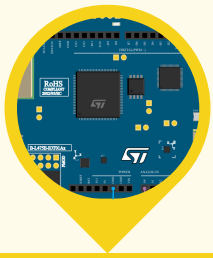
CHAPTER 3

BASICS OF PROGRAMMING - SOFTWARE AND HARDWARE

Authors :Jonathan Baudin, Sébastien Nedjar

As you are now aware from the previous chapters of the pedagogical pillars of the Let's STEAM approach (inclusion, equity, experiential approach), we propose to introduce you to the programming learning tools that are used in our activity proposals: the MakeCode editor and the STM32 board. This presentation will give you the initial information to start your projects with these software and hardware tools.



Technological choices made in this coursebook are proposed as they have a real pedagogical interest in the framework of the deployment of large and challenging projects using programming in secondary schools, from lower to higher levels. Specifically, this chapter will approach:

- **The Microsoft MakeCode editor**: a free, open-source platform for creating engaging computer science learning experiences that support a progression path into real-world programming. To access the Let's STEAM MakeCode follow this link: https://makecode.lets-steam.eu/
- The **STM32 IoT Node Board:** a board embedding interesting and relevant sensors and tools, useful for experimenting with challenging projects in the classroom.

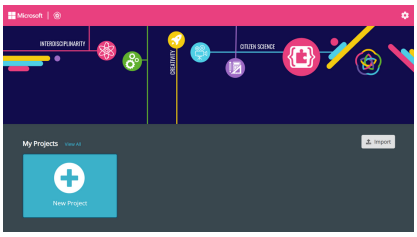
DISCOVER THE MAKECODE SOFTWARE SOLUTION FOR LEARNING PROGRAMMING

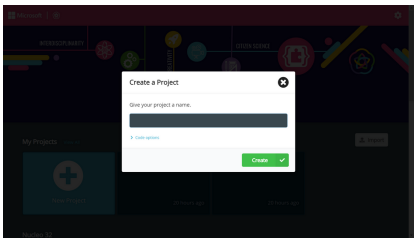
TAKE A TOUR OF MAKECODE

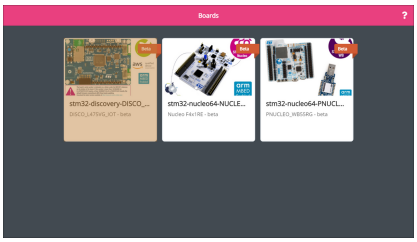
When you enter the MakeCode Let's STEAM website, you will directly land on the homepage. On this page, you can create a new project, open an existing project if you have been working on the editor before, view the supported boards and discover inspiring resources.

When you are creating a project, it is important to **name it with a clear and understandable title**, enabling you to express what will be the purpose of the program.

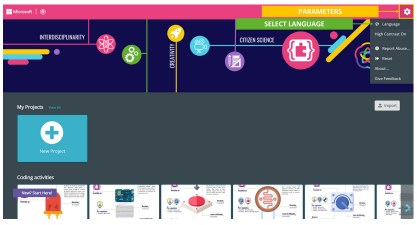
The next screen will request you to **choose the board on which you will work**. On the Let's STEAM activity sheets, all the examples have been developed using the STM32 IoT Node Board (the board is highlighted in orange in the picture presented here).

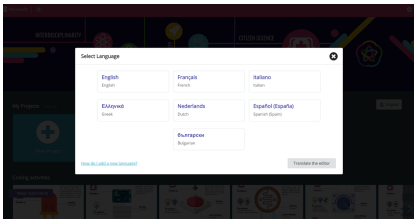




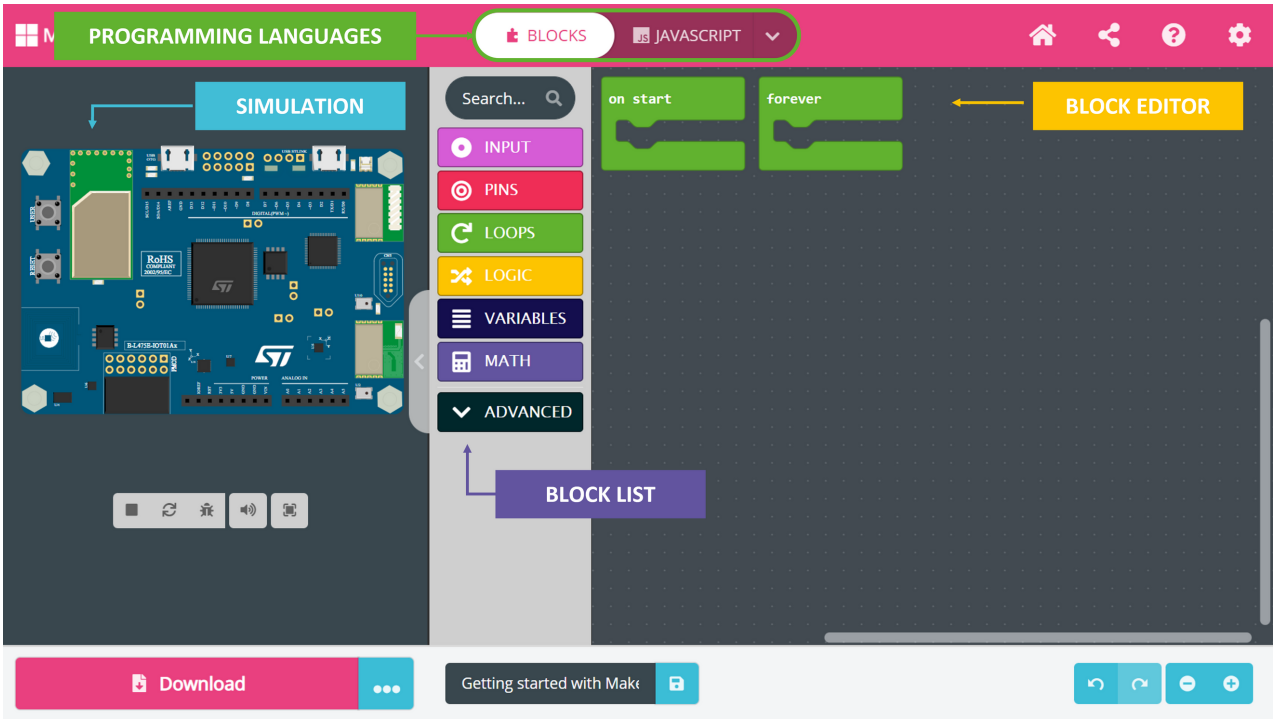


If the loaded interface is displayed in English when you launch Makecode, you can change the language by clicking on the "Parameters" button to see the supported versions.



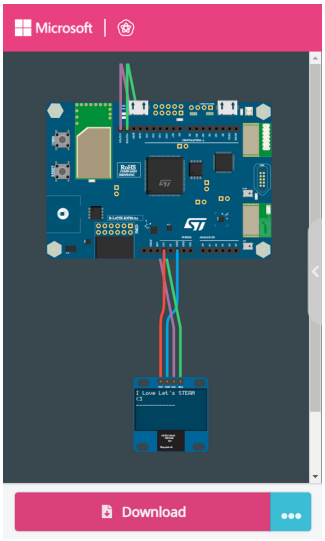


Once the board is selected, you will then have access to the editor, with three parts as shown hereunder:



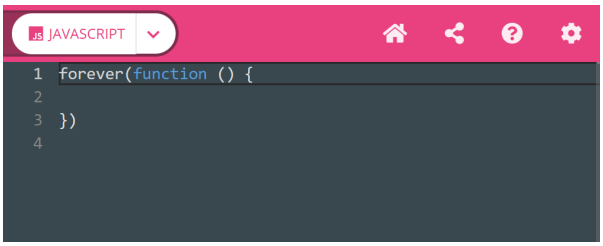
Here are the basic components of your editor:

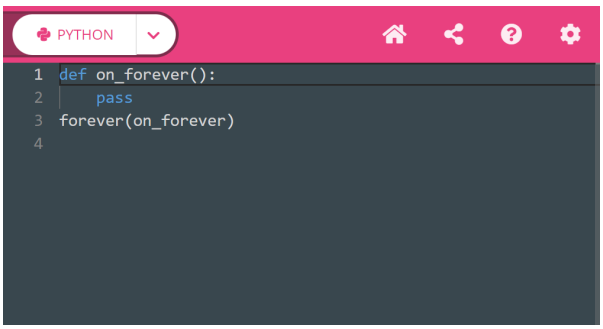
- The **SIMULATOR** (on the left side of the editor): an interactive simulator provides students with immediate feedback on how their program is running and enable them to test and debug their code.
- The **BLOCK LIST** in the middle, that can be used in your program to search for functions.
- The **BLOCK EDITOR** on the right part, that includes already 2 functions common to all activities: on start & forever loop. Students new to coding can start with coloured blocks that they can drag and drop onto their workspace to construct their programs.



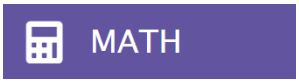
In the editor, you will also be able to choose the way of programming i.e.:

- **Through blocks** (see activity sheet R1AS1 - Blink a LED)
- **Through JavaScript editor** (all the activity sheets proposed in this coursebook will include the code in JavaScript that can directly be copy-pasted in this specific editor)
- **Through Python language** for more advanced students.



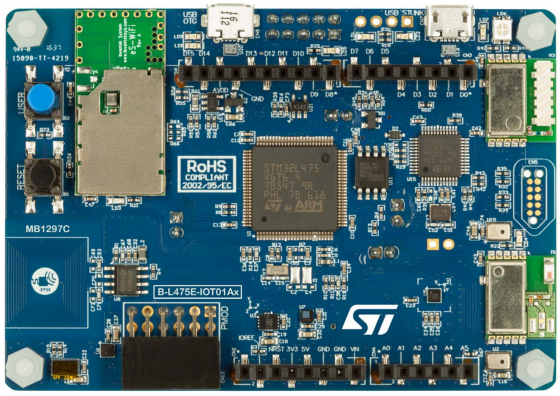


Even if you will have more precise insights on each block function in the diverse activity sheets proposed in this coursebook, here is the basic blocklist available that can be found on the Let's STEAM MakeCode editor:

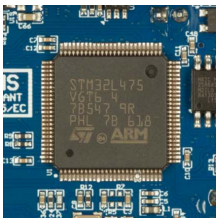
Input		Use sensors in your programme (such as buttons, thermometer)
Pins		Interact directly with the pins and change their status (from low to high, from on to off)
Control		Manage the execution of events
Loops		Implement repetitions
Logic		Perform tests, comparision and boolean logic operations
Variables		Create variables and counters
Math		Perform diverse mathematical calculations
Functions		Create subprogrammes
Arrays		Create a value or text in a table
Text		Modify texts
Console		Display data
Extensions		Access the list of extensions available in the MakeCode version
Datalogger		Create a dataset to store the data from the sensors
LCD Screen		Display text or information on a screen (LCD)
OLED Screen		Display text or information on a screen (OLED)
Magnetics		Communication programme
Music		Extension for playing music

DISCOVER THE STM32 IOT NODE BOARD & ITS SET OF SENSORS

The ***"STM32 Iot Node Board"*** is a programming board, which means it allows a user to create a programme and put it inside the board.

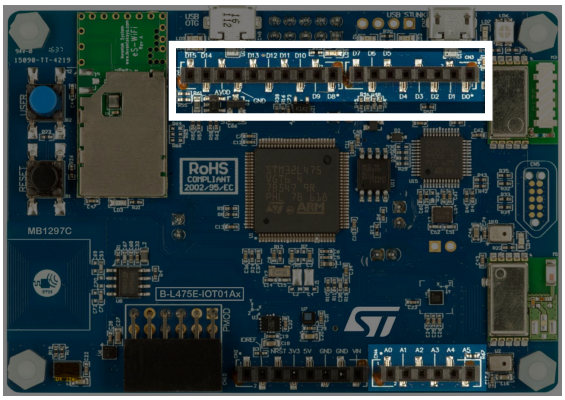


To execute this programme, you need a "microcontroller", i.e. the brain of the board (visible on our board in the middle - the big black square). The name of our microcontroller is: **STM32L475VG.**



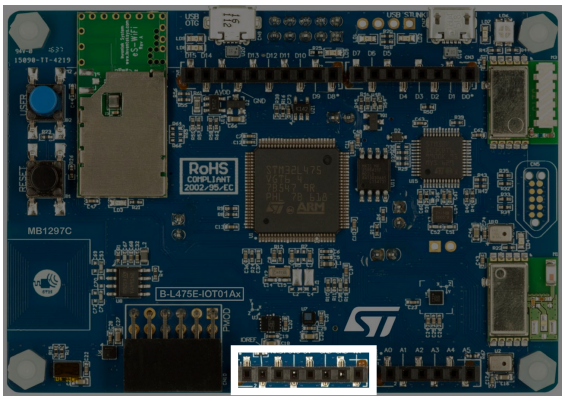
THE GPIOs

As you can see, there are lots of "legs" or "**pins**" around the microcontroller, called "General Purpose Input / Output" (or GPIO in short). Basically, you can use them to interact with the outer world. Even if there are lots of GPIOs, you cannot use all of them. The usable GPIOs are located on the top and bottom of the board.



There are these black rectangles with holes in them, called "**pinouts blocks**". If you look closely, you can observe some inscriptions around (D0, D1, D2, D3, ..., A0, A1, A2, ...). These inscriptions are the names of the GPIOs.

We will discover the differences between Ax pins (A0, A1, ...) and Dx pins (D0, D1, D2, ...), further in the activities.

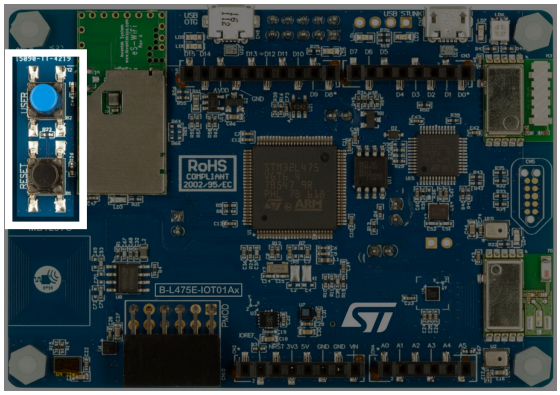


Another pinout block remains which is a "**power pinout block**". You can use these pinouts to power your sensors or actuators (like motor, light, and lots of different things).
The inscription on top of the pinout block, inform us how to use it. The "5V" is like the "+" (positive pole) of a battery and the "**GND**" (short for "Ground") is the "-" (negative pole).

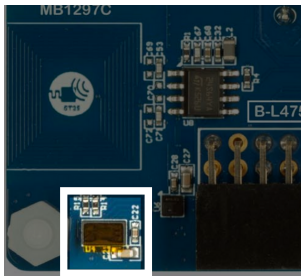
THE PERIPHERALS

The difference between the number of GPIOs available through the pinout block and the number of legs of the microcontroller can be explained by the presence of multiple peripherals already connected to the microcontroller, available on the "STM32 IoT Node Board" itself. The presence of all these peripherals makes this specific board very attractive, as it will enable you to implement a large range of activities, from simple to complex, and from basic to playful. This is a real asset for performing engaging activities in the classroom.

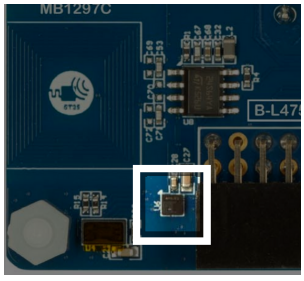
- **BUTTONS:** On the left side of the board, you can find two buttons. The black one is the **RESET** button, enabling the program to restart if you need it. The other one can be used in our program to de**tect when the user push-it** (short push, long push, release it, etc). It can be useful for creating simple user interactions, such as a quiz button for organising competitions using the board.



- **DISTANCE SENSOR**: Let's have a look at the bottom on the lower-left corner of the board. Just on the right of the nylon screw, you can find a sensor to measure distance. It is officially called the "**time of flight**" because it measures the time it takes for a laser beam to travel back and forth (***fly***) from the sensor to an object.

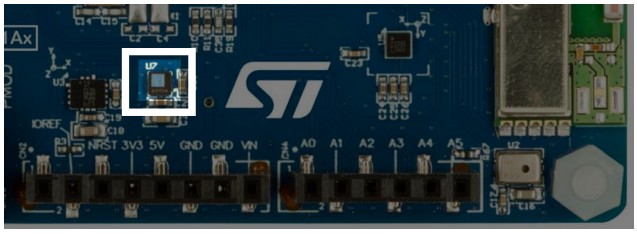


- **TEMPERATURE & HUMIDITY SENSOR**: Next to the "time of flight" sensor on the right, you can find a thermometer and hygrometer sensor ("2 in 1"). This can be useful to implement activities linked to the monitoring of heat or to approaching meteorological concepts.

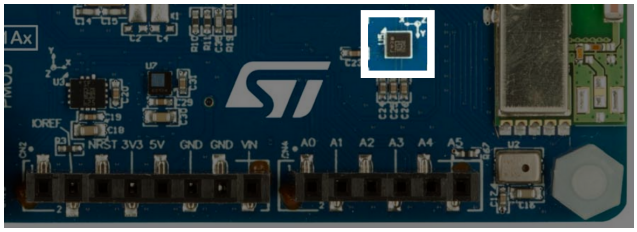


- **ACCELEROMETER & GYROSCOPE SENSOR:** On the centre of the board, just above the pinout block, there is the accelerometer and gyroscope sensor ("2 in 1"). An accelerometer is used to measure acceleration. You can use it to detect the movements of the board (for instance, if the board is shaken). A gyroscope gives us information about the inclination of the board. This sensor works on 3 axes (X, Y, and Z), which implies you can detect movements in 3D space.

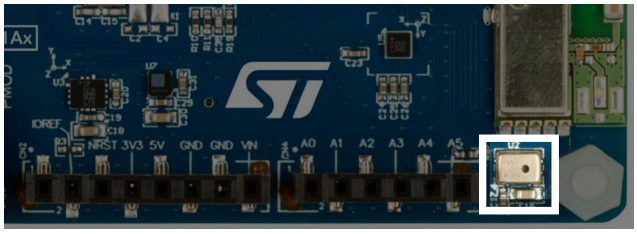
- **ATMOSPHERIC PRESSURE SENSOR**: Next to the Accelerometer/Gyroscope sensor, you can find a little sensor called the barometer. This sensor gives us the value of the atmospheric pressure.



- **MAGNETOMETER SENSOR**: Next to the barometer, you can see the magnetometer. It is used to retrieve the value of a magnetic field. It can also measure values on 3 axes (X, Y, and Z).

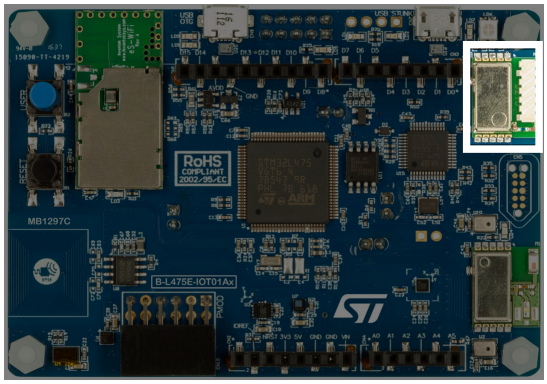


- **MICROPHONE**: On the right corner, you can see the Microphone, useful to capture sounds.



THE MODULES

- **BLUETOOTH MODULE:** On the top left of the board, you can find the Bluetooth module. It can be used to communicate and exchange data with other devices (such as another STM32 IoT Node Board, or your phone).



- **MICRO-USB CONNECTORS**: On the top of the board, you can see two micro-USB connectors. The USB port on the right is the one you will be using most of the time, as it enables to connect the board to your computer and send the program you will have done on MakeCode to the microcontroller. You can also see a second one on the left, call "OTG USB port". This particular one enables you to program the board to act and be recognised as another device such as a keyboard, mouse or gamepad.