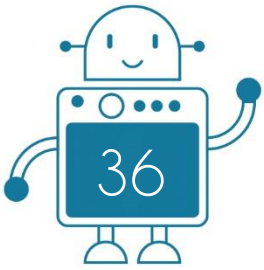


MATH RACE

STEMJAM Teaching Guide

Developing make spaces to promote creativity around STEM in schools

Acronym: STEMJAM
Project no. 2016-1-ES01-KA201-025470

www.stemjam.eu

Co-funded by the Erasmus+ Programme of the European Union

MATH RACE

ABSTRACT

The idea is to create a "math race" in between two mBots, commanded by two students´ teams.

On first version, the main goal of activity is writing a program using:

- Variables
- Generating random numbers
- New block defined by student (also with parameter)

Students will solve Math problems of different level of difficulty, (such as solving linear equations with an unknown, second degree equations, and systems of linear equations with two unknowns). The solutions given by the students will generate reactions in the robots, which will interact with each other showing different effects (sounds, lights, etc.).

Each robot will win "life", if its team gives the correct answer. But, they also will lose “life” every time the team gives a wrong answer.

DIDACTIC OBJECTIVES

TECHNOLOGY

- Introduction to computational thinking.
- Assimilation, creation and programming of algorithms, to decompose complex problems into ordered sequences of simple instructions, which solve it.

MATHEMATICS

- Solving linear equations with an unknown.
- Solving second degree equations.
- Solving systems of linear equations with two unknowns.

STEM Subject: Science☐ Technology ☒ Engineering☐ Mathematics☐

Education Level: 12-14 years☒ 14-16 years☒

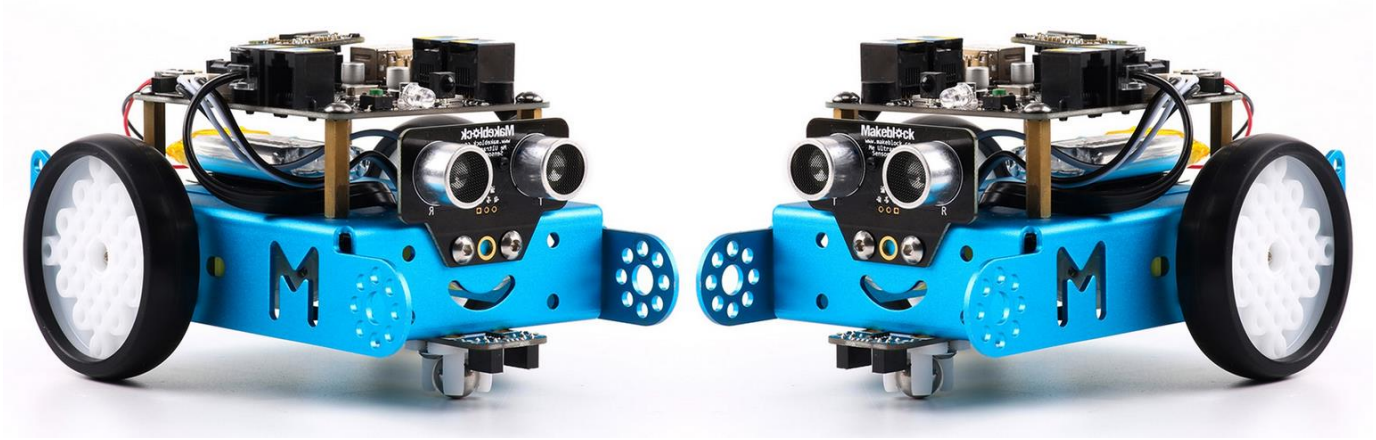
PROBLEM STATEMENT

The mBot robot has to be programmed to work altogether with the laptop, by creating the operations' algorithms and the resultant effects. This way, when the students calculate the answer to one equation, there is a specific effect on the robot and so there is in the race.

To build a robot to make a competition between two teams. Thinking about difficulties of maths operations. The basic one is for children at the beginning of primary school. Next you can make the problem more complex - add division with rational result. At the end – solving linear equation.

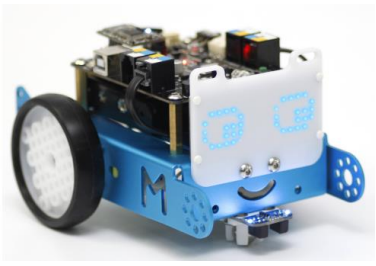
BOM (Bill of Materials Needed)

- (x2) mBot => Ref. 90054



- (x2) Me **7-Segment Serial Display - Red**:

- (x2) Me **LED Matrix 8 × 16**:



- (x2) Laptops.
- (x2) Calculators.
- (x2) Paper and pen.
- Starting and a finish line.
- Rest of Attrezzo (not essential).

ELEMENT	ID	CABLE	AMOUNT	PORT 1			PORT 2			PORT 3				PORT 4				P.MOT1	P.MOT2
				Am	Az	Bl	Am	Az	Bl	Am	Az	Bl	Ng	Am	Az	Bl	Ng	Bl*	Bl*
Mbot Robot 2´4G			2																
Motor 1	Bl*																	Bl*	
Motor 2	Bl*																		Bl*
Matriz de LEDs	Az	2	2		Az														
Display 7 segmentos (4 dígitos)	Az	2	2												Az				
RJ25 cables			4																
Structures																			
Support P1			2																
Cut-out beam			1																
Laptops			2																
Atrezzo (not essential)																			

ACTIVITY DESCRIPTION

First version

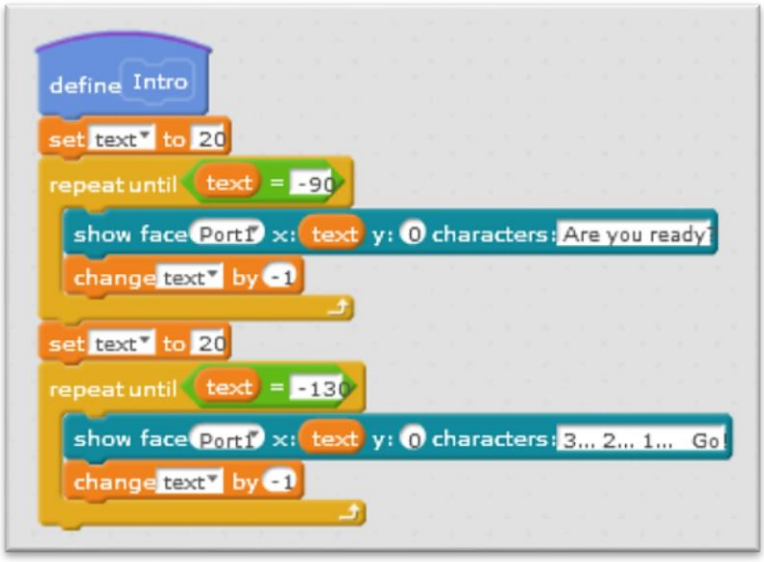
The aim of the activity is to practise Math exercises (such as solving linear equations with an unknown, second degree equations and systems of linear equations with two unknowns) by applying technological competences and working in a ludic environment.

This target will be achieved, since the students will have to design the programming blocks related to the robot's movement, as well as the different sound and dance effects for the activity.

Since programming needs to be designed so that a series of Math exercises lead of to another more difficult ones, mBlock software will be used for that purpose.

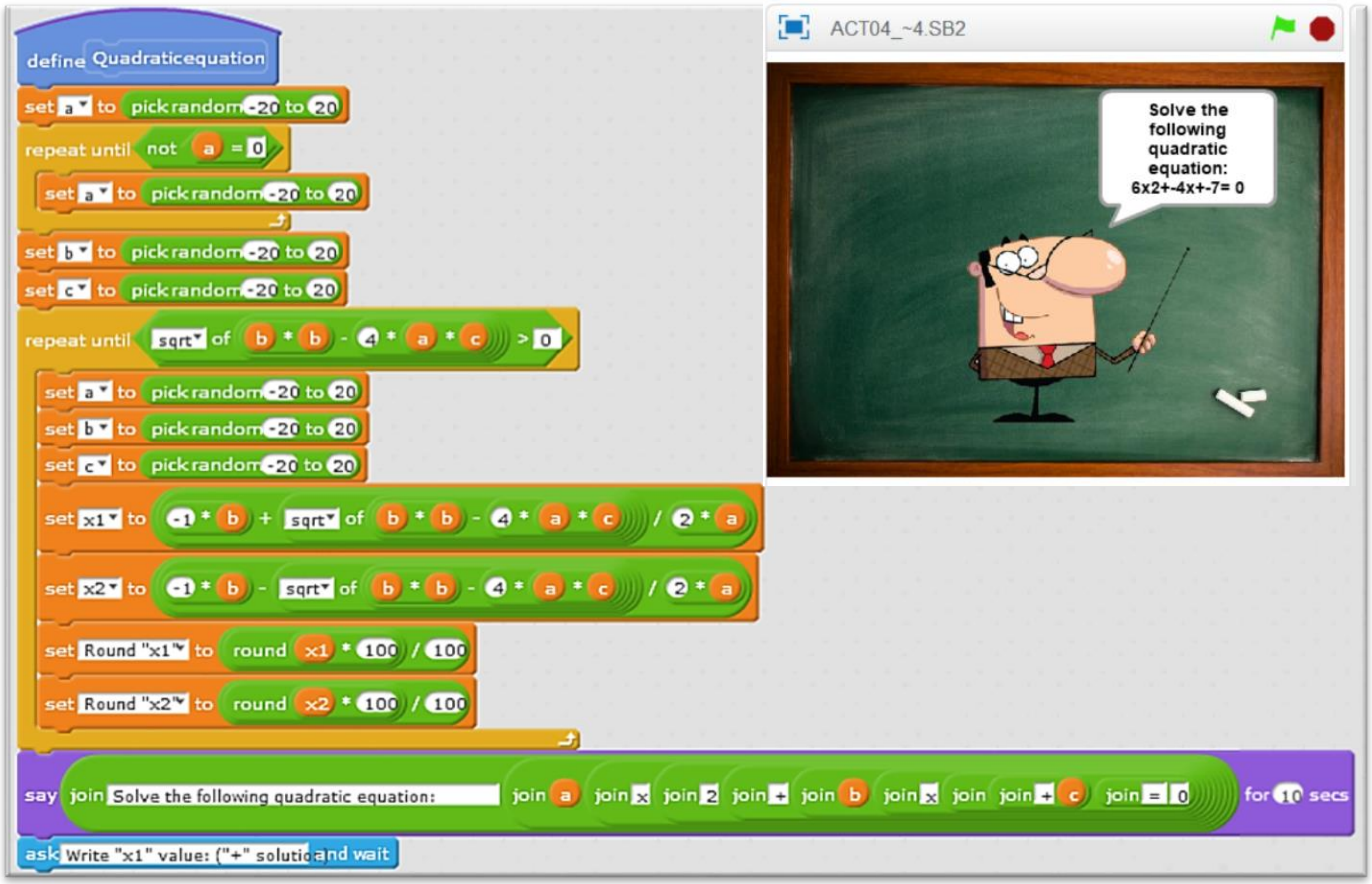
The first step is to start with PROGRAMMING tasks.

1. INTRODUCTION DEFINITION

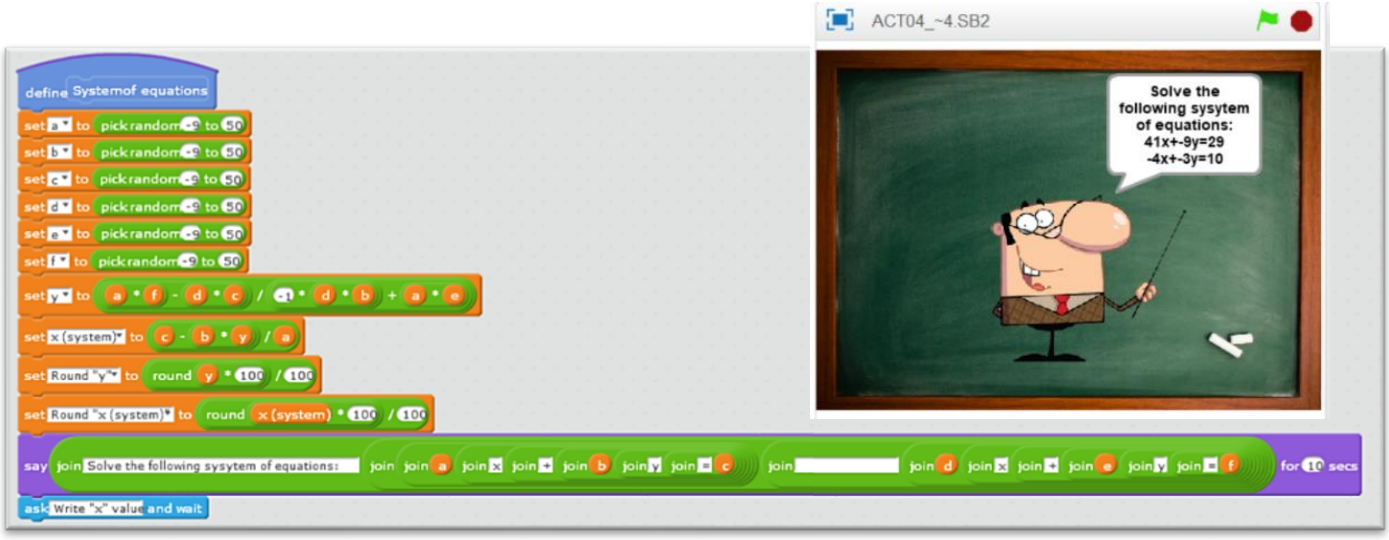


2. FIRST CHALLENGE DEFINITION: a simple equation

3. SECOND CHALLENGE DEFINITION: a quadratic equation

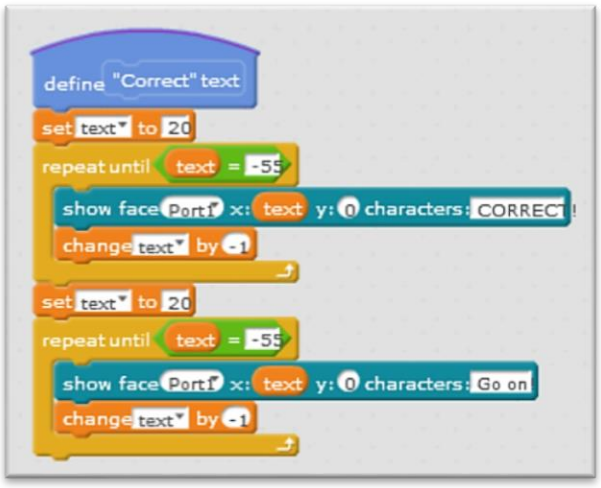


4. THIRD CHALLENGE DEFINITION: a system of equations



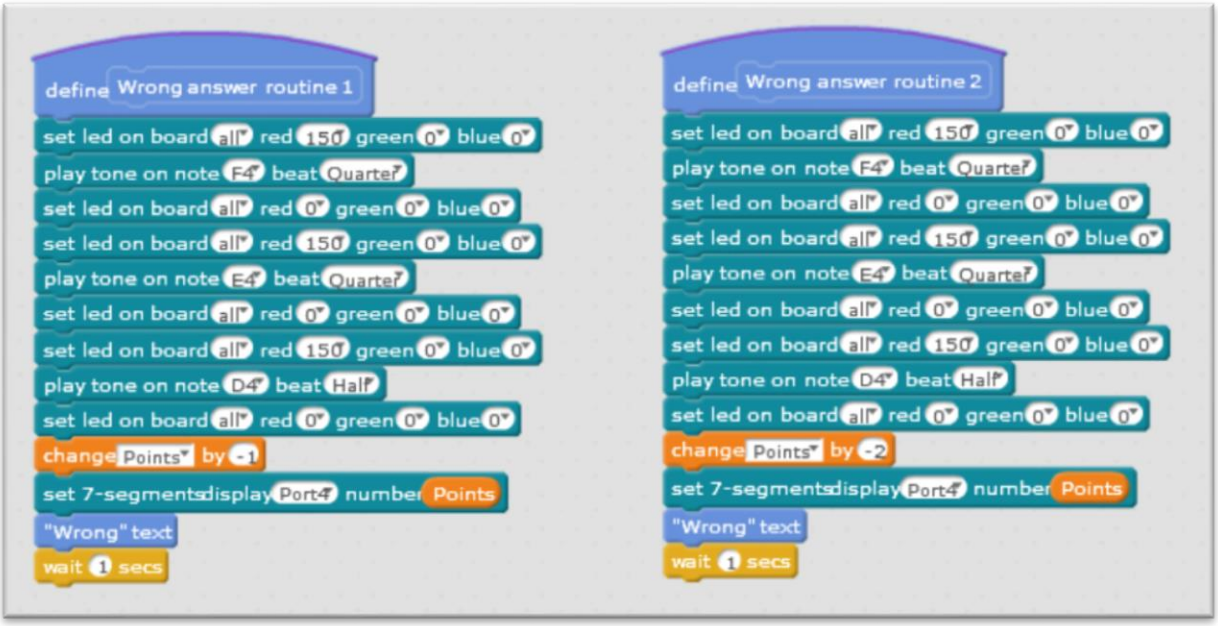
5. DEFINITION OF THE DIFFERENT "RIGHT ANSWER" ROUTINES:

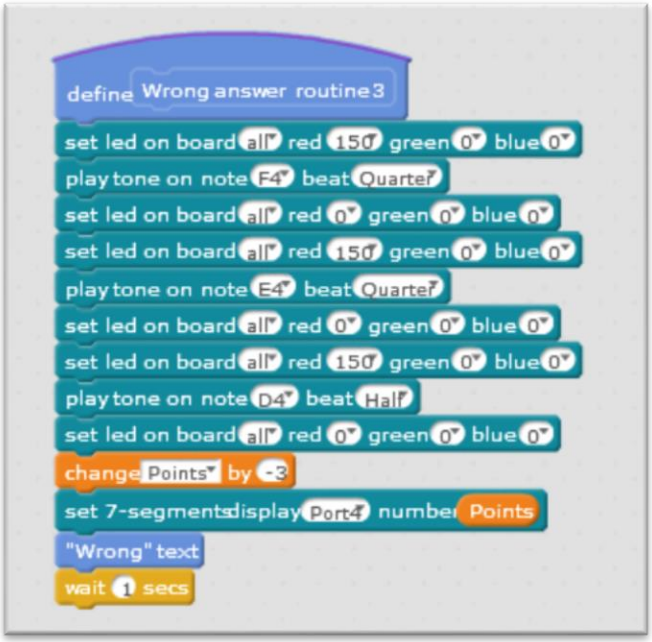
- **"Right answer routine 1":** performed when the team completes an equation successfully.
- **"Right answer routine 2":** performed when the team completes the first unknown ("x1" from the second degree equation and "x" from the system of equations).
- **"Correct text":** text performed during the "Right answer routines" when a team finds the right solution.

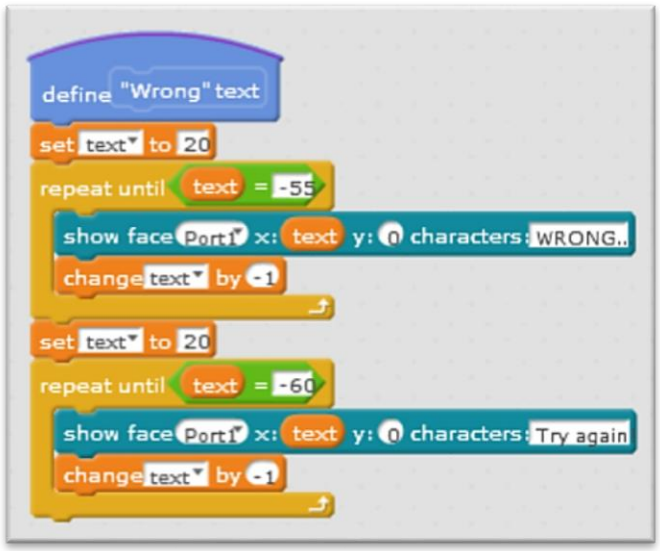


6. DEFINITION OF THE DIFFERENT "WRONG ANSWER" ROUTINES:

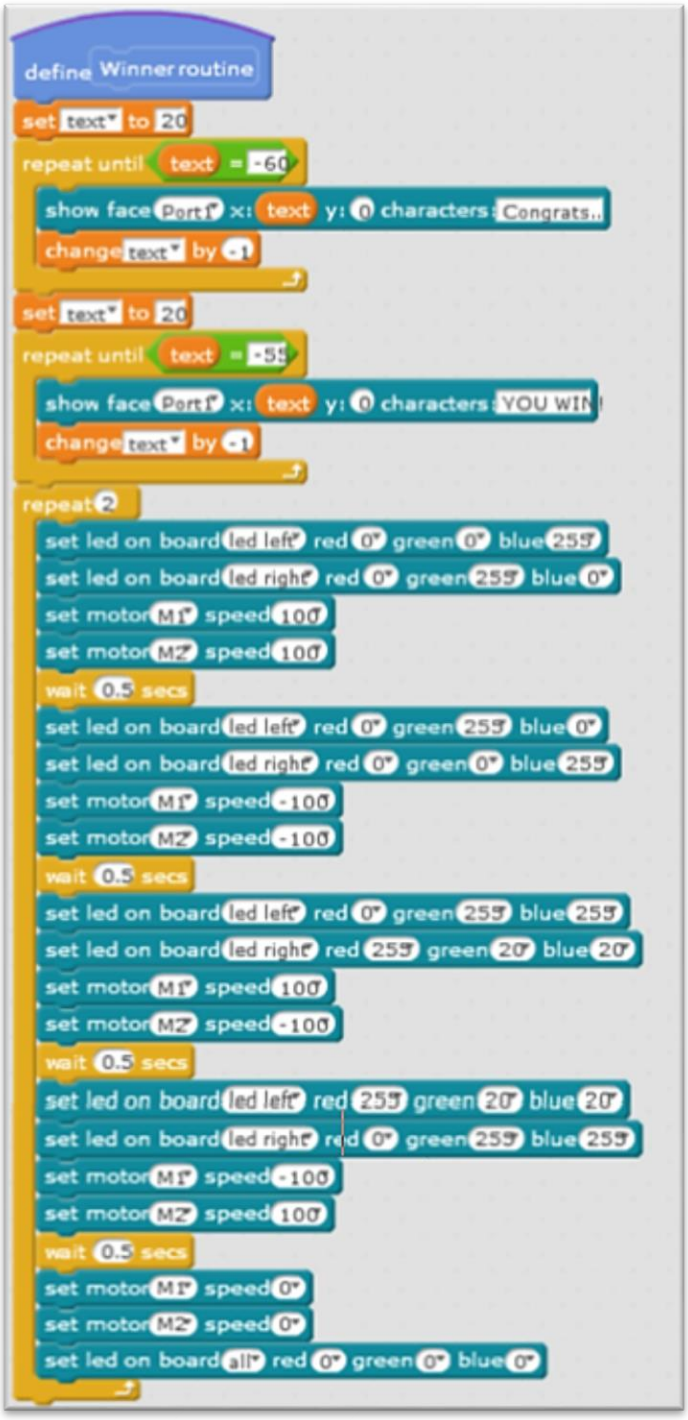
- **"Wrong answer routine 1":** performed if the team does not develop correctly the simple equation.
- **"Wrong answer routine 2":** performed if the team does not develop correctly the second degree equation.
- **"Wrong answer routine 3":** performed if the team does not develop correctly the system of equations.
- **"Wrong text":** text performed during the "Wrong answer routines" if a team does not find the right solution.


define Wrong answer routine 1
set led on board all red 150 green 0 blue 0
play tone on note F4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note E4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note D4 beat Half
set led on board all red 0 green 0 blue 0
change Points by -1
set 7-segments display Port4 number Points
"Wrong" text
wait 1 secs
define Wrong answer routine 2
set led on board all red 150 green 0 blue 0
play tone on note F4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note E4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note D4 beat Half
set led on board all red 0 green 0 blue 0
change Points by -2
set 7-segments display Port4 number Points
"Wrong" text
wait 1 secs

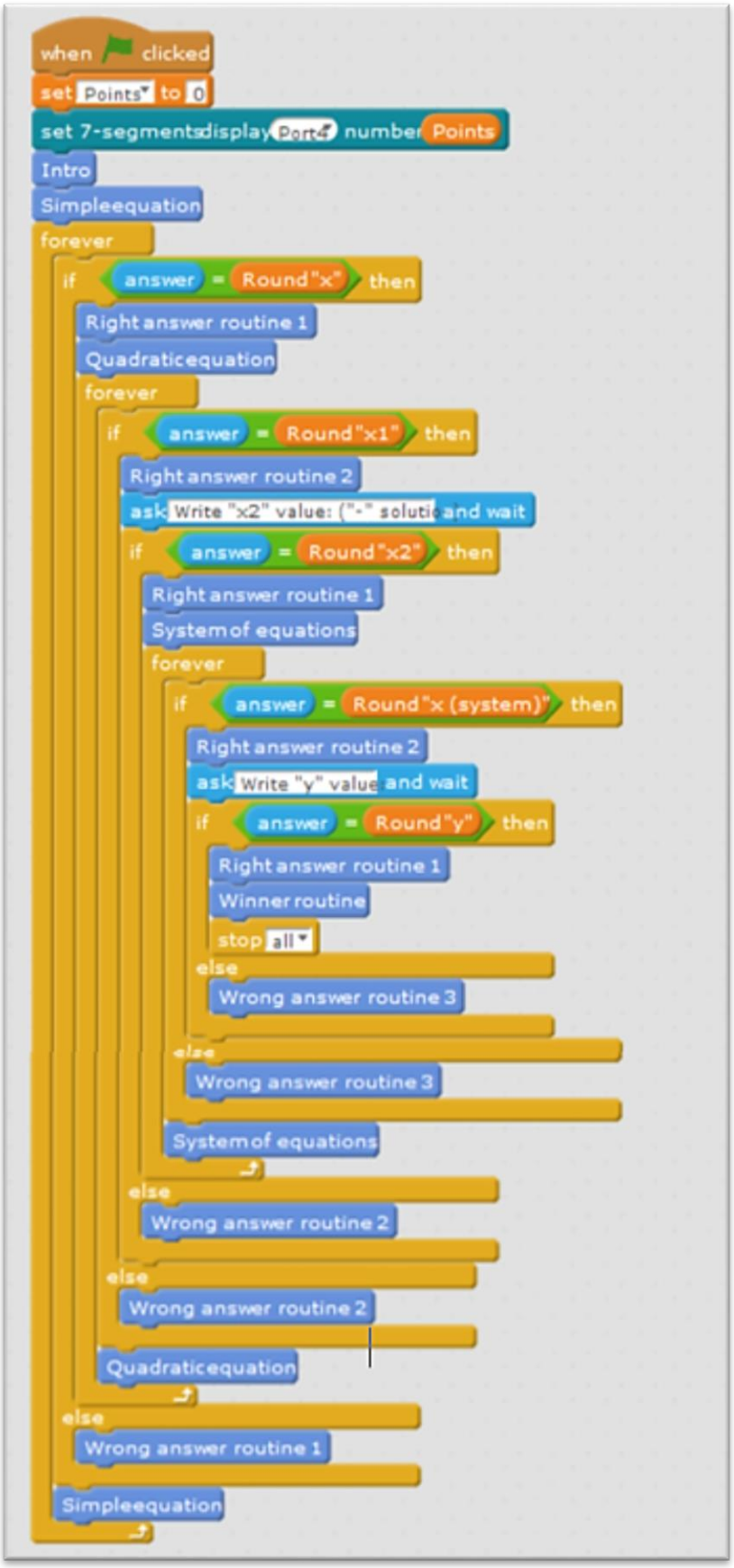

define Wrong answer routine 3
set led on board all red 150 green 0 blue 0
play tone on note F4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note E4 beat Quarter
set led on board all red 0 green 0 blue 0
set led on board all red 150 green 0 blue 0
play tone on note D4 beat Half
set led on board all red 0 green 0 blue 0
change Points by -3
set 7-segments display Port4 number Points
"Wrong" text
wait 1 secs


define "Wrong" text
set text to 20
repeat until text = -55
show face Port1 x: text y: 0 characters: WRONG..
change text by -1
set text to 20
repeat until text = -60
show face Port1 x: text y: 0 characters: Try again
change text by -1

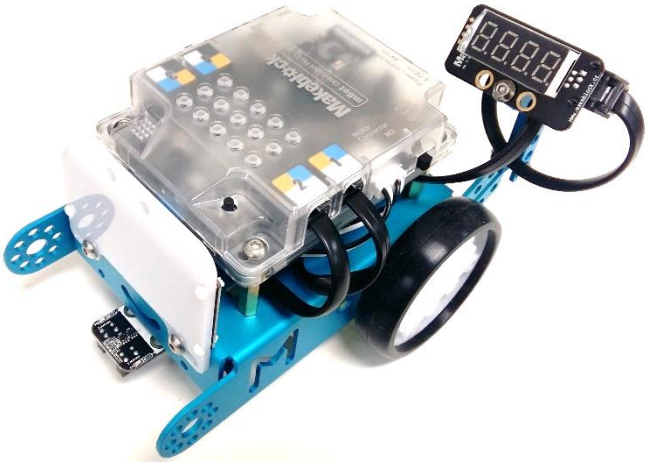
7. DEFINITION OF THE WINNER ROUTINE: performed when a team arrives to the finish line

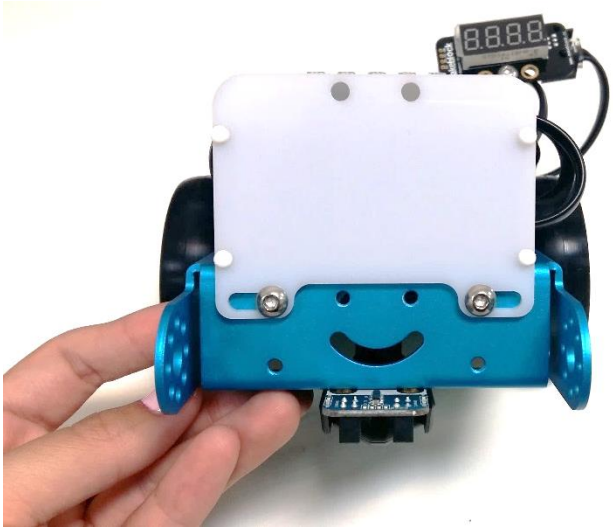


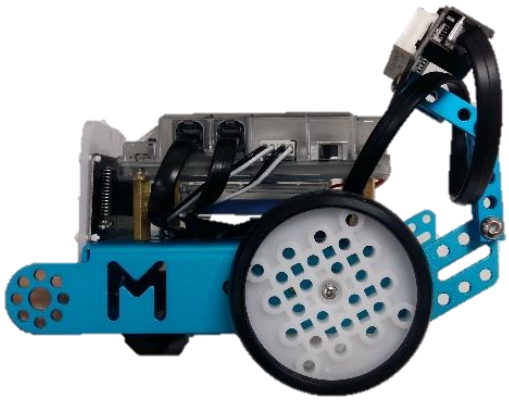
MAIN PROGRAMME: the sequence of the activity

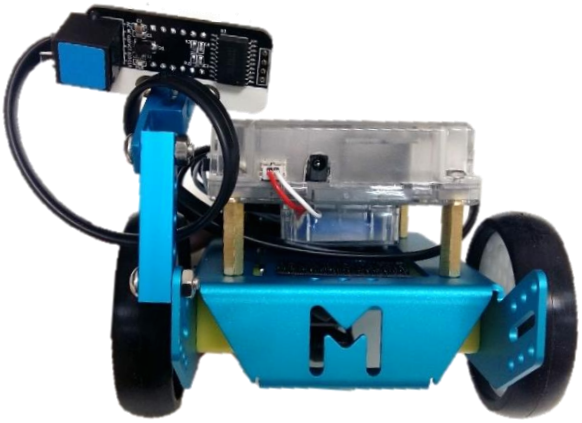


Once, the programming is finished, we start building up THE STRUCTURE, where all the mechanical elements will be set. Also the electronic elements.

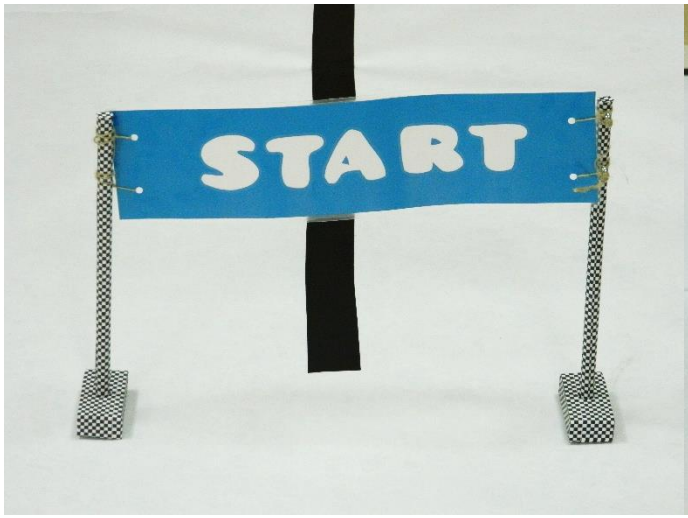









FINISH
START


START


FINISH
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Second version

The aim of activity is to build complex program, but this program should consist of subroutines and function to make it easier to control.

We start from the easiest version: Program gives the math operation to solve like addition, subtraction and multiplication numbers from 1 to 10.

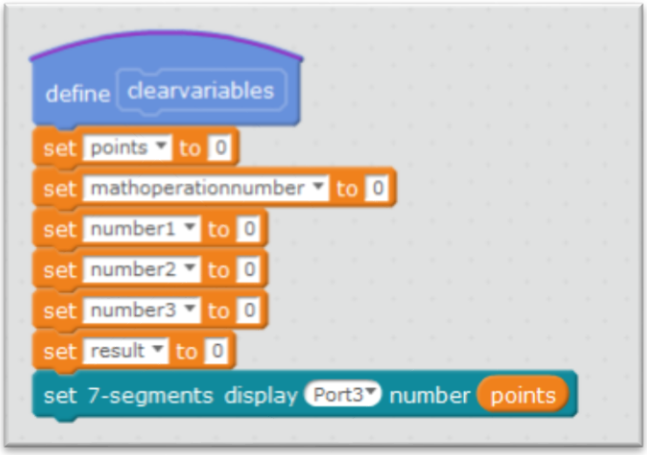
If the answer is correct the player receives one point, the robot go forward. There is the text “Correct” on the led screen.

Else the player loses one point. There is the text “Wrong” on the led screen.

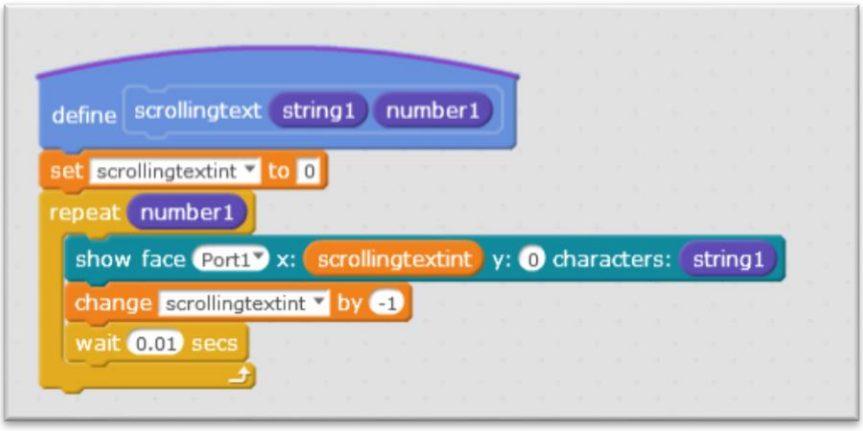
The program runs in forever loop

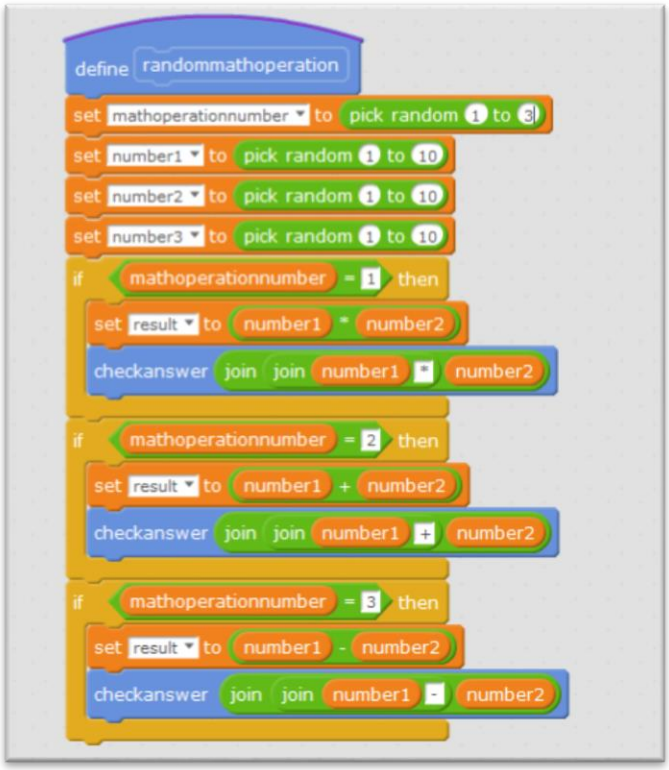
THE BASIC PROJECT**:** the basic program consist of four functions:

1. Function 1, which set variables to 0. It will be used at the beginning of program.



2. Function 2, which show on LED screen the inscription (string parameter). The parameter number 1 depends of length of the string.

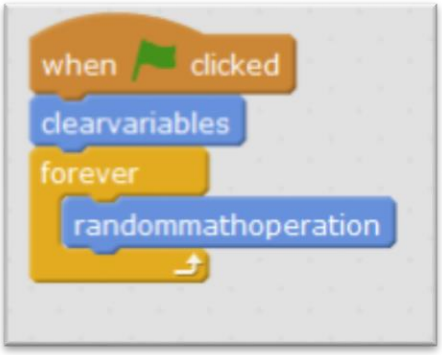




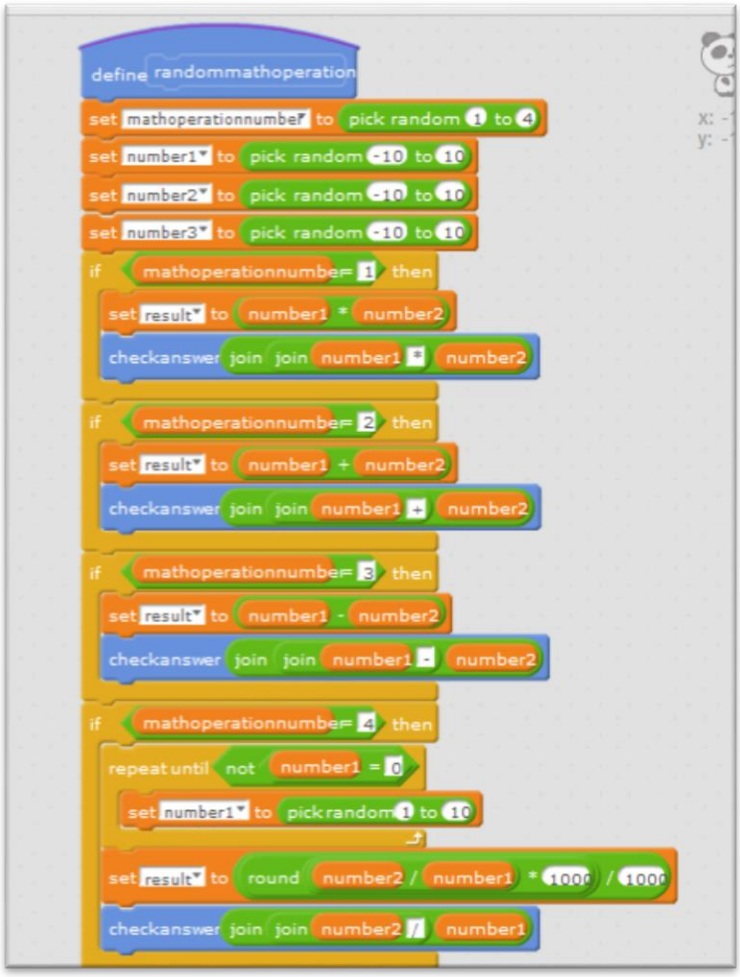
3. The first action of the function Checkanswer is displaying the math operation on the screen of computer. This operation is passed as a string parameter. The computer wait for the player answer. Then it compares it with right answer and controls the robot (robot goes and show the text)

The main program is very short. The firs instruction is clear variables.

Then we can put the function randommathoperation to forever loop.



Second Version: To randomoperation function we add next math operation – devision. The dificulty is that the result could be rational numer and we have to round the result.



We add fourth IF instruction. We have to also check divider – it can't be zero. In repeat loop we pick new divider, which is different from zero.

The result of division is rounded to 3 decimal place. The math operation is:

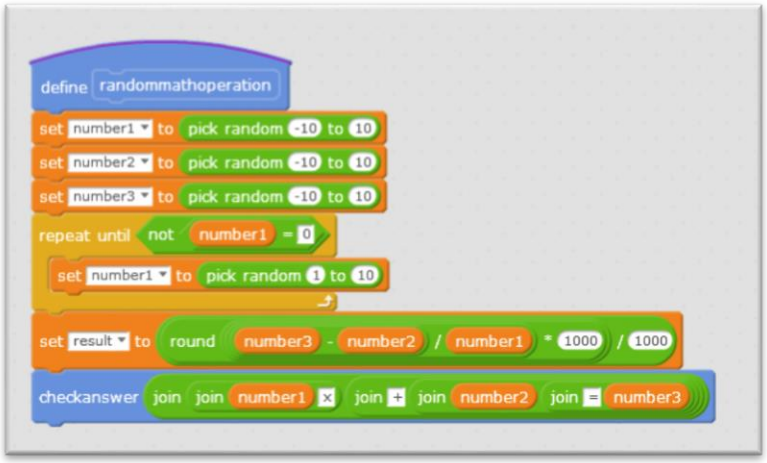
Round(result*1000)/1000

It is important for students to understand this construction, because it will be used in other programs.

Third version: Instead of simply math operation the student solve linear equation

$$ax + b = c$$

The *a,b,c* are numbers from the range -10 to 10

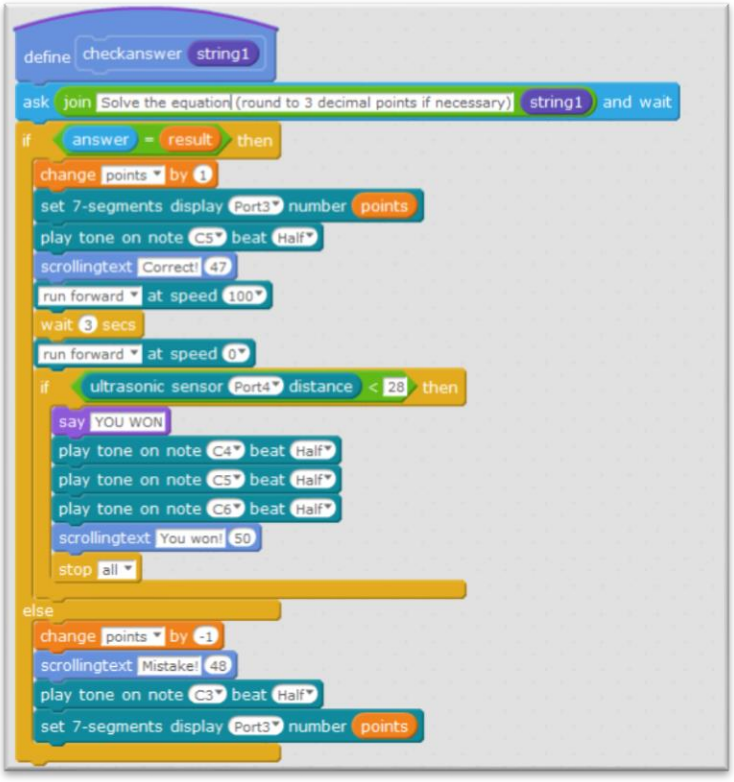


The solution is:

$$x = \frac{c - b}{a}$$

We need to round the result. In this exercise student built the more complex expression. The sequence of operation is realised by nesting instruction. This could be difficult.

Fourth version: We define the ending of the race. This time we use ultrasonic sensor. When the robot is near the wall the robot finish the program and show the statement “YOU WON”



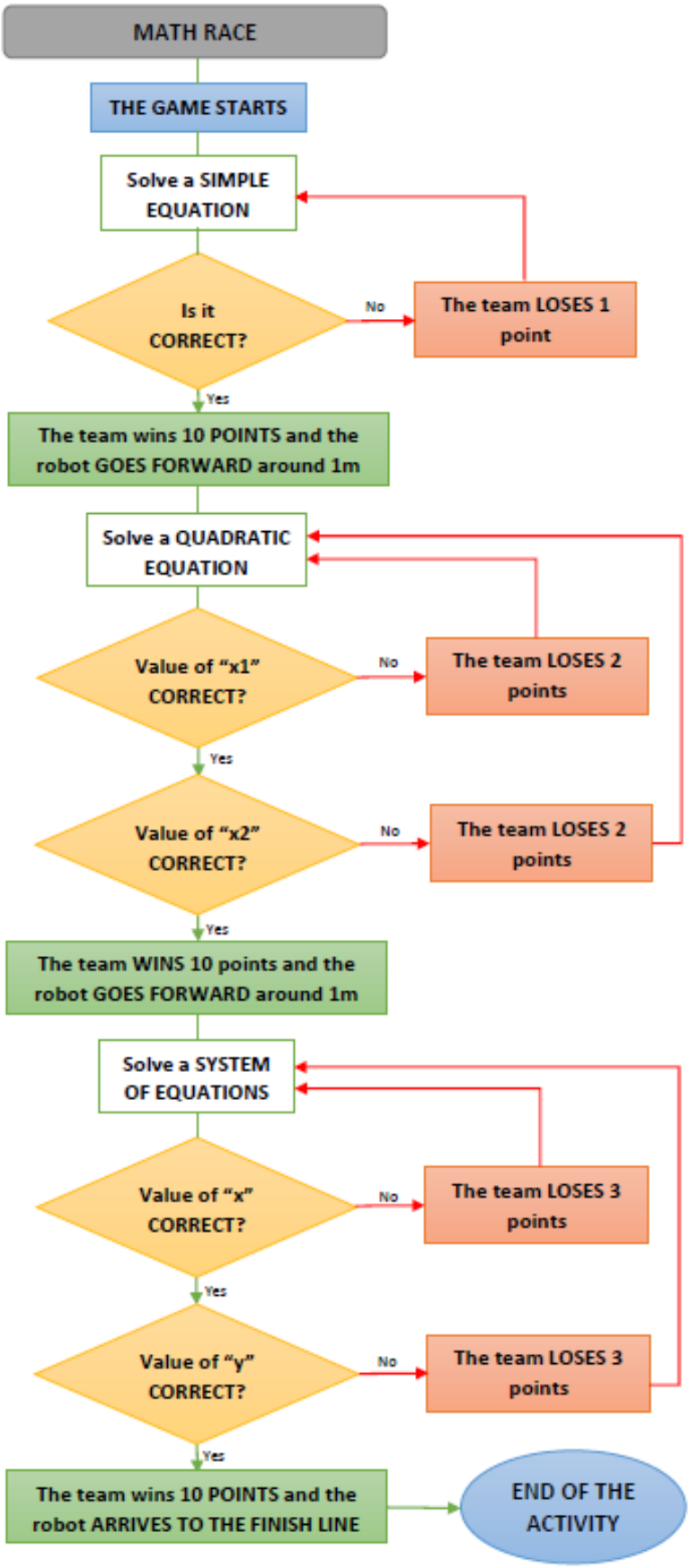
There are other option to end the race. For example, the race finished when the player gets 10 point.

Once, the programming is finished, we start BUILDING UP THE STRUCTURE where all the mechanical elements will be set, just as the electronic elements

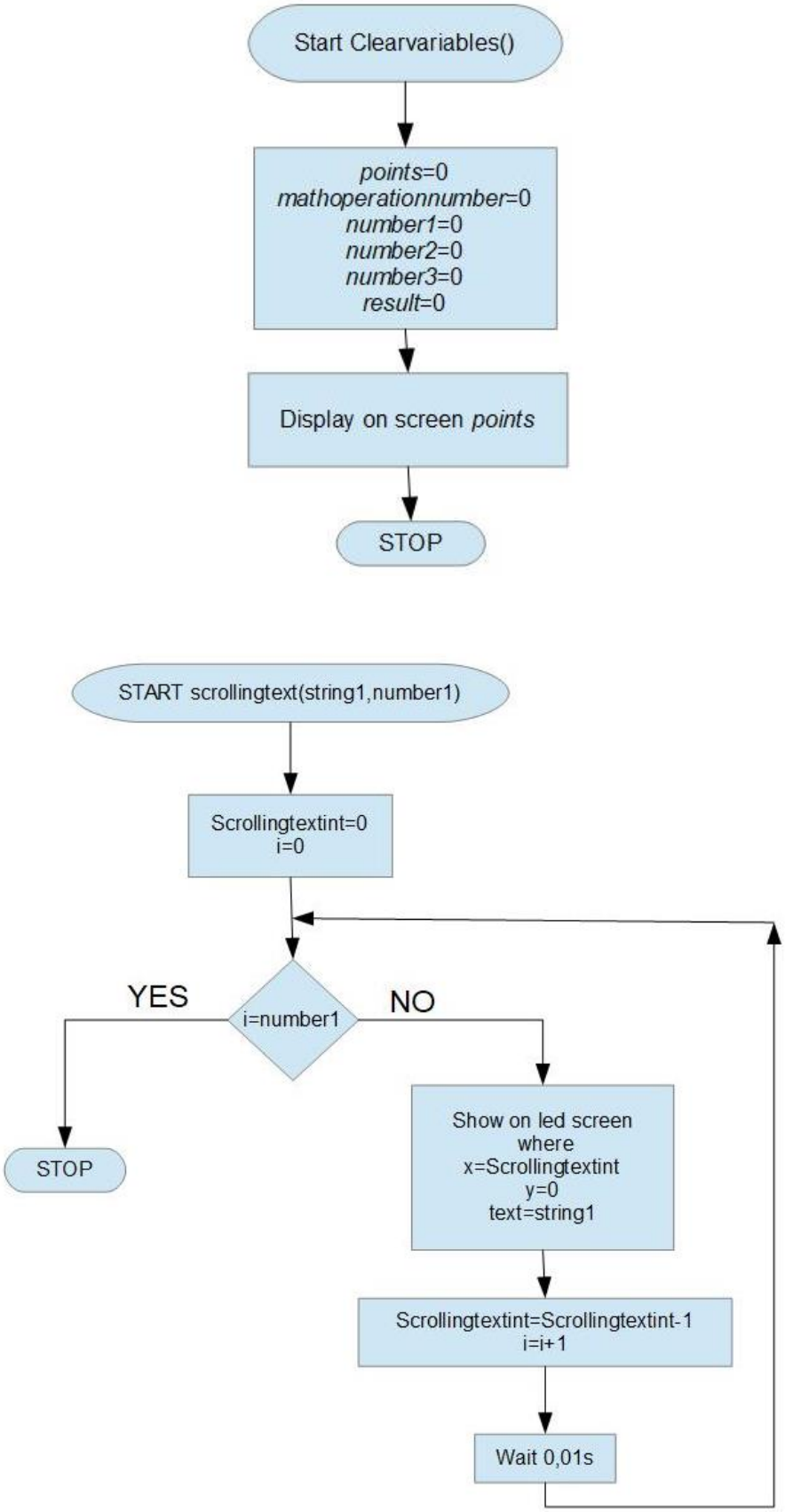
The math race in primary school:

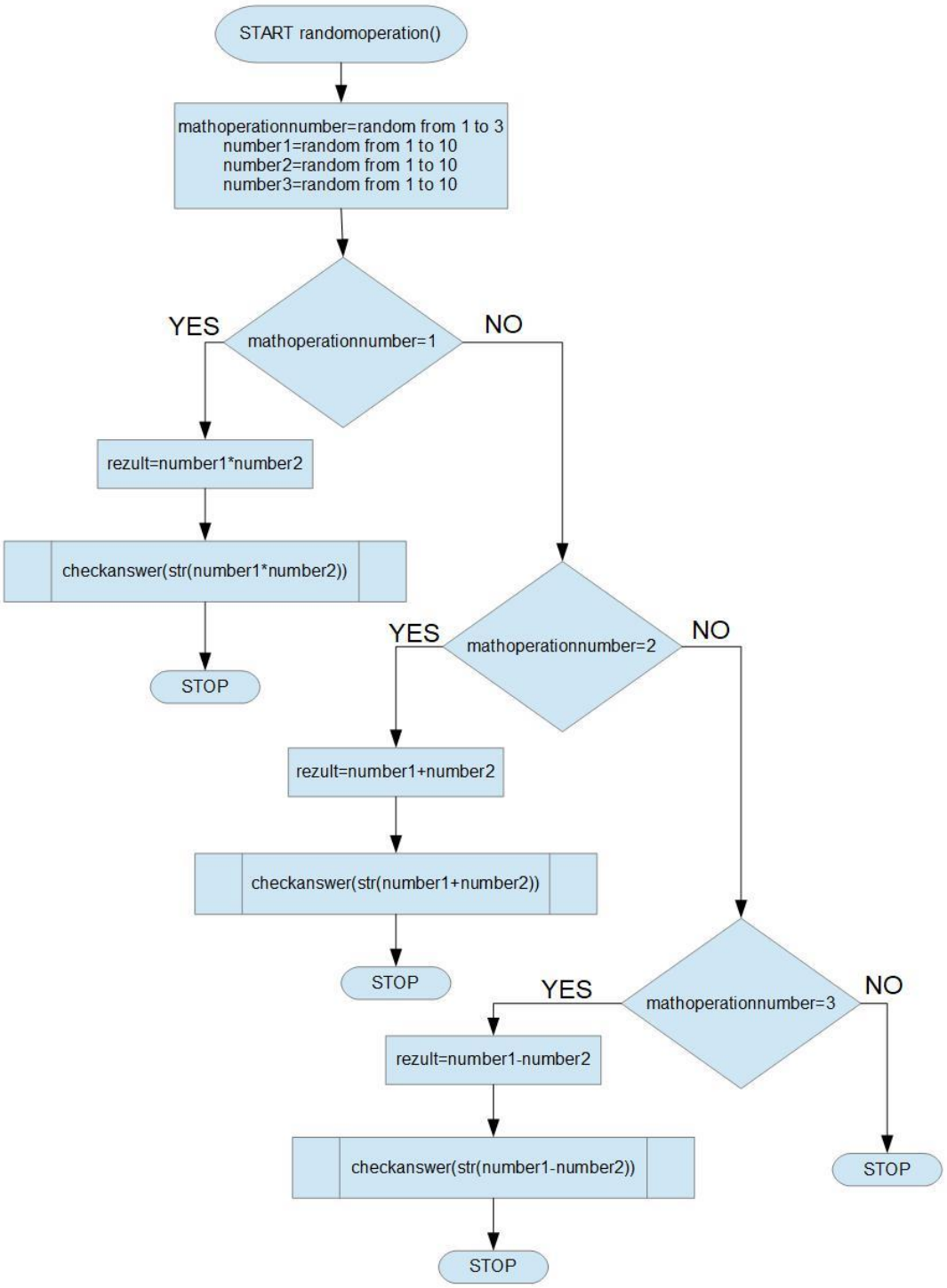
FLOW CHART

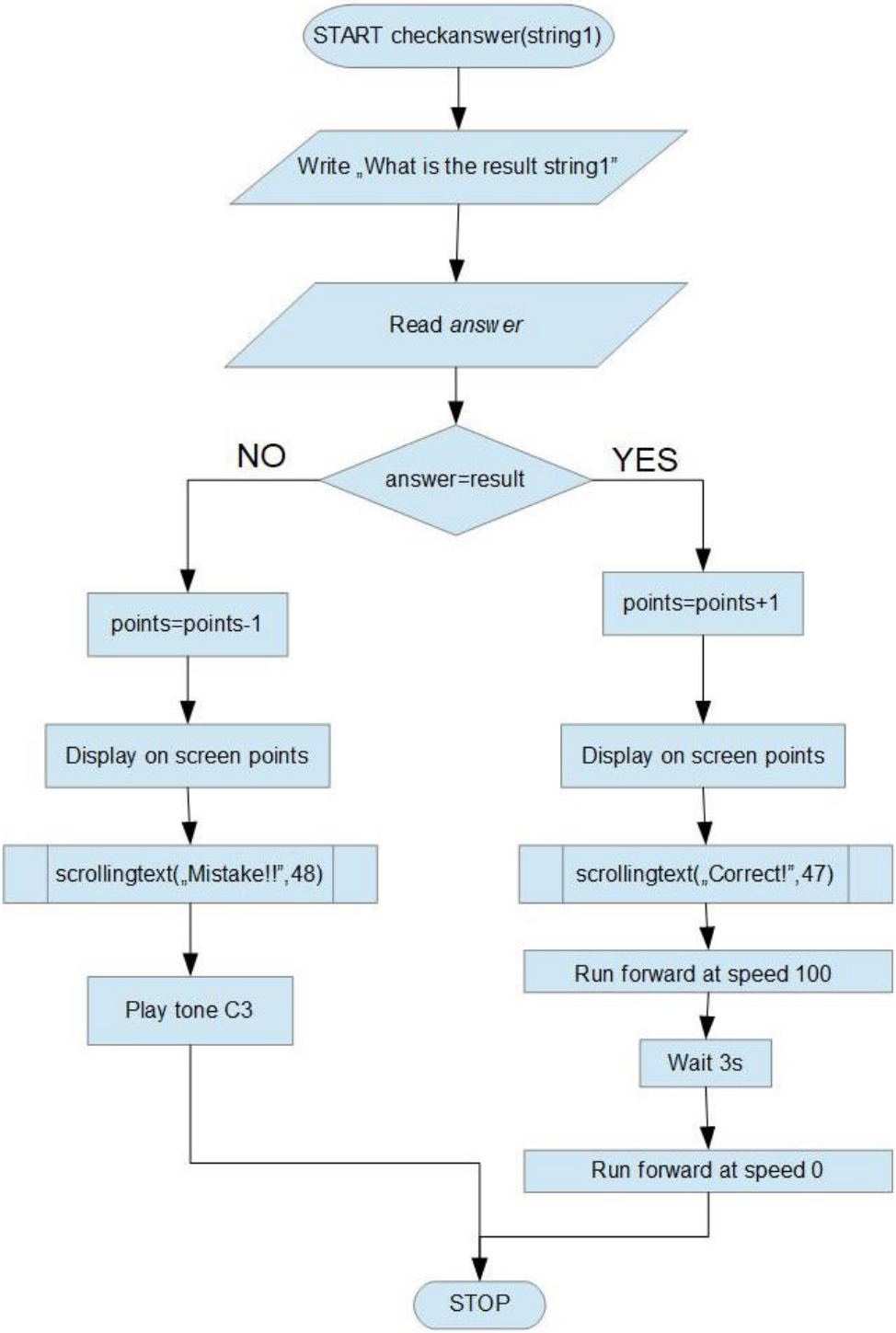
First version

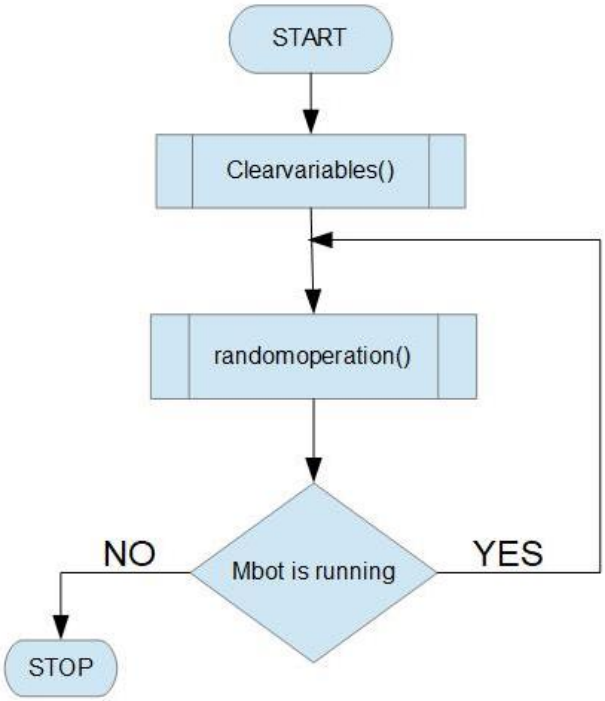


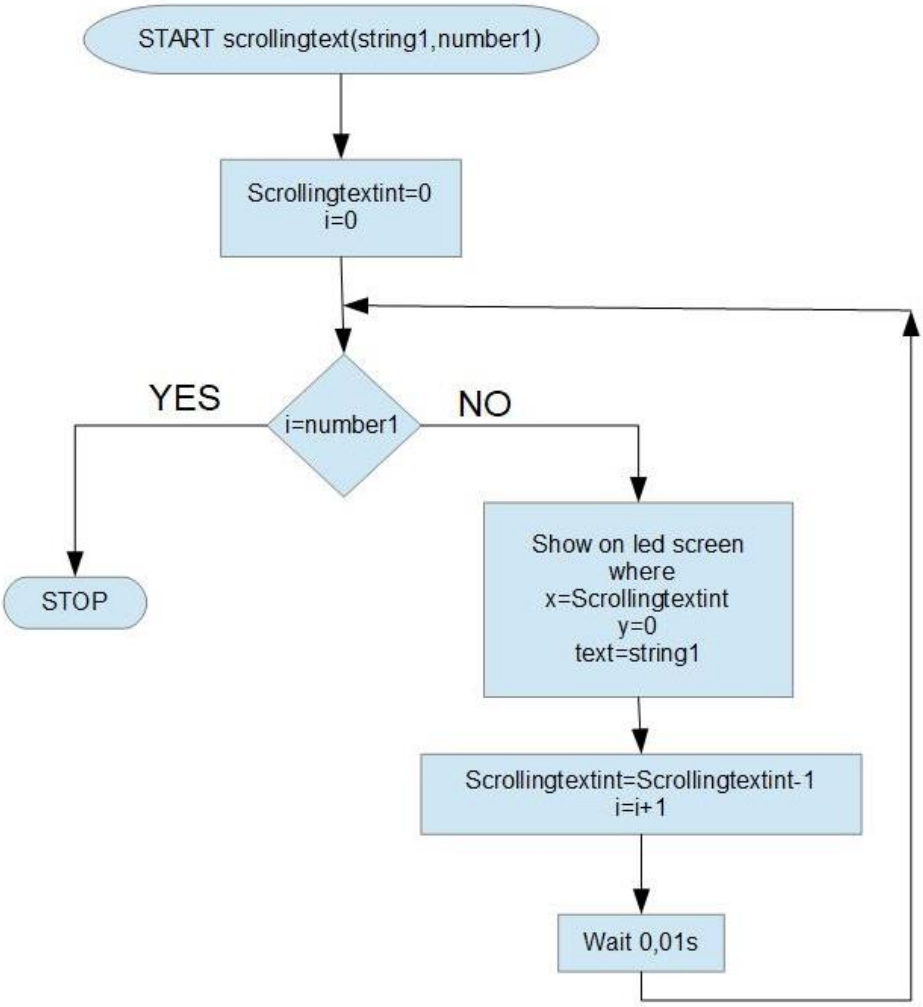
Second Version




START randomoperation()
mathoperationnumber=random from 1 to 3
number1=random from 1 to 10
number2=random from 1 to 10
number3=random from 1 to 10
mathoperationnumber=1
YES
NO
rezult=number1*number2
checkanswer(str(number1*number2))
STOP
mathoperationnumber=2
YES
NO
rezult=number1+number2
checkanswer(str(number1+number2))
STOP
mathoperationnumber=3
YES
NO
rezult=number1-number2
checkanswer(str(number1-number2))
STOP
STOP


START checkanswer(string1)
Write „What is the result string1"
Read answer
answer=result
NO
YES
points=points-1
Display on screen points
scrollingtext(„Mistake!!",48)
Play tone C3
points=points+1
Display on screen points
scrollingtext(„Correct!",47)
Run forward at speed 100
Wait 3s
Run forward at speed 0
STOP


START
Clearvariables()
randomoperation()
Mbot is running
NO
YES
STOP


START scrollingtext(string1,number1)
Scrollingtextint=0
i=0
i=number1
YES
NO
STOP
Show on led screen
where
x=Scrollingtextint
y=0
text=string1
Scrollingtextint=Scrollingtextint-1
i=i+1
Wait 0,01s

STUDENT'S EVALUATION

After the activity student who built the robot:

- Use variable.
- Can make block (the function with parameter).
- Can use round instruction.
- Devide program to smaller function.

This robot can be used to practise math operation on different level of education.

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"Scratch. Guía didáctica para profesores". (Pdf). (www.isuriarte.com)

Página web Scratch en español. (https://scratch.mit.edu)

"Jugando con MBlock". Makeblock España

"Divirtiéndome con MBot". Susana Oubiña

Comunidad de Makeblock en español. (http://www.makeblock.es/foro/)

MORE INFORMATION

DIFFICULTIES:

- MOTORS FOLLOWING A STRAIGHT LINE: when executing the order "move forward", robots tend to divert slightly to the left side. In order to correct it, it is advisable to set M1 (left motor) to a 255 speed and M2 (right motor) to a 245 speed.

- ARBITRARY PARAMETERS STABLISHMENT: when the second degree equations are created, "a" value cannot be "0" and the square root solution cannot be negative, since the result will not exist. The programme will have to find arbitrary parameters until these conditions are accomplished.

- ROUNDING: the "round" block rounds the solution to a whole number. In order to get two decimals it is necessary to multiply the result per 100, and afterwards to round that number divided by 100.