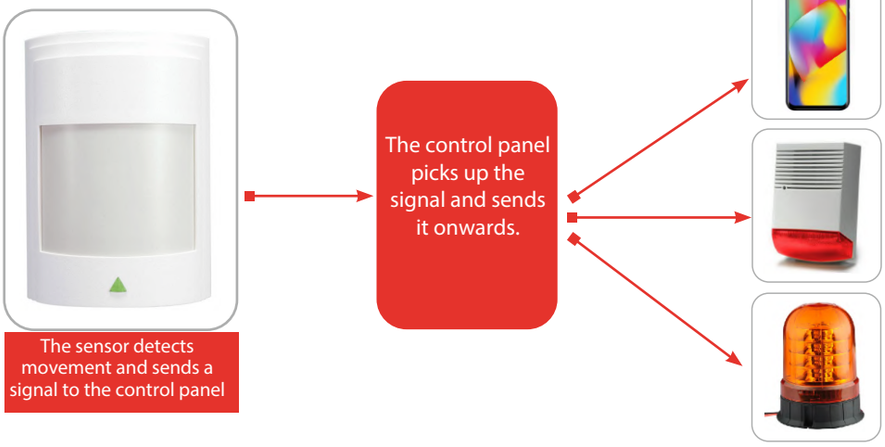
STEP 1 REVIEW

Cut out squares (5x5cm) from a few sheets of colored paper (red, green, blue).

Write a program that performs the following task:
- the computer's webcam "sees" the sheet you place in front of the lens and lights up the Hub with the same color it detects. Good luck!

STEP 2 THE ALARM SYSTEM

Motion detection is one of the methods used by security applications and systems. A motion detector sensor can tell you, for example, if someone has entered your home in your absence. Here's how these sensors work.



ACTIVITY 15 min. MOTION DETECTION

Using the Spin module, the Castor module, a phone and the computer's webcam, create a program that, upon detecting movement in front of the camera, performs the following tasks:

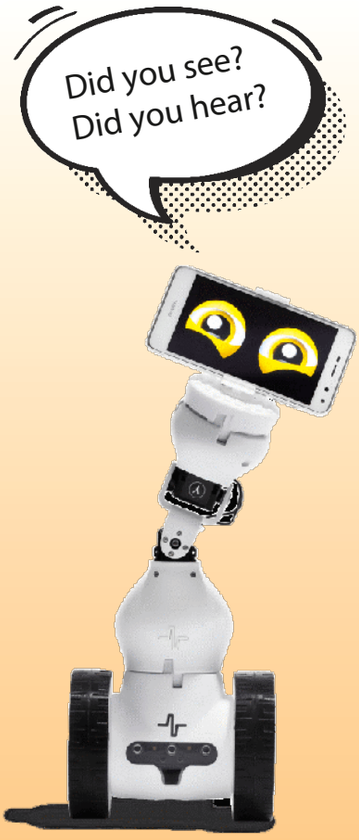
- Spin module advances for 3 seconds
- the computer emits a warning sound
- the phone displays a surprised face

ACTIVITY 15 min.

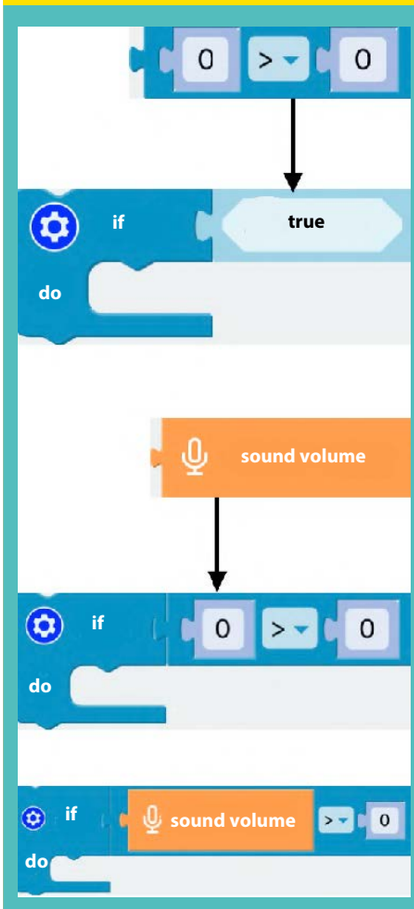
NOISE TRAFFIC LIGHT

Sound sensors detect noise. A "sensitive" sensor reacts even when noise is low. The degree of "sensitivity" is the threshold above which the sensor triggers the alarm.

In what situations can a sound sensor be useful?



REMEMBER!

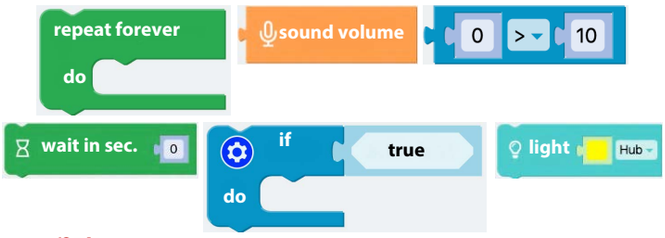


How to form a detection command.

By comparing the volume of sound around the computer with a certain value, you can create an alarm that is triggered by sound. Such an alarm is used in cars to detect, for example, a vandalized car window.

Using the commands below and a Hub connected to your computer, build a program to act as a "noise traffic light".

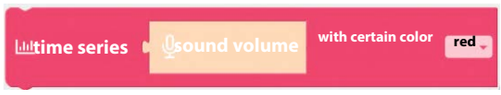
If the sound is too loud (e.g. exceeds 5 units), the Hub will light up red; if the sound level is medium (e.g. exceeds 2 units), the Hub will be yellow; and if the sound is almost non-existent (e.g. does NOT exceed 2 units), the Hub will turn green. Save this program!



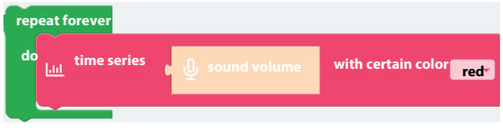
ACTIVITY 10 min.

NOISE IS VISIBLE

In FableBlockly the sounds produced are visible. How?
Go to the application menu, go to Advanced Mode and pay attention to the Sensors category. Here you can see the command in the image below.

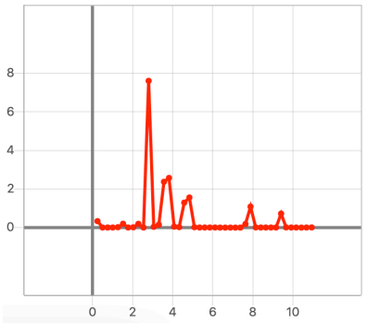


Write the program below, turn it on and make some noise. What do you notice?



Add this new command to the program made earlier (the noise traffic light) to observe when the traffic light changes color.

The horizontal axis is the time axis, expressed in seconds. The vertical axis represents the detected noise level.



ACTIVITY 5 min.

NOT ONLY SOUND CAN BE SEEN

From the Actions menu, under Advanced Mode, also use the commands that detect the angle on the axes for Joint mode and the number of fingers on the screen for the phone. Write a program to use this data and translate it into a graph.

CONCLUSIONS VISUAL IS BETTER

Graphical user interfaces make our jobs easier. Thanks to screens, acoustic or visual systems, we can understand better and faster "what an electronic system wants to tell us". "The visual "translation" of sounds is a very good example of the usefulness of these graphical interfaces. The dashboard screens of a car make you quickly understand what is going on. Graphical representation can also help you make a decision more quickly. Imagine a car that "doesn't talk to you". It has no screen, no LED, no sound. Could you handle it? What do you think it would be like if all cars were built this way?

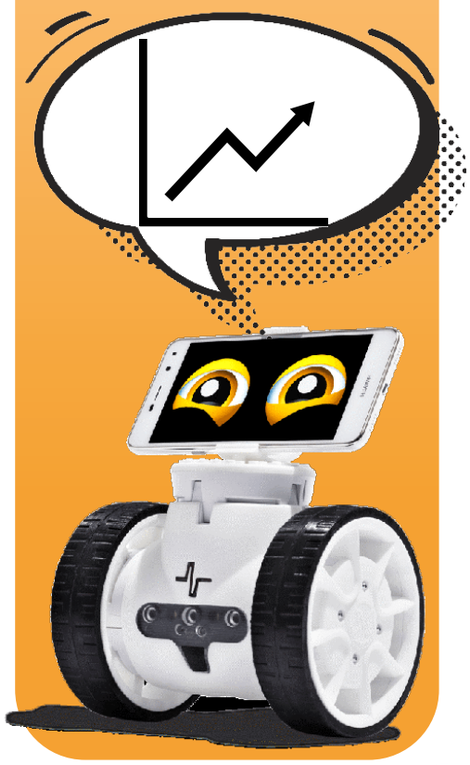
NEW BLOCKS!

This command displays a graph of the evolution of the sound level over a certain time period.

NEW BLOCKS!

This control block gives the program the angle value on the X motor or Y motor for the Joint module. The angle is measured in degrees, from -90 to 90 degrees.

This command block gives the program the number of fingers touching the phone screen.



Sensors and Detections - 4-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
MATHEMATICS

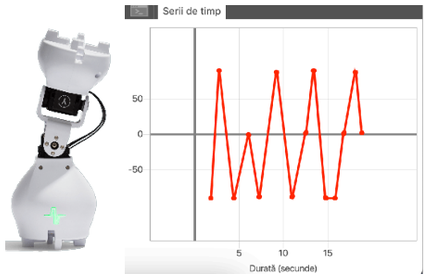
LEARNING OBJECTIVES

- Building a robot that can move.
- Programming the robot to simulate automatic braking and automatic parking for cars.

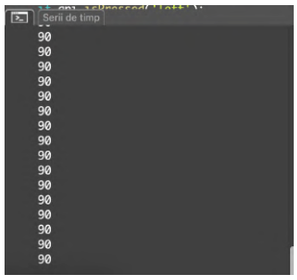
STEP 1 REVIEW

Open the Fable Blockly app and write a program that moves a Joint module from the keys in the four directions (forward, backward, left, right), and on the graph on the bottom right you can see/print the angle measurements of where the X and Y motors are after each key press. Can you also do this with the display in the output console?

Example as a graph



Example with console output



STEP 2 HOW CAN A CAR BRAKE ALL BY ITSELF?

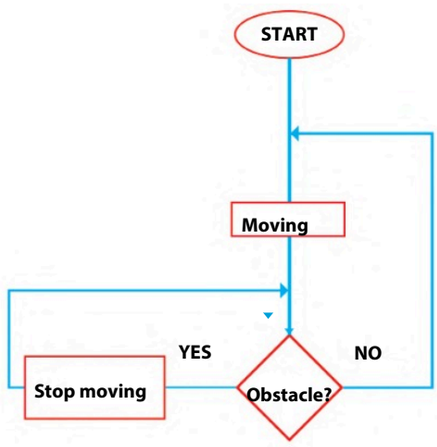
Cars are already driving down the street braking by themselves. Automatic braking is the result of the action of proximity sensors, which detect the presence of nearby objects without having any physical contact with them. Proximity sensors also work in conjunction with video cameras that analyze obstacles, and, in combination with the measurements taken, the car can tell if and in which direction an object (car, pedestrian, pillar) is "moving".

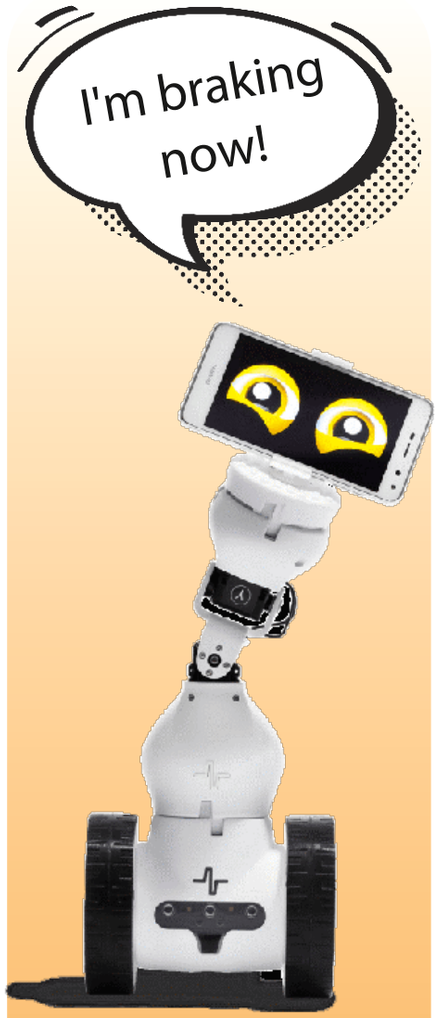
The Spin module is equipped with proximity sensors, so it can be programmed to brake when it detects an obstacle in front of it.

ACTIVITY 15 min.

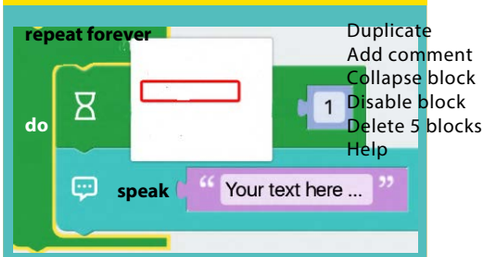
AUTOMATIC BRAKING

Open the FableBlockly app and program a Spin module (equipped with wheels and a Castor module) to act according to the flowchart below.





REMEMBER!

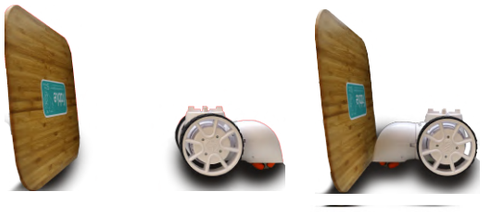


The Collapse Block command allows you to save space in the work area. You can expand it back from the same place with the Expand command.

ACTIVITY 20 min.

AUTOMATIC PARKING

The task of the robot (Spin module equipped with wheels and Castor) is to park with its back as close as possible to a wall. The robot will move forward, detect the wall, turn backwards and park close to it. Build and play the program in FableBlockly. How many attempts did it take to execute a perfect parking? What situations did you face during testing? Which method got you closest to the wall without touching it?

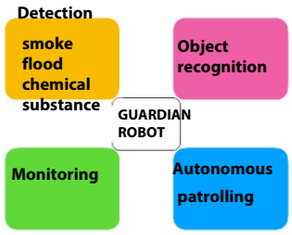


Measure and record in the table the distance from where you parked to the wall. At what minimum distance did you manage to park and on how many attempts?

Try 1	..... cm	Try 5	..... cm
Try 2		Try 6	
Try 3		Try 7	
Try 4		Try 8	

STEP 3 DUTIES OF A GUARDIAN ROBOT

See in the diagram below which tasks a guardian robot can perform.
Can you fill in the scheme with new ideas?



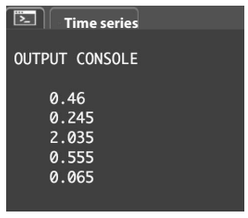
ACTIVITY 10 min.

GUARDIAN ROBOT

Create a program in FableBlockly where the robot should perform the tasks of a security guard. The robot will trigger an alarm if the conditions below are met (simultaneously):

Condition 1: A noise level higher than 2 is detected.
Condition 2: A movement is detected.

The console will display every noise level greater than 2. In the image below you have an example of the display.



STEP 4 SAVING AND READING DATA

When working with data (sound level, motor angles...), you may need it even after you close the program.
Go to Data in the menu, in the Log files category, you will find two commands: save to log file and read from csv. Saving the file will be done in CSV format, in your documents directory, the Fable folder. Write a program that saves the sound level and then load it into another program, with console display.

CONCLUSIONS AUTOMATIC

Programs need data to work, and artificial intelligence needs data continuously to grow. Just like our brains, software needs information to understand and make decisions at any given moment. The ability to save data and read and use it enables new functions for robots.

DID YOU KNOW?

Guardian robots are already on duty in shopping malls, warehouses and even on the street. They are patrolling to see if certain conditions are broken. For example, a robot might warn you that you've dropped a package on the ground or crossed on a red light.

The first robot with police rights was registered in Dubai in 2017. This means that this robot has the same rights as a human colleague police officer.

NEW BLOCKS!

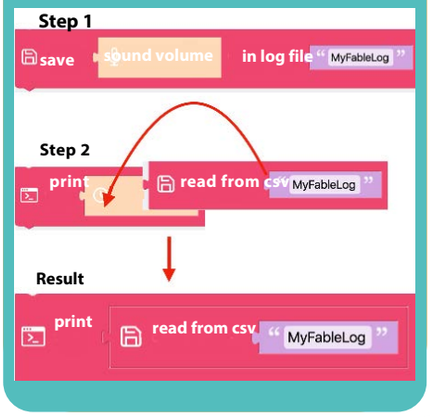
This block adds data to a CSV file created in your document directory and can be opened with Microsoft Excel.

This block reads data from a CSV file stored in the Fable directory.

REMEMBER!

You can also use the two new commands in combination with other commands.

Here is an example:



More Wheels - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
HISTORY / PHYSICS / ENTREPRENEURSHIP

LEARNING OBJECTIVES

- Building a robot with four wheels.
- Programming four independent motors to make the robot turn.

STEP 1 REVIEW

Open the Fable Blockly app and program a Spin module to meet the following requirements:

- Always go forward
- If it detects a louder sound, turn on the headlights for 1 second
- If it detects an obstacle, it stops, turns back to 180º and continues moving forward.
- Saves the sound level in a csv file.
- Also draw a logic diagram for this program in your notebook. Did you use a logic operator or did you find another way?

STEP 2 FROM ONE WHEEL TO ANOTHER

A man could travel on his own two feet at a speed of about 5 km/h. An insignificant numerical value compared to the social, economic and technological ambitions of mankind. The invention of a simple wheel completely changed the course of history.

The solutions found by humans to move faster were very ingenious, some even curious and very daring.

MONOCYCLE - A single-wheeled vehicle that was originally used in the circus world. The speed of a modern electric unicycle can exceed 40km/h.

VELOCIPED - The two-wheeled uneven vehicle, the forerunner of the bicycle.

The first velocipedes were built around 1865. From the picture it is visible that the pedals moved the larger front wheel and the rear wheel "followed" the front wheel, being connected to it by a metal frame. So the force was applied to the front wheel.

BICYCLE - Unlike the velocipede, the bicycle has force control on the rear wheel. The bicycle is a 19th century invention and today, two centuries later, it is the main means of transport in some countries. It is worth noting that the electric bicycle has gained a lot of popularity. The principle of operation of the electric bicycle is relatively simple - the battery is connected to the motor, which in turn is started, for example, with an ignition key. Depending on the model, the bike can be pedal-assisted or have its own throttle button. More than one billion bicycles are in use worldwide.

THE BICYCLE WAS ONCE JUST AN IDEA TOO...

When you have an idea that hasn't occurred to someone else, you can register it, i.e. you can get an inventor's patent. A patent gives recognition but also protection to your idea, so that you have primacy in producing and using the idea. William K. Clarkson Jr. received a patent for the velocipede, the ancestor of the bicycle, on 26 June 1819, USA, NewYork). See the table for information on the patenting of famous ideas.

Inventor	Invention	Registration year	Patent no.
Alexander Graham Bell	**Phone**	1876	US patent no. 174,465
Apple	iPhone	2012	US D672,769 S

Do you have an idea that you think could be registered?

DID YOU KNOW?

Velociped means "swift foot" in French.

CAR - A four-wheeled vehicle that has become indispensable to people.

In most cases, the motor spins the two front wheels, but there are also car manufacturers who have active rear wheels. In this case you have a 4x2 drive, meaning you have four wheels and only two are coupled to the motor. This means that the other two wheels are "pulled" or "pushed" by the other two. If you have four wheels connected to the motor, you say you have 4x4.

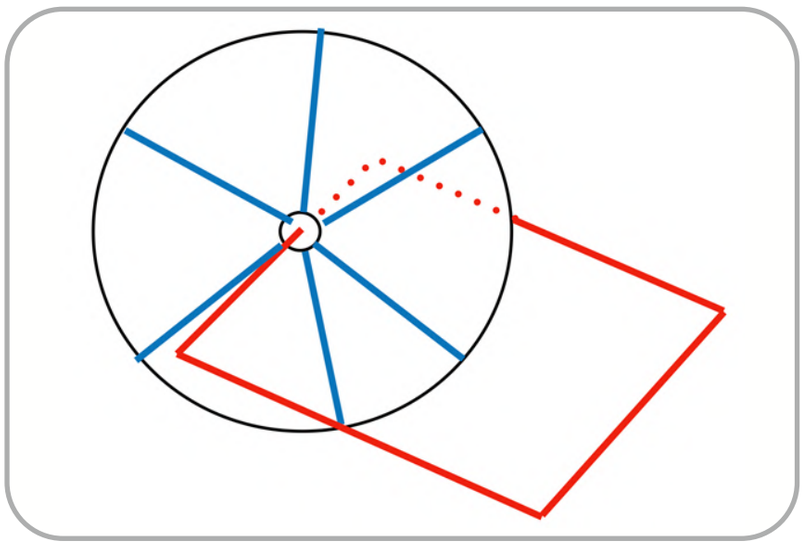
In what situations do you think an all-wheel drive car can help you?

ACTIVITY 10 min.

WHEEL AND AXLE

Apparently, anyone can come up with a definition for "wheel". In reality, quite a few details are omitted... for example, many omit the implication of the term "axle" in the definition of wheel. Axles are very important components of wheeled vehicles serving to transmit rotational motion to the wheels, as well as maintaining the position of the wheels relative to each other and to the body of the vehicle. To better understand the impact of axles I propose a little "experiment".

Connect a 3D stylus to the USB port, feed it with filament and build a wheel and an axle. Observe how the wheel "spins".



Now try to create a functional wheelbarrow with the 3D pencil.
Explain its working principle.

ACTIVITY 10 min.

INDEPENDENT WHEELS

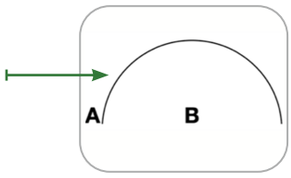
If you look closely at a Spin module, you'll see that the wheels are connected directly to the motor. If the motor spins, then they spin with it. When a motor is running, you won't be able to spin the wheel by hand, nor is it recommended to do so. The motor will sense a force that is not intended in the program and will certainly warn you.

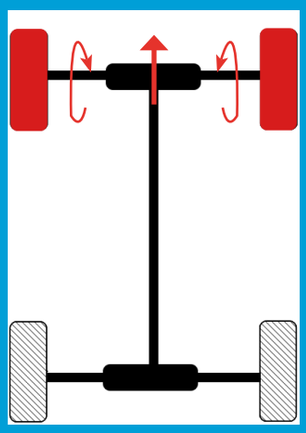
Open the Fable Blockly app, plug in a Spin module and run this command.

As you noticed, that Fable spins on the spot. Can you explain why this happens? How can you change this command to make it go forward? What about to go backwards?

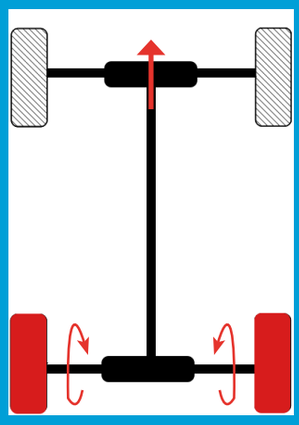
Build programs for the robot to execute:

- drawing of a semicircle (see position of the motors)
- a left turn on the spot
- a right turn on the spot

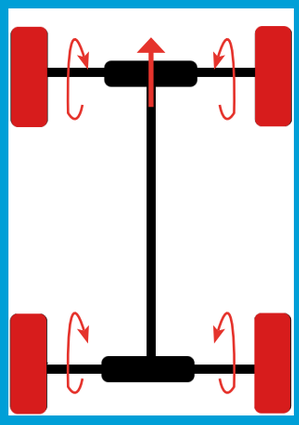




The front wheels are active.



The rear wheels are active.



All wheels are active

DID YOU KNOW?

The Mars rovers have six wheels each. What do you think are the advantages of having six wheels on Mars?

TEAM ACTIVITY 10 min.

TOWING

Towing is "the action of towing a vehicle. This is exactly what your activity is about. You will use a motor vehicle (the one that pulls) and a tow vehicle, without self-propulsion.

You will use a Spin module for the active vehicle. For the trailer you will use Fable needles, 3D prints and other Art&Craft materials. The link between the Spin module and the trailer will be a rigid, fixed link.

Open the FableBlockly app and create a program to control the movement of the new assembly from the keys.

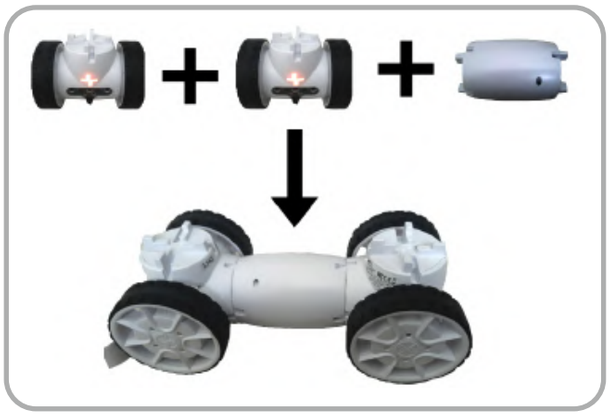
What are the differences compared to controlling the movement of a single Spin without any other accessories? Try controlling the assembly in reverse. Do you see any change in movement?

Now change the way you attached the trailer to the Spin module, using a link that is no longer mobile. It can be a rope or ribbon, for example. Can you control the new assembly with the same program as before? Do you need any modifications?

What are the differences with controlling the previous assembly? Try controlling the assembly in reverse. Do you see any change in the movement?

ACTIVITY 10 min.

Keeping the teams working, now connect two Spin modules as in the picture below.



Test the program in FableBlockly. What do you notice?

Can it be move? Can it turn?

Can you find another solution that will make it easier to control the assembly when moving, even when taking a turn?

CONCLUSIONS WHEELS

To move a vehicle, the simplest option is to use wheels. In order to turn, the wheels need to be connected to other systems that allow them to turn on the spot. But this is not always possible, as wheels are designed to move a vehicle forwards, backwards, left, right and even diagonally. With such a system you can park a car, sideways, without turning the wheels. This means you have access to narrower places where you couldn't park a normal car.

Coordination - 2-step Lesson

LEVEL: BEGINNER **INTERMEDIATE** ADVANCED

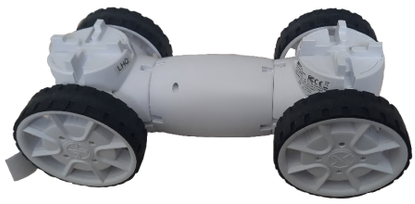
FIELD ROBOTICS and PROGRAMMING
PHYSICS

LEARNING OBJECTIVES

- Building a robot with four engines.
- Making a program to coordinate four motors of a robot.

STEP 1 REVIEW

In teams of two, build the robot below and program it to:
- move forward when pressing the "up arrow" key
- move backwards when the "down arrow" key is pressed



STEP 2 CHANGING DIRECTION

Changing direction is a necessary action when you have a robot that you need to maneuver in a movement or that has an autonomous movement as a task. Changing direction, for a wheeled robot, means that the wheels can move left/right. There are other options: you could move one wheel forwards and one backwards; you could move one wheel slower than the other; or you could not move one of the wheels while moving.

Let's see what the differences are for each of the situations!

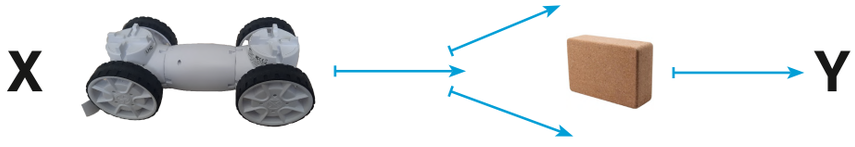
Program the Spin module (equipped with wheels and Castor) for each situation. Attach two different colored markers to the front, as close as possible to the wheels, and place the robot on the surface of a flipchart sheet. This way you will be able to see the path of each wheel and understand more easily how it moves.

ACTIVITY 20 min.

MOVING ON FOUR WHEELS

Using Fable modules and accessories, build a four-wheeled robot.

Create the path in the picture on the ground and program the robot so it can be controlled from the keys. The goal is to start at point X and get to point Y by following the directions on the route.



Could you think of a two-module Spin robot with just two functional wheels?

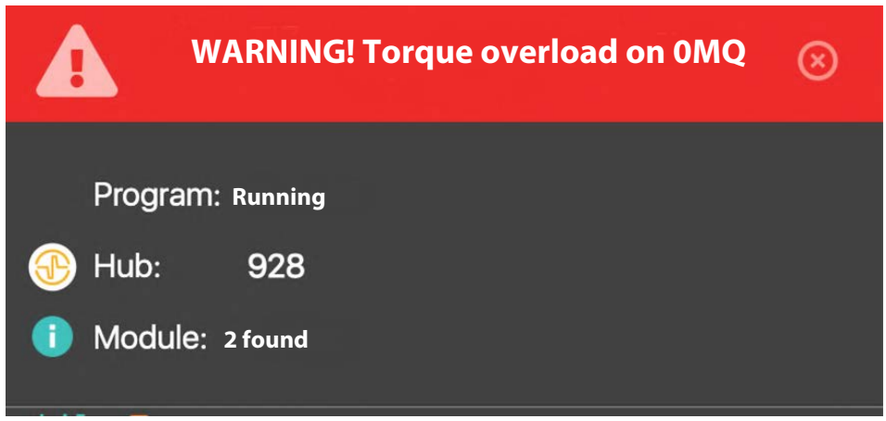
What conclusion can you draw about turning movement when you have four fixed wheels?

DID YOU KNOW?

Autonomous robots are robots that operate on their own, based on a preloaded program. They need special functions to understand what is happening around them. A car in autonomous mode should be able to handle itself: move, overtake, avoid other cars, pedestrians or obstacles.

Not all engines have connected wheels. In these pictures you have examples of equipment that use motors but do not have wheels for movement, the motors perform other roles.

The solution you tried earlier is not exactly effective, and you could see that on the move. Turns are hard to take, the wheels can't move smoothly, the motors are forced and consume a lot of energy. This is also caused by the way we chose to build the model. It is very likely that during the tests an error message will appear on the screen.



When this message appears, it is mandatory to stop running the program. One of the engines is not working within the parameters, being overloaded.

If, for example, we put two Spin modules face to face and programmed them to go towards each other with the same parameters, they will meet and push each other without being able to make a full rotation of the motors. Such situations should be avoided.

SOLUTION

Maybe you've already found the solution for the four-wheeled robot that can be operated from X to Y position. Here is an example of a construction that simplifies things a lot, allowing better handling. There are other solutions, even more efficient. Have you found a design that doesn't strain the motors?

Front View

Rear View

Try to remake the robot and the program so that you move along the route mentioned above.

CONCLUSIONS MULTIPLE

More motors mean more power or more flexibility. A hybrid car has two engines, an internal combustion engine (petrol or diesel) and an electric one. The James Webb Telescope has 132 small motors. In many places around you, you can see motors: washing machine, fridge, conveyor belt... Come up with some examples too.

DID YOU KNOW?

Each wheel of the Perseverance rover has a motor. The wheels have the ability to rotate the entire vehicle in place, 360 degrees. The wheels are made of aluminum with lugs for traction and curved titanium spokes for elasticity. They are 52 cm in diameter, and a full rotation moves the rover 1.65 meters. Travel speed is 152 meters per hour, consuming less than 200 watts.

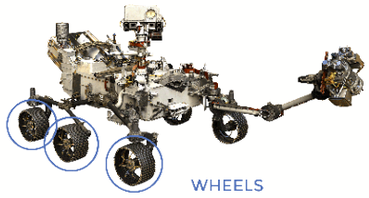


Photo source: nasa.gov

Robots Talk, Part I - 3-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
HISTORY

LEARNING OBJECTIVES

- Understanding the concept of communication.
- Teaching two new commands, transmission and reception of IR messages.

STEP 1 ABOUT COMMUNICATION

Communication is a link between at least two parties. It can be news, a dialogue, a piece of news, an announcement. Communication can be divided into two categories: verbal and non-verbal. In verbal communication we send a vocal message on a "channel" that our interlocutor understands. And in non-verbal communication, we use other methods to convey a message, but not our voice. You could use sign language or Morse code.

ACTIVITY 10 min.

Form teams of two students. One student will deliver a message and the other will reveal it. The message can be delivered by any means, but not by voice or written text.

After the exercise, discuss the experience with the whole class.

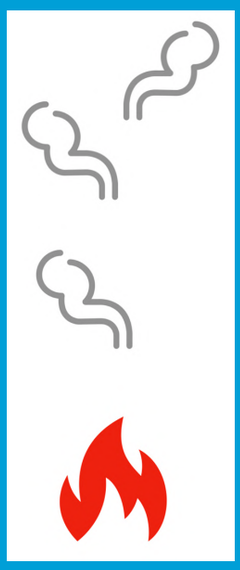
Did any errors occur (message received incorrectly)? Could you come to a common conclusion as to the best method of communication among those you used?

ACTIVITY 10 min.

Open the ClassVR app, go to Search subscription, type in The evolution of humans and upload the material. Observe human settlement and imagine ways humans could communicate at a distance or up close without using language.

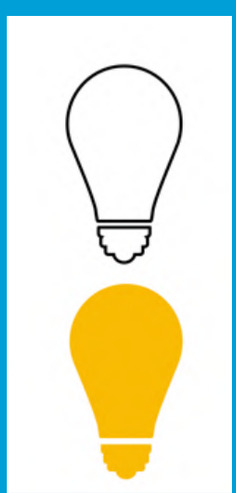
What do you think were the advantages and disadvantages of the ways people communicated back then?

Smoke signals were used to communicate over long distances.



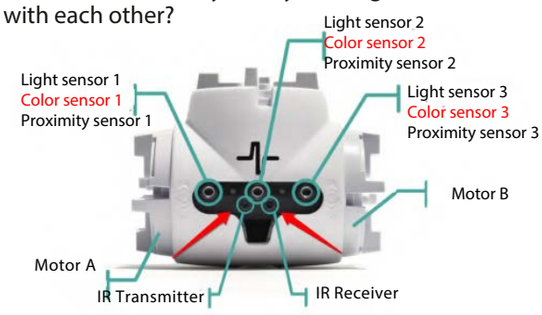
Acoustic signals can be heard at medium distances. You can create a "dictionary", a code that explains the transmission and reception messages.

Simply turning a light bulb (a flashlight for example) on and off can help you send a message. Even Morse code can be played back with a flashlight.



STEP 2 ROBOTS CAN COMMUNICATE

Robots do communicate also. They can do it through sensors. They can "understand a sound", receive a message, transmit signals that can be recognized by other robots or human operators. Communication between robots brings new functionalities. Think of how a robot vacuum cleaner returns to base to charge. It can do this because it "communicates", it talks to the base. The advantage of this communication is huge: the robot can run itself, permanently, because it doesn't run out of battery and can work continuously. Can you imagine some situations where robots communicate with each other?



Front View of the Spin Module

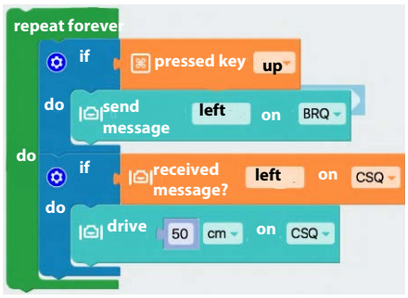
STEP 3 SPIN MODULE SENDS MESSAGES

Looking at a Spin module first identifies the infrared transmitter and receiver. You can see that the Spin module can transmit messages and receive messages. So you could make two Spin modules communicate with each other.

To SEND messages from one Spin module to another, use the Send Message button in the Actions category of the menu. To RECEIVE a message from another Spin module, use the Receive Message command in the Sensors category of the menu. These are different menus because the first command is an action (send message) and the second is possible because of reception. Any verification element, in our case reception, is found in the Se

Analyze the program below and answer a few questions.

- Who delivers the message?
- What command causes the message to be transmitted?
- Who receives the message?
- What does the module that received the message do?
- What do the two Spin modules do if the UP key is not pressed?



ACTIVITY 15 min.

SENDING MESSAGES

In teams of two, using two Spin modules (we'll call them Module 1 and Module 2), create a program that meets the following requirements:

1. Module 1 will be controlled from the keys to align with Module 2 (front facing sensors).
2. Module 1 will transmit a message at the press of a key to Module 2.
3. Module 2 will receive the message, transmit a voice message, and the programmer will take over key control for that module and take it to where Module 1 started.

CONCLUSIONS COMMUNICATION

A remote control "talks" to her drone, an autonomous tractor keeps in touch with the base to receive work tasks and report results. Equipment communicates with each other to streamline its work and increase the capabilities of systems.

NEW BLOCKS!

This command uses infrared light to transmit a message. The message in this situation is that the space key has been pressed.

NEW BLOCKS!

This command checks via the infrared receiver whether a specific command has been received. In this case it checks if a space key press message has been received.

DID YOU KNOW?

The Sumerians were the first to use writing to communicate, more than 5,000 years ago. They lived in Mesopotamia, between the Tigris and Euphrates rivers. The name Mesopotamia comes from the Greek words "mesos" (between) and "potamos" (rivers).

Evening gatherings in a cave around a fire could be Earth's first social network.

Drawings and inscriptions on cave walls could be considered the earliest forms of blogs.

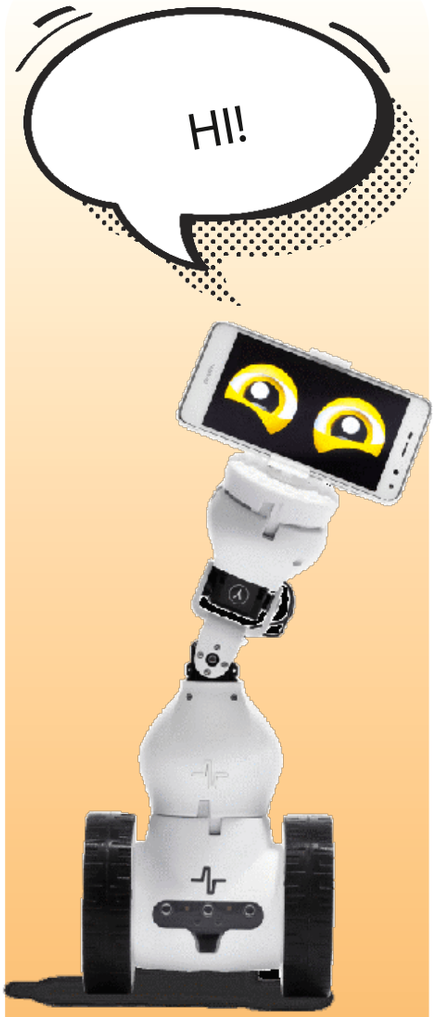
Robots Talk, Part II - 3-Step Lesson

LEVEL: BEGINNER **INTERMEDIATE** ADVANCED

FIELD ROBOTICS and PROGRAMMING

LEARNING OBJECTIVES

- Programming Spin modules to communicate Infrared.
- Identifying controls for Spin mode motor acceleration.



STEP 1 REVIEW

Open the FableBlockly app and write a program with which two Spin modules communicate with each other:

- The first Spin module transmits a message using infrared light.
- The second Spin module receives the message and confirms it visually or acoustically

The robots "talk" to each other out loud, managing to communicate acoustically. But they can also communicate in ways we can't normally see or hear, via Bluetooth, Wifi or Infrared. Robots that communicate with each other can solve very complex tasks. A group of robots can communicate, for example, to synchronize their timer when they start a new task. This is necessary so that they can operate as a group, always knowing what another robot is doing. Communication between robots is not necessarily new, as humans are interested in coordinating "swarms" of robots, like insects or animals

Any idea where and how you could use a swarm of robots that can communicate with each other?

STEP 2 SOLVING PROBLEMS

Situations where robots need to communicate with each other are very common. Communication between robots is an advantage as long as humans understand the language used, i.e. the message of the dialogue. What would happen if robots used a language unknown to humans?

TEAM ACTIVITY 25 min.

MATCH BETWEEN ROBOTS

Divide the class into two teams. Next up is a "championship" shootout. To organize the "event" you need:

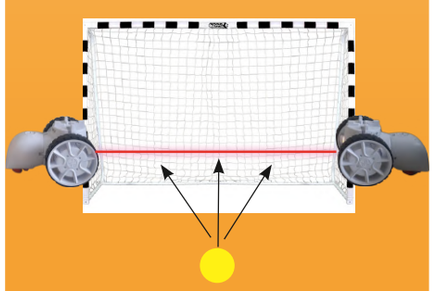
- one or more polystyrene balls.
- a gate - represented by two Spin modules that will detect the ball passing between them, using the infrared transmitter and receiver.
- one Spin module (per team) that will be programmed to kick towards the goal (from a fixed point).
- one "Plug" accessory (see picture) attached to each attacking robot, for




DID YOU KNOW?

Replacing traditional fireworks with swarms of drones that communicate with each other is an important step in increasing safety and reducing pollution.

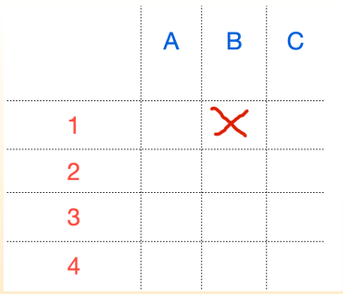
There are also artistic advantages - a huge number of shapes, colors and combinations of lights can be created to enhance the night sky.



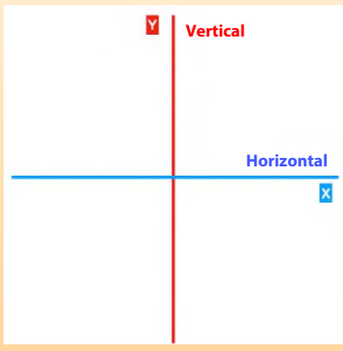
STEP 3

Communication between robots is often also about where each one is at any given time. When you talk about position, you don't just mean your proximity, i.e. what is next to you, around you. You often need to know exactly what position a robot is in. For example, in the case of a robot vacuum cleaner, the app's interactive map shows you the position of the vacuum cleaner in real time. In the case of a very large warehouse, the position of a robot can be even more important. For one thing, it can communicate with other robots so that it can optimize its routes and not collide. Knowing the exact position is also important if the robot malfunctions and a human operator has to go there to analyze the situation.

The simplest way to communicate position in a plane is by using the Cartesian coordinate system in two dimensions, conveying the abscissa and ordinate of a point in the plane. The abscissa (horizontal axis) is denoted by x, the ordinate (vertical axis) by y, and the point of intersection is denoted by O. This positioning system is also used when positioning a point on the screen or in games.



In the adjacent diagram we have marked with an X the point of the crease (B,1). Mark the following points with an X: (A,3), (A,4), (C,2).



To position the coordinates we always read the data on the horizontal line first and then on the vertical line.

The chessboard is square in shape and is divided into 8 lines and 8 columns forming 64 squares, also called positions. Each position is assigned a coordinate. Look at the pictures below and identify the positions of the newly moved pieces.

Position:

Position:

Position:

In these examples you have positioned certain points at the intersections of the horizontal and vertical lines. In the same way, by constantly reading the position, the phone can tell for itself if it has been tilted during a game. If you continuously read the phone's position (its tilt forwards, backwards, left and right) you could take this data and send it to a Spin module to move, the phone thus becoming a remote control.

ACTIVITY 15 min.

REMOTE CONTROL

The Spin module can also be controlled by phone. You need to have the Fable Face app installed on your phone. Control will be achieved by moving the phone. In real time it will send acceleration data on the two axes, X and Y (these values change as the phone is tilted in one direction).

And this acceleration is interpreted by the Spin module and "translated" into movements: forward, backward, spin left, spin right.

DID YOU KNOW?

The longest game of chess, theoretically possible, is 5949 moves.

The modern chessboard, as we know it today, first appeared in Europe in 1090.

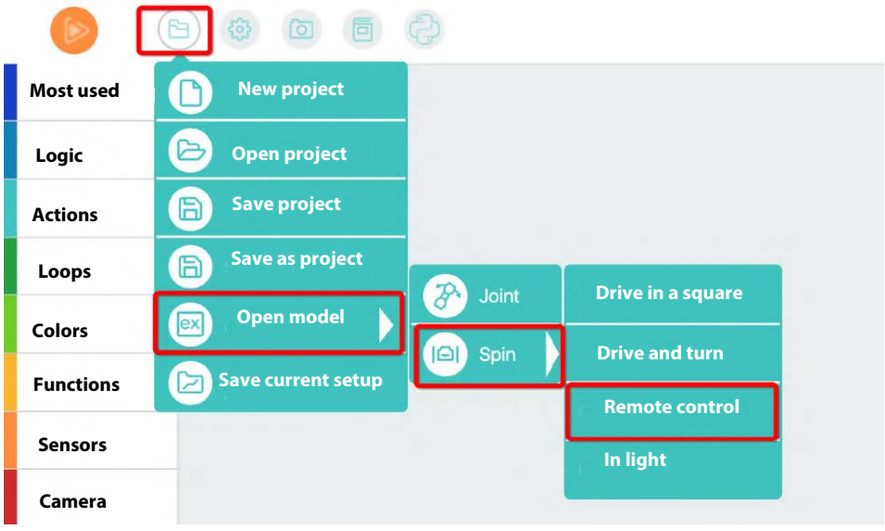
The first chess game played in space took place on 9 June 1970. The game began in orbit 141 and ended in orbit 144.

NEW BLOCKS!

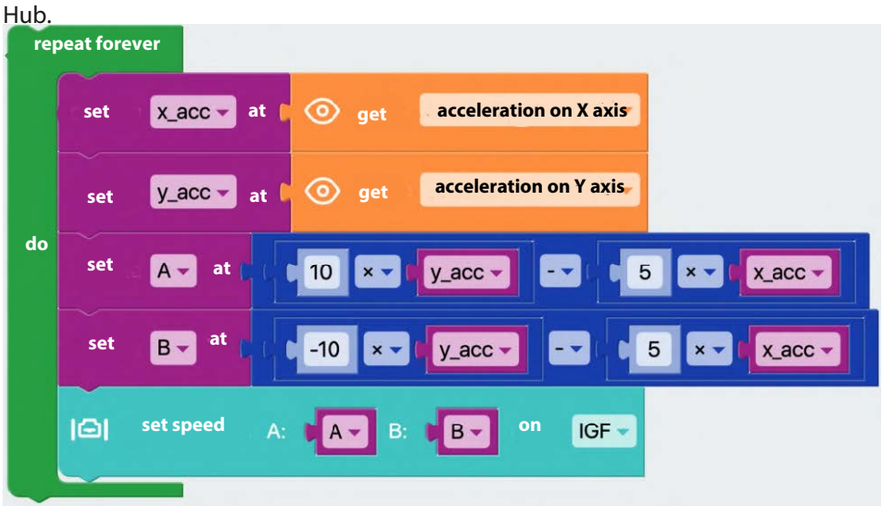
This command block "reads" the numerical value the phone gives you for left or right tilt.

This control block "reads" the numeric value the phone gives you for forward or backward tilt.

Open the Fable Blockly app and go to the Project - Open Model - Spin - Remote Control menu.
The program below will open in the workspace. Connect a Spin (with wheels and a Castor accessory) and your phone with the Fable Face app running to the Hub.



The workspace will open the program below. Connect a Spin (with wheels and a Castor accessory) and your phone with the FableFace app running to the Hub.



The "get acceleration on X axis" command is the one that takes the data from the phone to then identify a movement. The same goes for the command "get acceleration on Y axis".

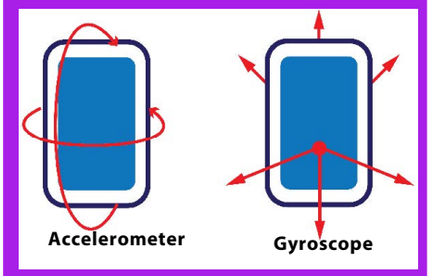
Run the program and observe how it works and controls. Identify the blocks of commands that control spin movement.
Because you are working with changing data (acceleration on the X-axis and acceleration on the Y-axis), you need to work with variables. That's why x_acc and y_acc were used.

Can you modify the program so that Spin runs faster?
But to go slower?

CONCLUSIONS SPACE ORIENTATION

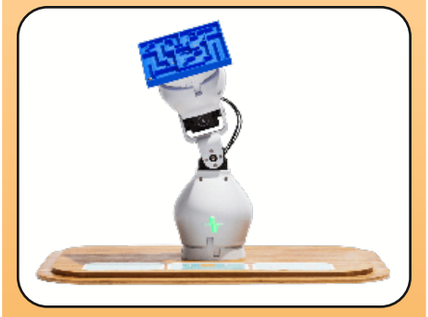
In order to remotely control equipment that moves, you need to know its position at all times. That way you can tell if what it's doing is correct, according to the algorithm, and you can improve the results. Knowing the position of certain equipment, components or sub-assemblies is vital in many cases. An aircraft flying at night or in dense fog, without a gyroscope to tell the pilot the position, would have a hard time. The same goes for satellites, space telescopes, telephones... Come up with some examples too.

DID YOU KNOW?



The accelerometer and gyroscope are two very important components in electronic equipment. They're even in your phone.

The Accelerometer measures acceleration and the Gyroscope ensures orientation in space. Space telescopes and Mars rovers also use such equipment.



Connect a labyrinth board to a Joint module and control arm movement with your phone. Modify the program loaded for the Spin module and use the command for the robotic arm.

General Assessment - Sensors - 3-Step Lesson

LEVEL: BEGINNER **INTERMEDIATE** ADVANCED

FIELD ROBOTICS and PROGRAMMING ARTS

LEARNING OBJECTIVES

- Identifying construction solutions for the requirements received in the exercises.
- Creating programs for the requirements received in the exercises.
- Identifying errors in the programs.
- Checking knowledge of the role of learned commands.

ACTIVITY 5 min.

NOISE AND FLAG

Build and program a robot to raise a flag every time the noise level exceeds a certain value. If the noise falls below that value, the flag will be lowered.

Use a Joint module, a Hub, a support element (for balance), Fable accessories or accessories of your own creation for this activity.

Good luck!

ACTIVITY 5 min.

THE ROBOT AND THE SURROUNDING COLORS

Create a program in the FableBlockly app that every second tells you what color the camera sees, and after 10 seconds tells you how many times it saw red and stops.

ACTIVITY 5 min.

IDENTIFIED EXIT

Program a Spin module to be "enclosed" in a space provided with a single exit zone. The robot's task is to identify that area and announce, using its beacons, that it has succeeded.

The robot is only allowed to exit through the exit zone and is not allowed to pass over the "walls" you create.

Option 1: make a perimeter with adhesive tape.

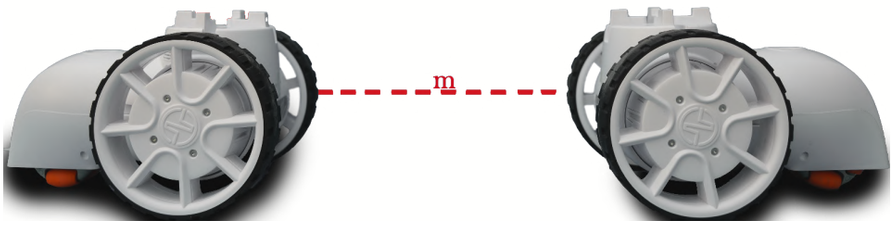
Option 2: use a wall boundary with obstacles.

How can you make the robot realize that it has found the exit? Test the proposed solution.

ACTIVITY 5 min.

THE ROBOT AND THE LETTERS

Using two modules (Spin1 and Spin2), write a program in which Spin1 sends a message (e.g. the letter "m") to Spin2. After detecting the signal, Spin2 will confirm receipt of the message by switching on the lights (for three seconds).

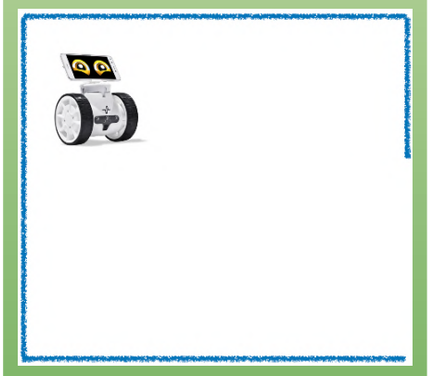


DID YOU KNOW?

The checkered flag, black and white, is used in motor sports and announces the finish line, the end of the race. It was introduced in 1906.

There are many other types of flags that convey messages to race participants.
In Formula 1, the yellow flag announces a danger on or near the track and the red flag stops the race.

Flags are also used to announce new rules/procedures during the race.



ACTIVITY 5 min.

IDENTIFY THE RESULT

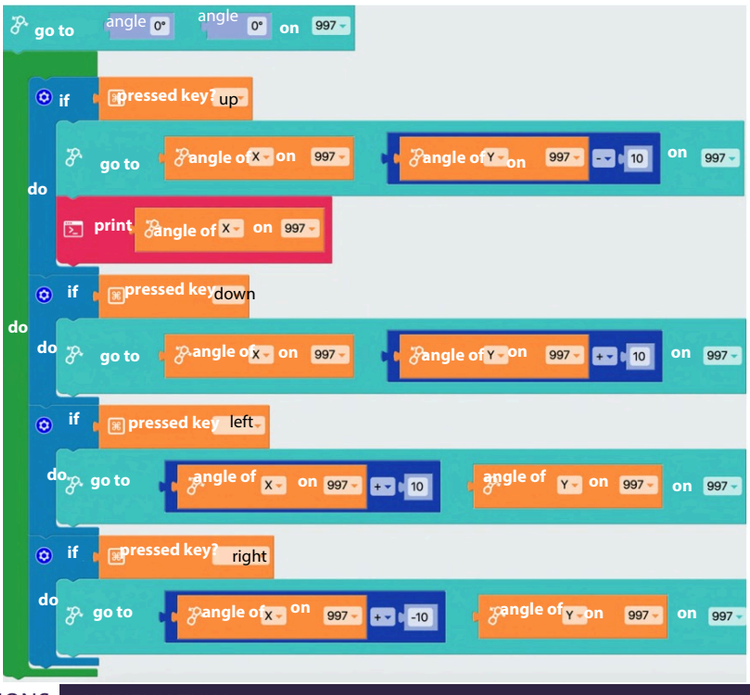
What does a Joint robotic arm do when running the following program?

ACTIVITY 5 min.

IDENTIFY THE ERROR

You want to print in the FableBlockly app console the X motor angle for a Joint arm while moving it from the arrow keys.

Identify the error and correct the program.

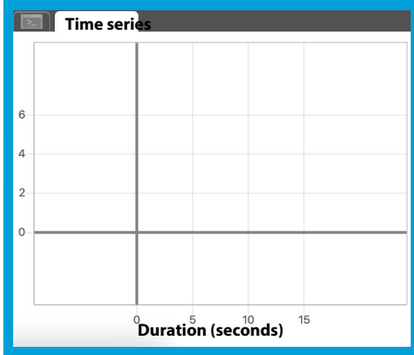


CONCLUSIONS **VERIFICATION**

A verification of a program can be done by directly observing the code and observing the result of its execution. Error identification can be done both manually and automatically. The latter also sometimes requires human verification, usually for very complex systems. A program that can self-correct and self-program can become so complex that it may be impossible for a human to check its results in a timely manner. For this reason, the care with which such programs are worked on must be very high. In order to better control a program, the use of intermediate checkpoints and modularity is recommended.

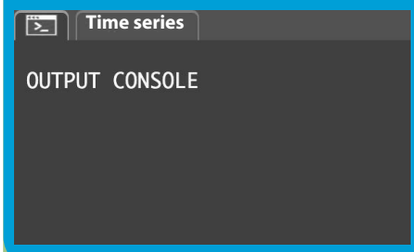
SOUND GRAPH

Write a program to graphically display, in the FableBlockly app, the volume of ambient noise for 10 seconds.

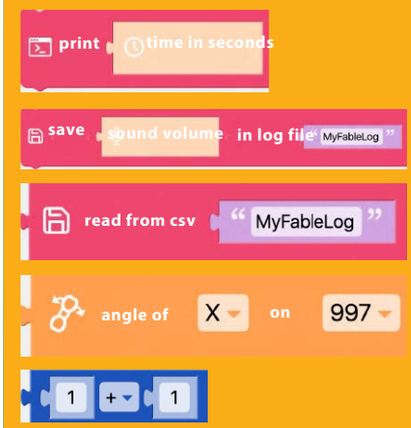


SAVED DATA

Write a program that uses the data recorded in the previous activity and displays this data in the FableBlockly app's work console.



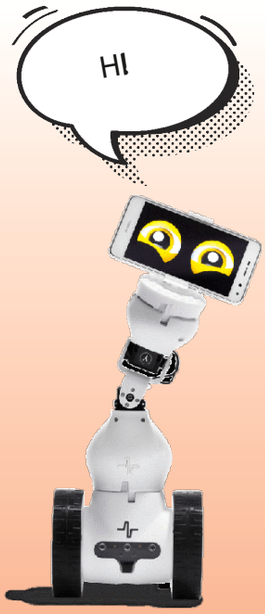
SUGGESTED BLOCKS



3D Printer - 2-Step Lesson

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
HISTORY/3D DESIGN/ECOLOGY/PHYSICS



LEARNING OBJECTIVES

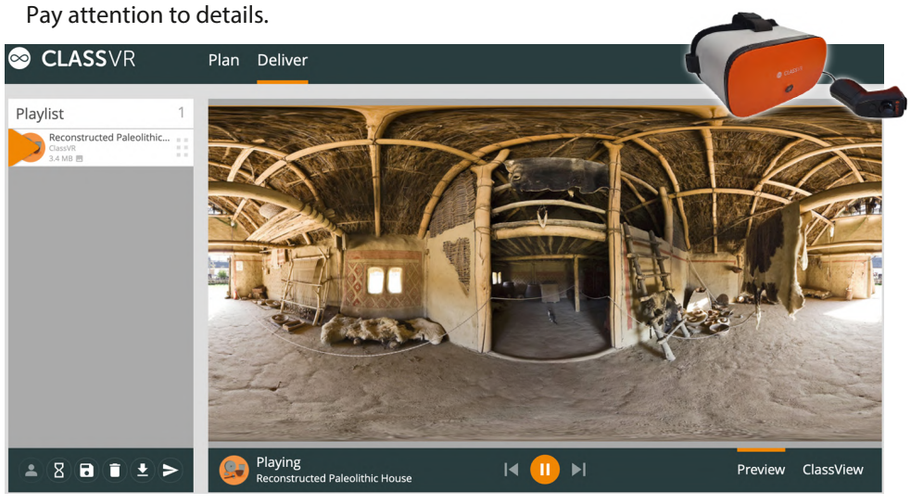
- Knowledge of the operating principle for a 3D printer.
- Creating a multi-layered structure with the 3D pencil.

ACTIVITY 10 min.

VISIT TO THE UPPER PALEOLITHIC

Open the Class VR app, go to Search Subscription and search for Reconstructed Paleolithic House. Load the material onto your headset and carefully view the images. See how people's homes are built and how they had things organized. Try to understand what activities they did.

Pay attention to details.



In the Upper Paleolithic people developed the first art forms after cave paintings and spiritual rituals. Archaeologists note that the earliest musical instruments, in various shapes and materials, also come from the Upper Paleolithic.

European Upper Paleolithic art also includes drawings, engravings, carvings in clay, bone, antler, stone and ivory. These were usually representations of real things and situations, just much smaller in size.

In the Upper Paleolithic we are talking about the oldest example of ceramic art in the world - the Venus of Dolni Vestonice, a ceramic statuette depicting a female nude from the period (29,000-25,000 BC).

During this period Homo sapiens became the dominant hominin on the planet. Greater cranial capacity allowed them not only to improve tool-making techniques, but to create the first sophisticated art forms.

ACTIVITY 10 min.

CARVER IN THE UPPER PALEOLITHIC

Synthesizing the information they have learned about Upper Paleolithic art, create your own piece of art from plasticine. The method used - removing layers of plasticine until you reach the desired shape.

INFO

Aurignacian Flute, flute made over 35,000 years ago.
Location: Württemberg Museum of History in Stuttgart
Photo source: Wikipedia

INFO

Venus of Dolní Věstonice, statue discovered in 1925
Location: Moravské zemské muzeum, Czech Republic
Photo source: Wikipedia

STEP 1 AN EXAMPLE FROM TODAY'S WORLD

How does an ice cream machine work? The ice cream machine mixes a few ingredients, cools them and then "pours" them into a cone. What would happen if the material flowing through the nozzle and into the cone was too liquid? What if it was too solid?

Here's how the condition for a delicious looking ice cream cone is the temperature and consistency of the ice cream. Just how important are these material characteristics in sculpture, but in painting?

ACTIVITY 10 min.

This time I encourage you to create another object out of plasticine, an object from the era we live in. Technique used - layer upon layer application.

An example might be a glass made of long, thin "snakes" applied one on top of the other. What colours and shapes did you use this time? Why?

Which modelling technique did you like best, "by removal" or "by application"?

STEP 2 3D PRINTER

A 3D printer uses a special material that it processes and applies layer upon layer to a substrate. Which is exactly what you did with plasticine. In a way, the ice cream machine is a 3D printer too.

So the principle of how 3D printers work is simple: apply multiple layers of processed material to build something.

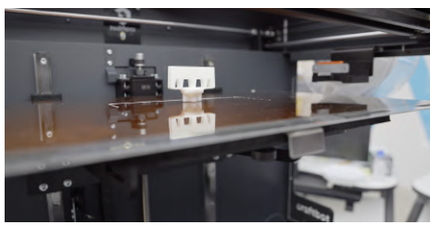
The materials a printer works with, depending on the model: plastic, PLA (made from starch or sugar cane), concrete, clay, rubber.

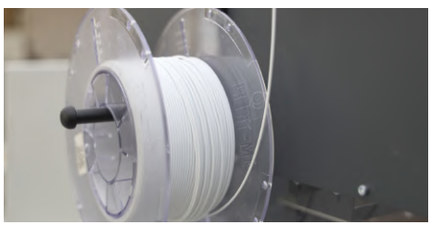
PLA (Polylactic Acid) printers made from corn are used in schools. There are models with one printing head, but also with two heads, like the one in the lab. The double-headed printer can print two colors. The two-headed model in the lab is also equipped with a video camera that allows you to view the model while printing. The graphical user interface allows even more detailed control of the printer, with the ability to upload job files directly via drag&drop, as well as real-time time to completion and material consumption. Together with colleagues and your teacher, identify each component of the 3D printer in your lab.

ACTIVITY 10 min.

Use 3D printed accessories in the lab and connect them to Fable Joint or Spin modules to give new functionality to robots. Use materials from the Art&Craft area to embellish creations or even add functionality.

3D printed accessory for the Fable robotic system





CONCLUZII 3D PRINT

3D printing is going to be more and more present around us. A huge step is being taken today by medicine testing and developing solutions for printing human organs.

On the International Space Station, tests are being carried out for printing under weightless conditions. The US space agency has chosen a model of houses that can be 3D printed, right on Mars. Such a printer will have to be transported there, and materials from the planet will be used on site. The houses will be durable, modular and easy to assemble.

DID YOU KNOW?

Industrial ice cream production began in 1851 in Boston, USA. The first ice cream on a stick was patented in the US in 1923.

Frank Epperson, claims to have come up with the idea by accident, forgetting a glass of lemonade with a spoon in it. Overnight it froze and so the first lemonade-flavored ice cream on a stick was created.

REMEMBER!

Filament is stored on rollers so that it can be easily "pulled" through the printer without tangling.

DID YOU KNOW?

In 1984 Chuck Hull invented a process called "stereolithography" that uses UV rays to solidify photopolymer to create 3D objects, layer by layer.

NASA uses 3D printers in space to create spare parts when needed.

REMEMBER!

Here you can find more accessories for the Fable robotic system, ready designed and ready to print.

www.thingiverse.com/shaperobotics/designs

Mission on Mars, Part I - ACTIVITIES

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
ASTRONOMY / ARTS

LEARNING OBJECTIVES

- Building an air-propelled rocket model.
- Building a four-wheeled vehicle.
- Programming the four-wheeled vehicle
- Creating a route for the vehicle and moving autonomously on it.

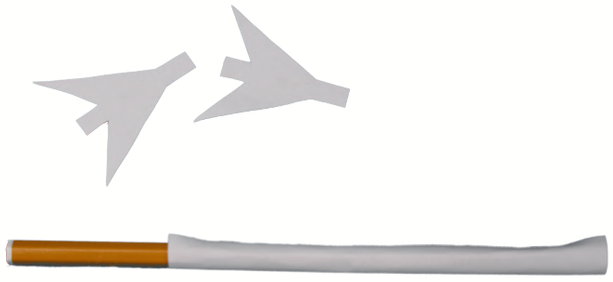
ACTIVITY 15 min.

ROCKET

Prepare some working materials because you're going to build a rocket that you will take home. The idea belongs to NASA and you can explore it further here: https://www.jpl.nasa.gov/edu/learn/project/make-a-straw-rocket/

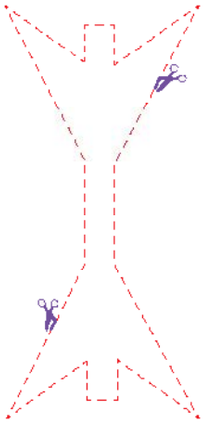
STAGE 1

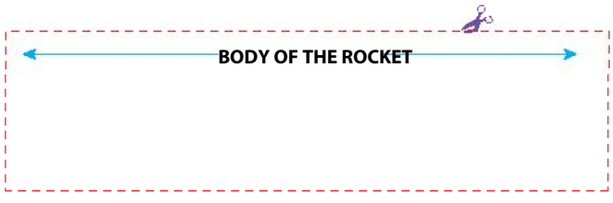
Creating the rocket body - Cut out the rectangle without overshooting the outline. Wrap the rectangle around the pencil and tape it with a little tape (be careful not to tape the pencil too).



STAGE 2

Create the rocket wings - Cut out the wings and tape them as close to the end of the pencil as possible. Fold the edges of the wings so that they form a "+" sign.

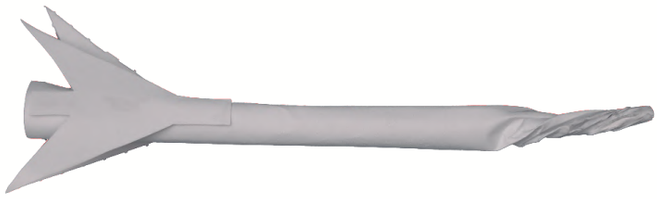




WORK MATERIALS

STAGE 3

Create the rocket tip- Pull the rocket body towards the tip of the pencil so you can twist the paper and build a tapered tip.



STAGE 4

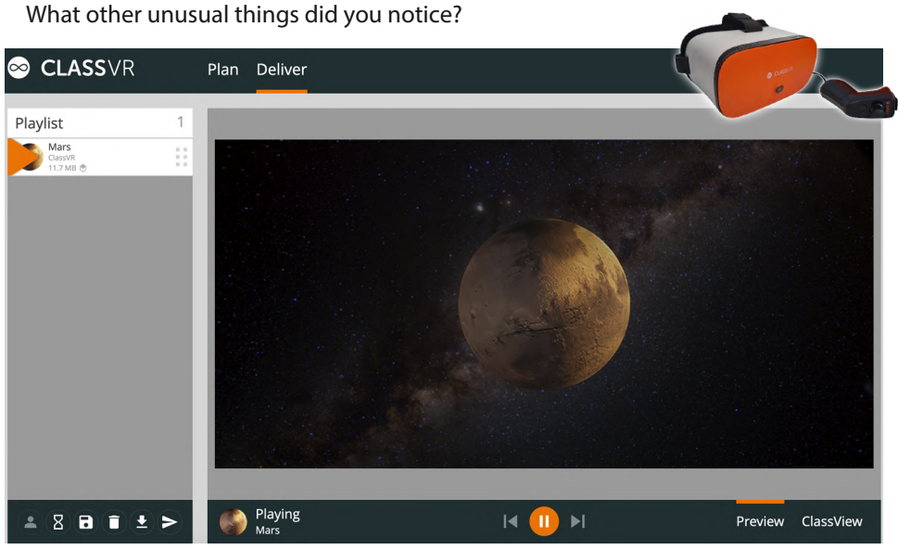
The rocket flies- Replace the pencil with a drinking straw. Your rocket will be powered by air, so blow hard through the straw.

ACTIVITY 15 min.

TRAVELLING ON MARS

Let's explore Mars! With the ClassVR headset and platform, you can get up close and personal with the Red Planet. Open the Class VR app, go to Search Subscription and search for the word Mars. Open the video called Mars. Watch the 360º video carefully and try to create a list of physical features of Mars.

What other unusual things did you notice?



You may have noticed that Mars has a reddish appearance. This is due to iron oxide or rust on the planet's surface. Shades of gold, bronze, brown, greenish... The colours differ depending on the minerals present.

Mars has a slightly smaller surface area than the Earth's total land area. Mars is less dense than Earth and is about 15% of Earth's volume and 11% of Earth's mass.

The planet's average distance from the Sun is about 230 million km, which explains the low temperatures on Mars (average temperature -60º C).

DID YOU KNOW?

Mars is 4.603 billion years old and Earth is 4.543 billion years old. So there is a 60 million year age difference between the two planets.

DID YOU KNOW?

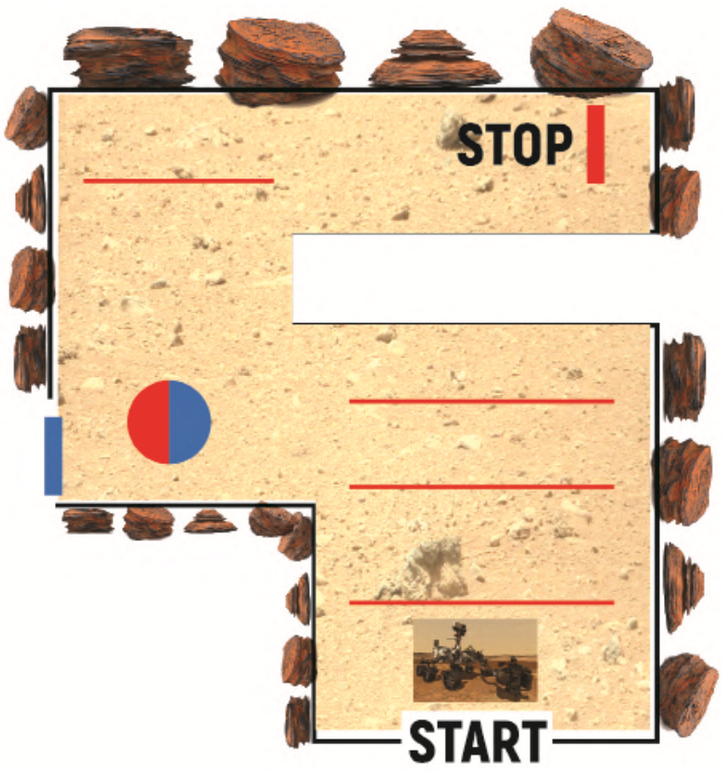
The first spacecraft to visit Mars was Mariner 4, launched by NASA in 1964. And 12 years later, Viking 1 made its first successful landing on the Martian surface.

STEP 1 YOUR ROVER ON MARS

According to Wikipedia, "Rover is a vehicle that travels on the surface of planets (other than Earth) or Asteroids". The physical and functional characteristics of rovers differ depending on the conditions where they are sent and their mission. For example, the Soviet Mars 2 and Mars 3 rovers were equipped with skis instead of wheels because nothing was known about the nature of the Martian soil.

Today's mission is to build and program an autonomous rover to carry out a series of activities on Mars. Given the complexity of the mission, teamwork is recommended.

Working materials: Fable robots and accessories, Mars "map" (flipchart, markers, colored tape for drawing red and blue lines, cork blocks or other wall elements, a Styrofoam ball colored half blue and half red). See the suggested map in the image below.



Action plan:

1. The rover will depart from the point marked "Start".
2. Once started, the rover will identify for itself when to turn left, following the red lines drawn on the ground.
3. If it sees the red part of the Styrofoam ball, the rover will push the rock/ball slightly forward, turn right and continue on its way.

The vehicle will detect for itself when it should turn right again and recognize where it should stop.

4. If it sees the blue part of the Styrofoam ball, the rover will push the "rock"/ball forward until it pushes it outside the perimeter (see blue line drawn on the bottom), turn right and continue on its way.

The vehicle will detect for itself when it should turn right again and recognize where it should stop.

In case the mission does not go according to plan, prepare a backup in FableBlockly. With a certain command (set by you) you will manually take control of the Rover and bring the mission to an end.

CONCLUSIONS LIFE ON OTHER PLANETS

Exploring other planets will help us populate one of them in the future. One of the most important events on Mars is the successful production of oxygen from carbon dioxide. New, larger equipment may be sent there that can produce and bottle oxygen for future human missions.

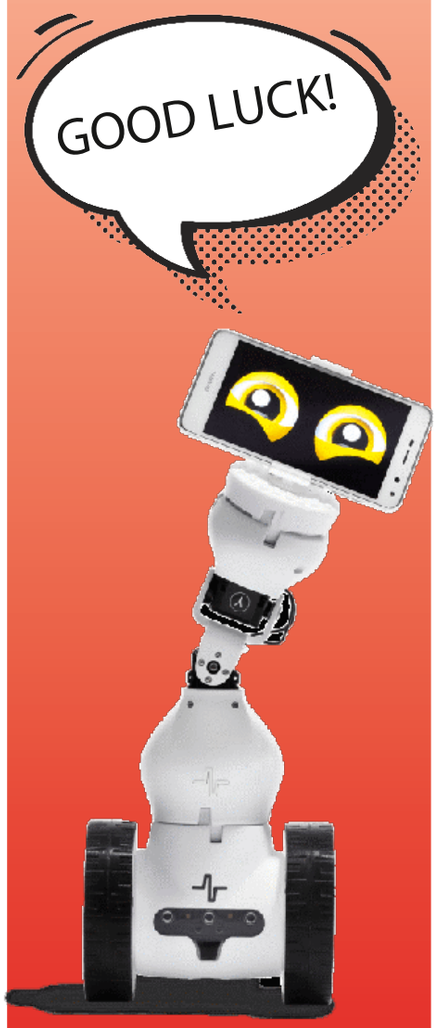
REMEMBER!

FUNNY CALCULATION

1 day on Mars = 24.6 hours
1 year on Mars = 687 days on Earth

That means you would be a different age on Mars. To calculate exactly how old you would be on Mars, multiply your age now by 0.53. What did you get ?

And to estimate how many kilograms you would weigh on Mars now, multiply your mass by 0.37.
So would you be lighter or heavier on Mars than on Earth?



Mission on Mars, Part II

LEVEL: **BEGINNER** INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
ASTRONOMY / ARTS

LEARNING OBJECTIVES

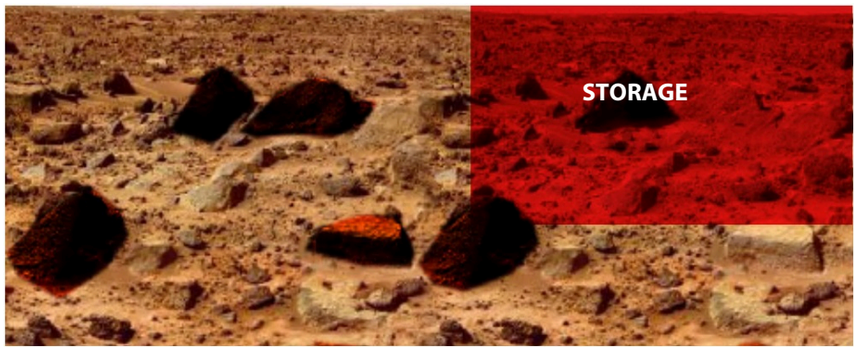
- Building a path for the robot.
- Creating a robot capable of grasping, lifting and transporting objects.
- Programming the robot created.

TEAM ACTIVITY 10 min.

MARTIAN TERRAIN

Using materials from Art&Craft, the Fable kit and 3D printed accessories, build a trail that simulates Martian terrain. The trail will have obstacles, Martian "rocks" and other elements you think are necessary for this project. For the samples to be collected, you can use Styrofoam balls, paper balls or any other existing or lab-made items. Keep in mind that the robot needs to be able to pick them up, lift them and carry them. Lightweight materials are recommended. The placement of these obstacles is up to you.

Also create a designated storage area where you will place what you harvest from the planet's surface.

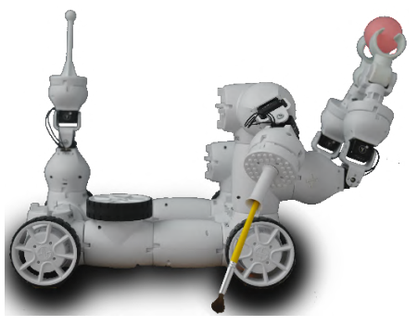


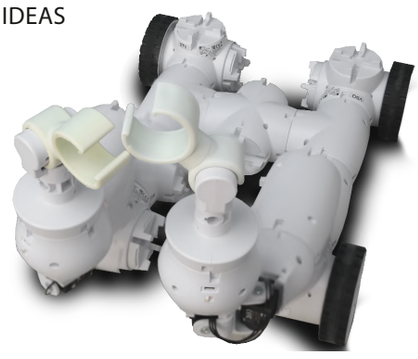
TEAM ACTIVITY 10 min.

THE ROBOT

Build and program a robot so that it can move (controlled from the keyboard), grasp and pick up objects. The robot's mission is to collect "Martian stones" from the path you have built. For this task you need the robot to be equipped with arms, pliers, double-sided adhesive tape... Each sample collected from the bottom will be moved to the storage area and the robot will return to the trail to collect more samples.

BUILDING IDEAS





DID YOU KNOW?

Six Rovers are now on Mars. Sojourner (1997), Opportunity (2004), Spirit (2004), Curiosity (2012), Perseverance (2021), Zhurong (2021). Of these, the last three are actually operational. The first five belong to NASA and the sixth belongs to the Chinese Space Agency.

DID YOU KNOW?

The Perseverance rover also took a very ambitious helicopter to the planet. Its name is Ingenuity. It cost $80 million and has already managed to fly distances of more than 700m at 5.5m/s in a single flight.

Ingenuity's role is simple but very important. It demonstrates that we can fly to the surface of another planet and at the same time provide a different view from above than the ground-based rover.

TEAM ACTIVITY 20 min.

COLLECTING MARTIAN SAMPLES

Once you have completed the first two activities, you are ready to test your constructions. Time the times in which you manage to complete the task of collecting three Martian samples. Look for other solutions to meet the same requirements. Have you found better solutions by changing the configuration of the robot or modifying the program it runs on?

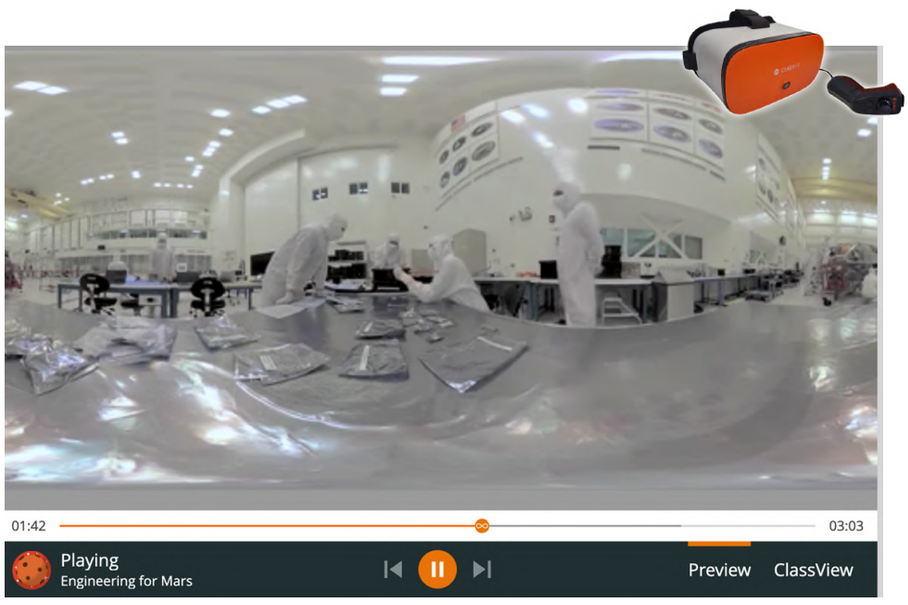
Test each program and assembly model and observe the results while handling the robot. Note in your notebooks which solutions are more successful and why they are better (what you have modified).

After this stage is completed, modify the program so that you can use the console and graph area in the FableBlockly application. What data could you display there? Would saving the data help you?

TEAM ACTIVITY 5 min.

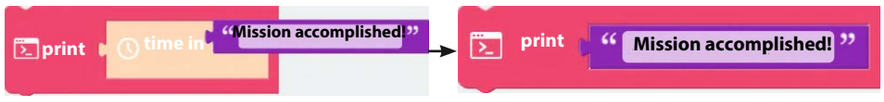
NASA LABORATORY

Open the ClassVR app, go and type in the search bar "Engineering for Mars". With the VR headset you'll enter the NASA lab where the Mars rover is being developed. Listen carefully to the information you receive. What impressed you most?



Modify the program of the rover so that it can also display data in text form. To do this go to the Advanced Mode section, Text category in the menu. Here you will find two commands. Use this command combination every time you want to display a message in the console.

It simulates a communication mode with the "base", so that the robot transmits the result of an action, whether or not it was successfully completed.



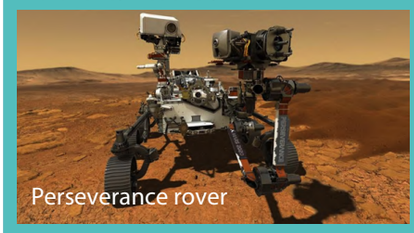
CONCLUSIONS YOUR ROVER ON MARS

Collecting samples from the surface of other celestial bodies is nothing new. Such work can be carried out either autonomously or by remote command. Such robots are also used on Earth to collect objects from hard-to-reach areas or areas with a high risk to humans.

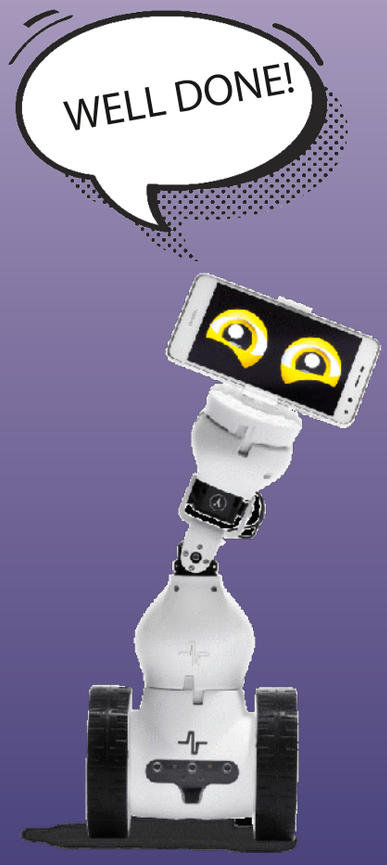
The equipment of such robots can be very sophisticated. They can detect temperature or noise anomalies, even operate a tap, open a door, go up or down stairs. If you could build a robot to collect samples from another planet, what additional tasks would you give it?

DISCOVER!

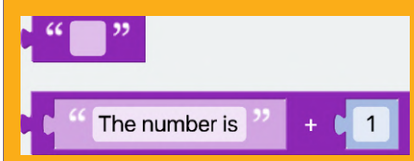
Find out what the weather is like on Mars today by visiting the website: https://mars.nasa.gov/mars2020/weather/


Perseverance rover


Zhurong rover



NEW BLOCKS!



These command blocks allow you to work with a character, a word or a line of code.

New Functionalities - 2-Step Lesson

LEVEL: BEGINNER INTERMEDIATE ADVANCED

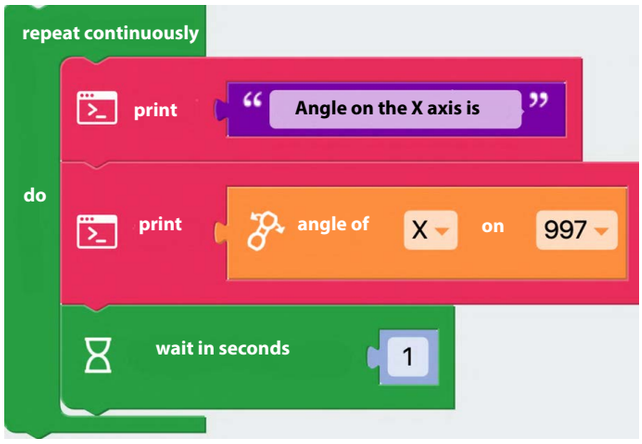
FIELD ROBOTICS AND PROGRAMMING

LEARNING OBJECTIVES

- Building model that bring new functionalities.
- Solving real-life situations.

STEP 1 REVIEW

Analyze the following program and say what the result is after running it. Connect a Joint module to the computer, write the program and check your answer.



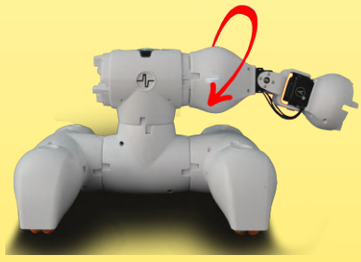
STEP 2 SOME ROBOTS DON'T HAVE WHEELS

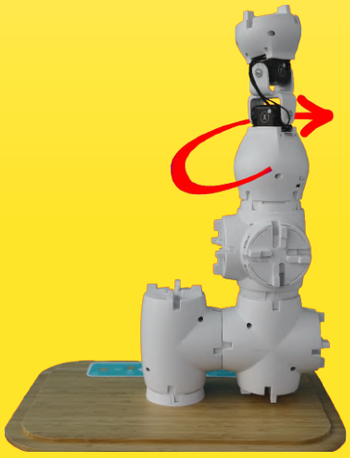
Not all robots move. Most of them, in fact, sit still or perform tasks in close proximity, so they don't move much or at all. The Spin module can operate without wheels. In the Fable kit the wheels are accessories. With the Spin mode's two motors you can spin other components and accessories. If the Joint arm can't rotate, connecting it directly to a Spin motor gives it new functionality.

Almost always a task has several possible solutions, both from a hardware and programming point of view. Take two electric machines as an example. You will quickly find differences in terms of construction and technical features, as well as software functionality. Both machines fulfill their purpose, but come with different functions. The same goes for any other equipment or sub-assembly. There are, of course, optimal (best-fit) solutions, i.e. preferred because of a very good combination of several factors: construction price, materials used, lifetime, cost. Can you identify other aspects that can be included in this optimization of an equipment? Keep in mind that to do this you start from your need first.

Here on the right is an example of using Fable modules and components for the task - rotating a Joint arm.

Tell which option seems optimal to you and argue. What is the main reason why you think your choice is correct.



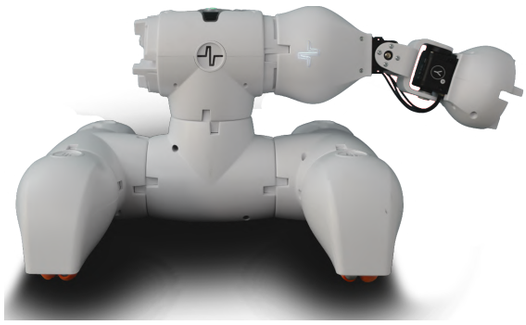


TEAM ACTIVITY 30 min.

OPTIMAL SOLUTION

For this activity you will work in a team of four colleagues. You have to build a robot that can hold a screwdriver and turn it back and forth. The control will be done manually, from keys. You also build a screw that can be screwed/unscrewed, using Fable accessories, 3D printed accessories and Art&Craft materials.

Here's a construction idea. As you've seen in other lessons, you can find a multitude of solutions.



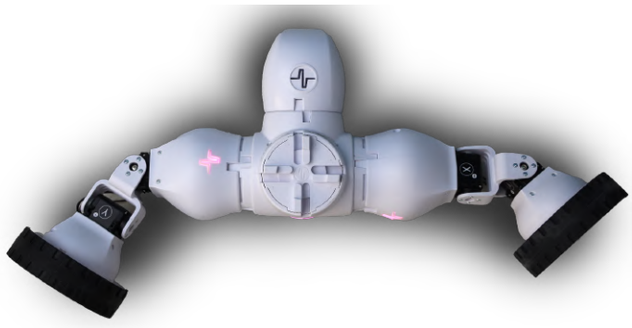
What situations have you faced along the way and what solutions have you tried? Do you also consult with other teams and choose together which solution is optimal for the task at hand? Discuss how you made your choice and what benefits the optimal solution brings.

Fix the constructed screw to a wall. Add wheels to your construction and write a program that allows the robot to move, position itself in line with the screw and rotate the screw (screw in and out).

TEAM ACTIVITY

10 min.

Build the model below. Program the machine so that it can move back and forth. Could you make it take turns too?



EXTRA ACTIVITY

For this activity you will make teams of three or four members. You will need cardboard, double-stick tape, tape, colored pencils/markers, Styrofoam balls, ruler, 3D printed items, Fable modules and accessories, phone.

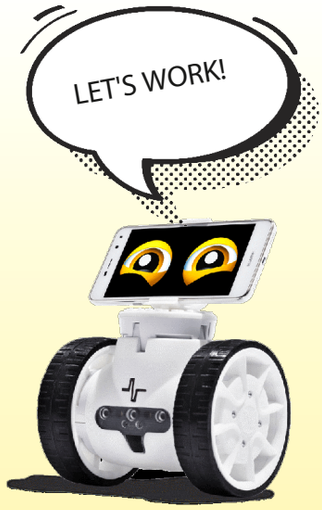
Build a cardboard pipe (L=1.5m) through which you can move a Spin module. Pay attention to its minimum diameter! Use mathematical measurements for this. Glue some Styrofoam balls to the inside walls of the pipe at various points. These Styrofoam balls will represent the deposits that appear on sewer pipes. Your robot will clean these deposits.

When building the robot, think about the fact that you need to be able to move the robot inside the pipe and point its arm at the balls that need to be removed.

Try to evacuate the "removed deposits" through the other end of the pipe.

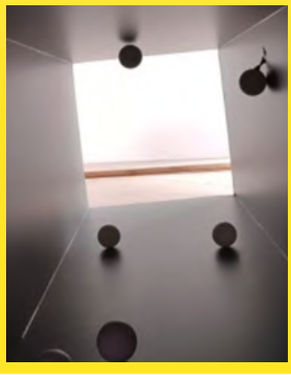
CONCLUSIONS

The fact that there are several solutions to a problem is a very good thing. Even in the classroom you have seen that throughout the school year you have practiced a multitude of choices for construction, programming and even how to approach it. Simple solutions are always more sought after. You'll always start from your needs. If you need a fast machine, you may not be interested in too much power consumption. And if you want a machine that uses little power, you won't have the most powerful car. Both choices are correct because they are related to the user's needs.



IDEAS TO ACCESORIZE THE ROBOT

IDEAS FOR PIPE CONSTRUCTION



Joust - ACTIVITIES

LEVEL: BEGINNER INTERMEDIATE ADVANCED

FIELD ROBOTICS and PROGRAMMING
HISTORY / ARTS

LEARNING OBJECTIVES

- Coordination of automatic and manual actions to accomplish work tasks.
- Remote control of a Joint module via another Joint module.

STEP 1 JOUST

During peacetime in the Middle Ages, knights also trained in public performances, often organized by the king himself. The shows featured mock battles between groups as well as contests between two participants. Such events were very well prepared and were the time to display weapons, armor, battle horses, flags and coats of arms, and many spectators were invited.

One of the most attractive competitions was the joust, in which knights competed in demonstration battles. Among the events in the competition were: spear throwing, cutting pumpkins or melons with a sword, knocking an opponent off his horse with a jousting lance.

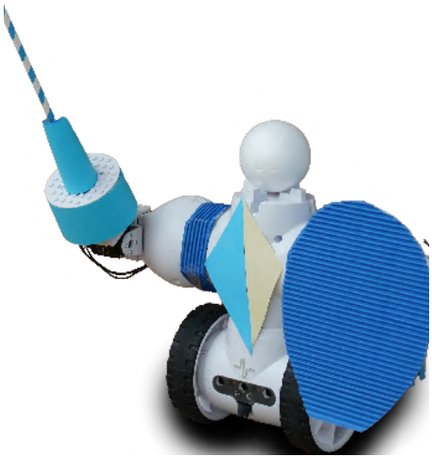
TEAM ACTIVITY

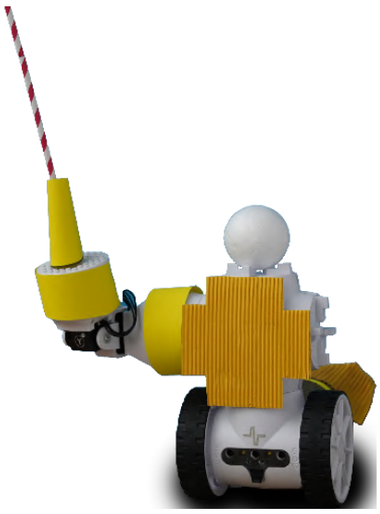
10 min.

EQUIPPING THE KNIGHT

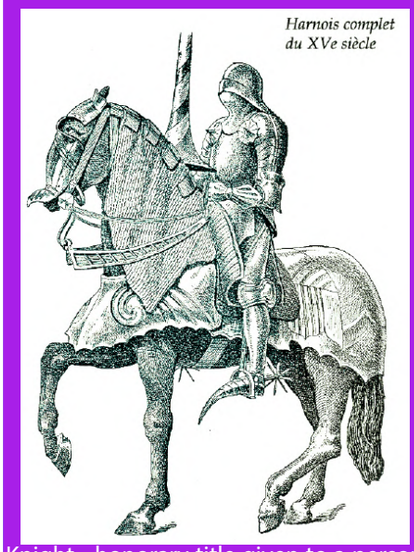
Use a Spin module, one or two Joint modules and other items of your choice from the lab to create a spear knight. Wheels will help him move, and a Joint module will help him wield the spear. The other module will control the shield. Your knight will participate in a joust. Using items from the Art&Craft corner, create a uniform and shield for your knight. Build a 20cm long spear and attach it to the robotic arm.

BUILDING IDEAS





DID YOU KNOW?



Knight - honorary title given to a person belonging to a knightly, lay or religious order.

Photo source: Wikipedia

DID YOU KNOW?

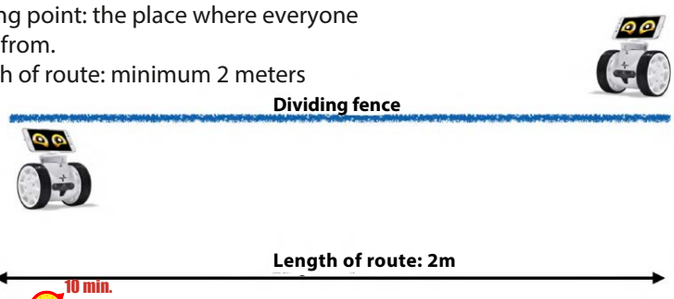
The Middle Ages, or Medieval Period, is the period between Antiquity and the Modern Age. The medieval period is divided into three: Early Middle Ages, Classical Middle Ages and Late Middle Ages and covers the 5th to 15th centuries. The Middle Ages began with the fall of the Roman Empire (476) and were characterized by many social and political changes.

GROUP ACTIVITY

5 min.

With the help of Fable accessories and items from the Art&Craft area, build your jousting route. Below are the specifications. You can embellish the route with flags or other elements that you find interesting and representative of the event.

- Dividing fence: it is designed to prevent knights from entering each other's land. The height of the fence will be a maximum of 10cm.
- Starting point: the place where everyone starts from.
- Length of route: minimum 2 meters



ACTIVITY

10 min.

KNIGHT CODE

Open the FableBlockly app and write a program that meets the following requirements:

- The knight starts from the start point at the press of a button, moves only forward at full speed and stops at the finish point.
- The spear is controlled manually from the keypad. For this you can use the angle readout for Joint or even variable modules. There are several workarounds, test and choose the one that suits your strategy

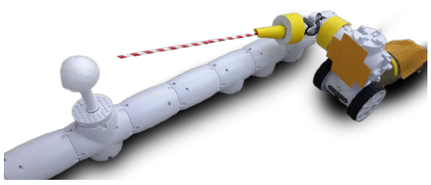
ACTIVITY

20 min.

JOUST

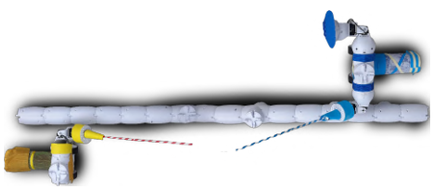
TRY 1

Grab a Styrofoam ball in the middle of the fence and maneuver your knight so that you knock the ball down as you pass by it. Repeat the challenge three times and score each knight.



TRY 2

Attach a Styrofoam ball with plasticine to the knight's head. You will all use the same method of gripping and the same amount of plasticine. Control the knights so that as one passes the other, it knocks the opponent's ball down. Repeat this try several times and note the score.



TRY 3

Clip a circle in the middle of the fence. Control the knight to insert the spear through the circle when passing through the circle. Repeat this three times and record the score of each knight.

EXTRA ACTIVITY

To make things even more interesting, you can control the Joint module with the help of another another Joint module, without using the keyboard control. Open the FableBlockly app and go to the Follow the Leader category in the menu.

CONCLUSIONS

ROBOTICS AND PROGRAMMING

You've seen over the course of this year that robotics is not just about robots, but rather it is a multidisciplinary field that mixes elements of design and construction techniques for computer and mechanical systems with resulting actions over the environment. The jobs of the future require technical skills, whether you're an architect, painter, lawyer, or engineer. That's why it is so important to understand how things work around you and to always try to improve them.

DID YOU KNOW?

The spear was an old attack weapon made of a long wooden rod and a sharp metal point. The spear was used for ranged attacks.