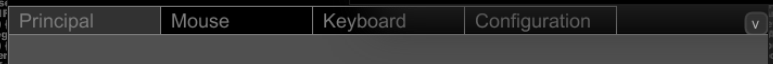
Meta_Processing Alpha 1.2

Programming for beginners



Jose David Cuartas Correa

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Programming for beginners

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Meta_Processing Alpha 1.2: Programming for beginners.

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INTRODUCTION

With this text I seek to introduce the reader to the basic aspects of the first version of Meta_Processing, a meta-programming language that I developed for the programming beginner. It is a personal initiative that is influenced by my work as director of the Hypermedia Laboratory [1] (Hitec Lab) at Fundación Universitaria Los Libertadores in Bogotá, Colombia.

The idea of creating Meta_Processing arises during the development of my doctoral studies in Design and Creation, which ended with the thesis: "Program the world in the context of free technologies and Hacker-Maker cultures. Case study: Hitec Lab "(Cuartas, 2017). There I highlighted the importance that designers, artists and creative people learn to program, and I was able to present evidence of the great variety of creative opportunities that this knowledge can offer to the curious and restless students.

During this time I also wrote the book "Digitopolis I: Design of Interactive Applications for Creatives and Communicators" which was an introductory guide to the Procesing programming language. With this book I sought to promote interest in learning programming in graphic design, advertising, and communication students. However for those who did not have a good foundation in English, it was difficult for them to remember the key words of the language.

[1]Hypermedia Laboratory http://hiteclab.libertadores.edu.co/

Meta_Processing is a programming environment designed to prevent the novice user from making common syntax errors. It is a meta-programming language based on the Processing language, and all the code created with Meta_Processing is exported as Processing code. With Meta_Processing you can write and read the same code in different languages, such as Spanish, French, Hindi, Japanese, Italian, Chinese, Portuguese and English.

The concept of meta-programming refers to a program that is capable of writing or manipulating other programs. The concept Meta comes from the Greek preposition that means: "after" or "beyond" but in this case it is used in the most contemporary sense that refers to the prefix "about". A good example is when it is used in the word "meta-cognition" which would mean "cognition about cognition".

So, Meta-Processing I define it as a meta-programming language that works on Processing. It is a higher level language than Processing, but it is translated and executed as Processing code. In other words just like Processing is a Java abstraction, Meta_Processing is a Processing abstraction. So Meta_Processing continues the MIT Medialab tradition and in the same way that John Maeda leaned on the shoulders of Java to create Design by numbers, and in the same way that Casey Reas and Ben Fry were inspired by Design by numbers To create Processing, Meta_Procesing also leans on Processing's shoulders to offer a much more beginner-friendly programming experience.

This meta-programming language also arises motivated by the reflections made by Bret Victor in his conferences: Inventing on a Principle (2012) and Stop Drawing Dead Fish

(2013), where Victor demonstrates the urgent need to build new tools that allow the creators to exploit the potential that computers have to offer us. Victor talks about the need to move away from the algebraic and textual paradigm (that is the most used when programming), and proposes a paradigm based on geometric manipulations. Metra_Processing seeks to make another type of approach by mixing the graphic programming metaphor (such as Scratch) with the text-based programming metaphor (such as Processing), in a hybrid tool that takes the best characteristics of both, to offer a friendly experience that does not take the user away from the predominant paradigm (which is the textual one), but that avoids some moments of frustration caused by insignificant syntax errors, which easily happens to beginners.

For years there have been fantastic programming language initiatives for children such as Logo and Scratch (developed in the United States by MIT) or Pilas Bloques (developed in Argentina by the program.ar initiative). However, Meta_Processing targets other types of users who want to learn to program without feeling that they are using tools designed for children. It could also be used by children and young people who do not want to use tools with child-style interfaces.

Introduction Alpha1.1.

In this new version of Meta_Processing some improvements are incorporated. Now offers support for communicating with Arduino boards using Firmata and allows you to scroll lines of code with the mouse. The *text* instruction can now be used to display variables. The

multiply, divide, and *formula* instructions are added in the Mathematics category, and the *native code* instruction is added in the Advanced category. Additionally, each time the run button is clicked, the meta code of the project is exported in three text files, which are saved within the **meta** folder of the project. The code contained in each tab is saved in a text file with the same name as the tab and with a **.meta** extension.

Alpha Introduction 1.2.

For this new version of Meta_Processing the Configuration tab is added and the Punjabi, Kannada, Bengali, Tamil, Korean, Russian and German languages are supported. Now also offers the option to communicate with ESP boards using the IoTControllerAP[2] library. The instruction *for* is added inside the Structures category. And lastly is added support for the keyboard shortcuts: ctrl+c, ctrl+x, ctrl+v, ctrl+z.

Jose David Cuartas Correa
Bogota Colombia
2020

[2] https://github.com/hiteclab/IoTControllerAP

Thanks:

To the unconditional support received from the Fundación Universitaria Los Libertadores who have believed in every project we develop at Hitec lab.

Dedication:

To my wife Shahzadi and my daughters Helen and Megan, who fill my existence with love and joy.

CONTENT

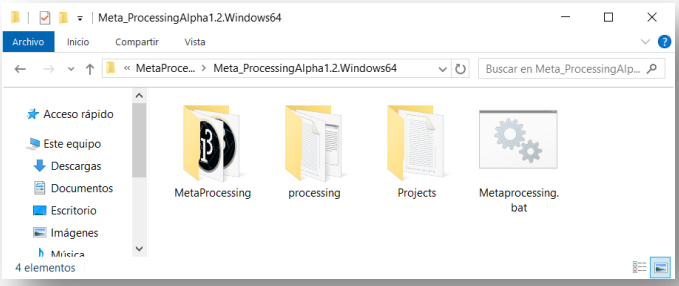
1. META_PROCESSING FIRST STEPS

1.1. How to open Meta_Procesing?

Meta_Processing was developed to work on the operating systems: Windows, Mac and GNU / Linux. The steps to open Meta_Procesing vary slightly depending on the operating system used, the steps for each system are described below:

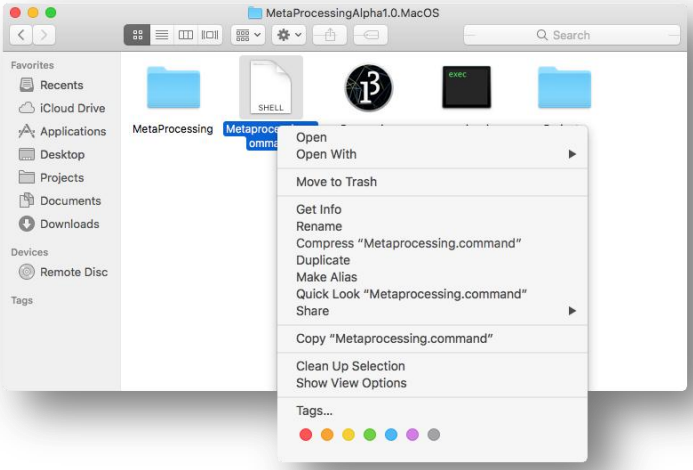
Windows

In Microsoft Windows, double-click on the file with the name: Metaprocessing.bat

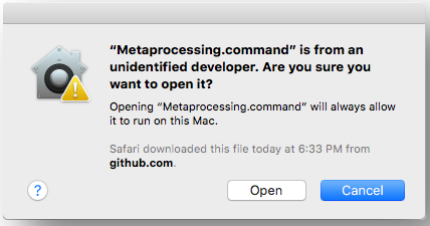


Mac OS

On Mac Os you must right-click on the file with the name **Metaprocessing.command** and select the option: **Open**

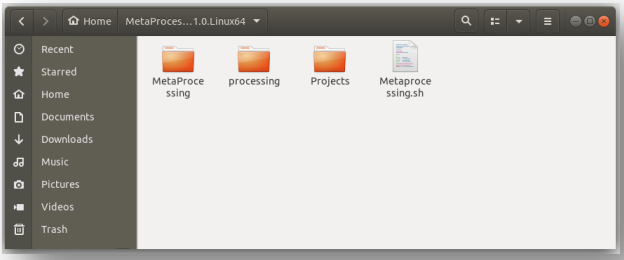


In the window that opens, select the option: **Open**

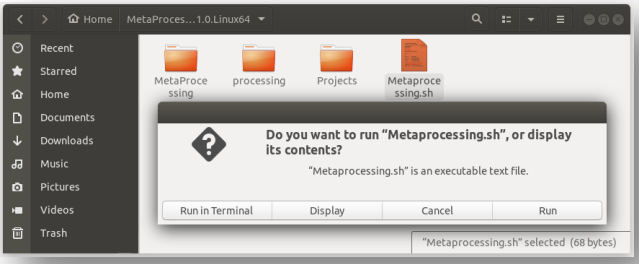


GNU / Linux

In GNU / Linux double click on the file with the name **Metaprocessing.sh**



In the window that opens you must select the option: **Run** (you can also use Run in Terminal if you want to open the **terminal window of Meta_Processing).**



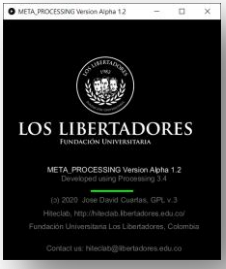
If the script does not open when you double click on it, you can try to run the following command in the Linux terminal to activate the previous dialog box.

```
gsettings set org.gnome.nautilus.preferences executable-text-activation ask
```

1.2. Windows that open when you start Meta_Prosessing

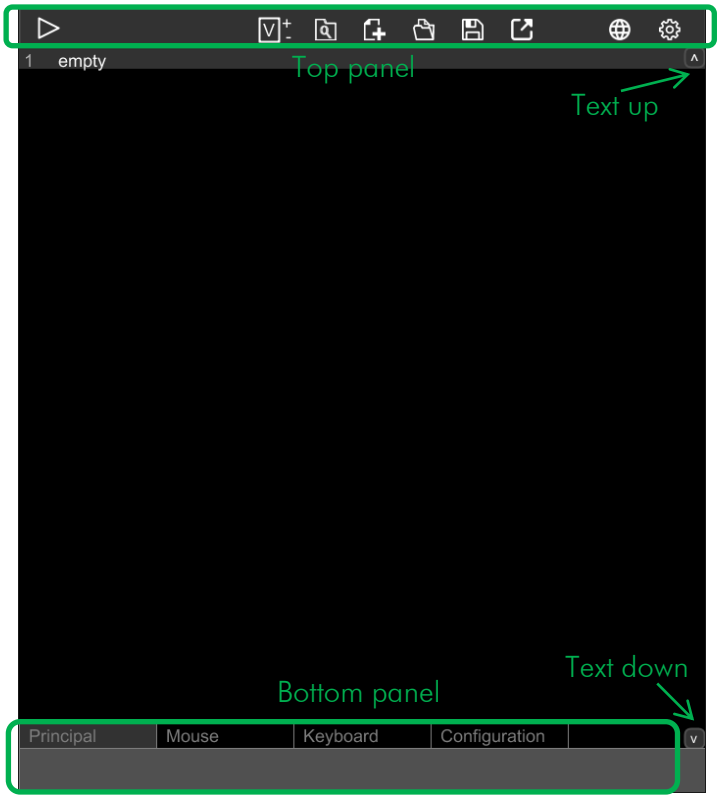
Once the Meta_Prosessing file is executed, regardless of the operating system you are working on, the terminal window opens where you can see messages that come from the main Meta_Processing window.

Then a second window opens with the animated splash of welcome to Meta_Processing. Clicking on or closing this window opens the main Meta_Processing window.



1.3. Basic elements of the interface

In the upper panel are the buttons: Run, Variables, Data, New, Open, Save, Export, Languages and Configuration.



In the Bottom panel are the tabs: Principal, Mouse, Keyboard and Configuration. Also there is the description bar: where the names of the buttons and the prototype of the instructions are shown.

1.4. How to select Languages?

To change the Meta_Processing language, click on the languages icon in the top bar.

Then in the window that opens, click on the desired language.

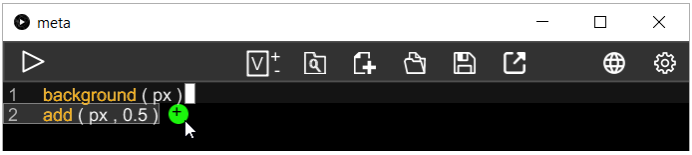
1.5. How to execute the code?

To execute the code, click on the run icon in the top bar.

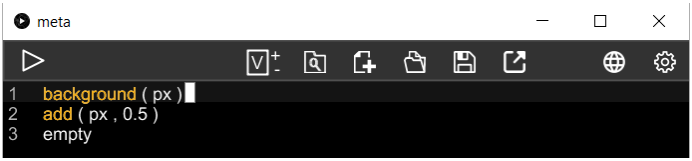
Wait few seconds and a new window should appear in which the created code will be executed.

1.6. How to add a line of code?

To add a line of code you must move the mouse cursor until a green circle appears with the plus (+) character inside it.

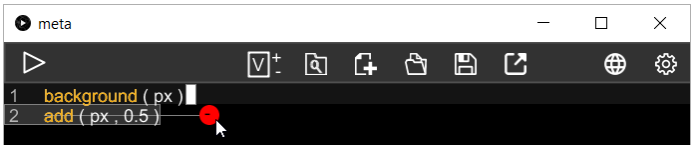


A new line of code will appear once the green circle is clicked.



1.7. How to delete a line of code?

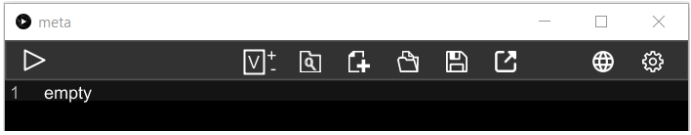
To remove a line of code, you must move the mouse cursor until a red circle appears with the minus character (-) inside it, and you see a gray line crossing out the entire instruction.



The line disappears once it is clicked.

1.8. How to add instructions?

To add an instruction, you must click on the word that says **empty**.

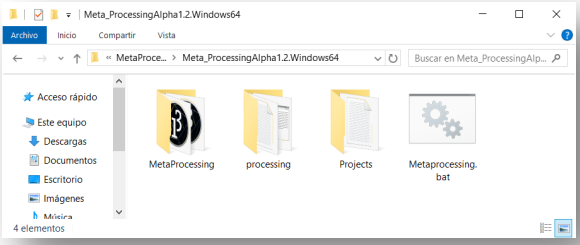


Once this is done, a new window will open where all the instructions available in Meta_Processing will appear, organized by categories like this:

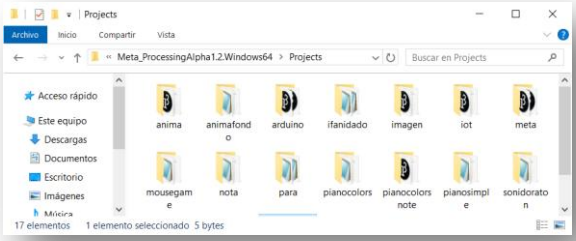
When the mouse cursor is placed on any of these instructions the instruction is highlighted, in this example you can see how the **rectangle** instruction is highlighted. Clicking will open a new window where you can enter the properties of each instruction. The description of each of these instructions will be made in Chapter 2.

1.9. What is the file and folder structure in Meta_Processing?

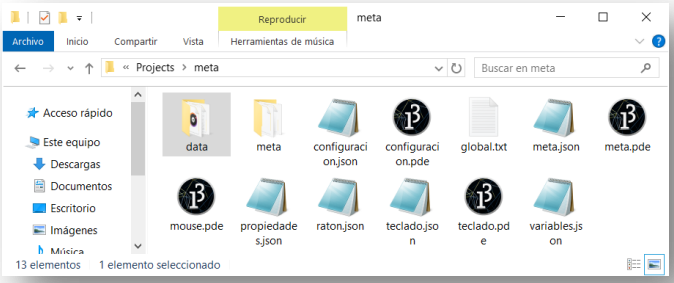
Inside the **Meta_Processing** folder is the file to run Meta_Processing and three sub-folders. The Meta_Processing folder contains the files that allow it to function. In the processing folder there is a distribution of this language that is used to compile and execute each of the projects that are created by the user.



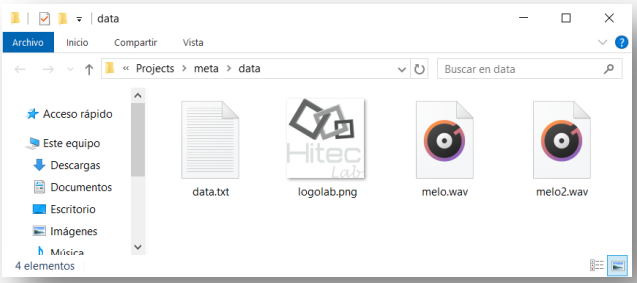
In the **Projects** folder it contains the folders of each of the program projects written using the Meta_Processing programming environment.



In the folder of each project there are **.json** files and **.pde** files. The .json files contain the information of the instructions in Meta_Processing language and the .pde files contain the processing code, and are generated every time the **run** icon is clicked.



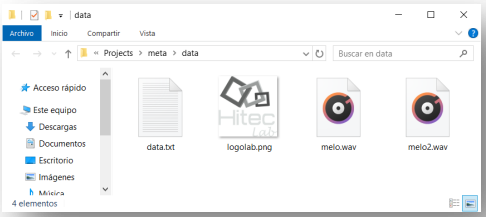
And in the **data** folder of each project the files that will be used in the execution of the program are stored, such as images, sounds and videos.



1.10. How to open the data folder of the current project?

To open the data folder of the current project, click on the **data** icon in the top bar.

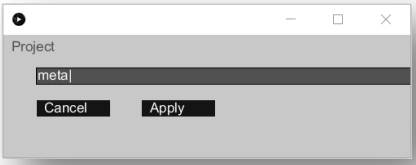
Once clicked, the data folder of the current project opens in another window



1.11. How to create a new project?

To create a new project, click on the **new** icon in the top bar.

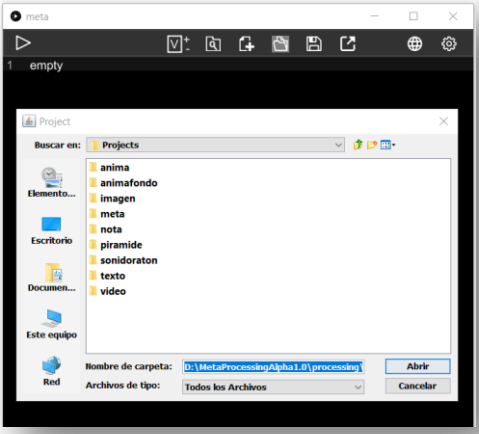
In the window that opens, you must write the name that you want to give to the new project and click on the **Apply** button.



1.12. How to open a project?

To open a project, click on the **open** icon on the top bar.

Then a new window opens in which you can select the project folder you want to open and click the **open** button.



1.13. How to save the current project?

To save the current project, click on the **save** icon in the top bar.

1.14. How to export the current project as application?

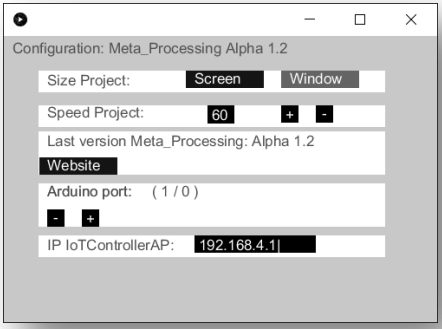
To export the current project as an application, click on the **export** icon on the top bar.

The application is saved in the subfolder called **app** inside the current project folder.

1.15. Configuration options

To change the configuration options click on the **configuration** icon in the top bar.

Then a new window opens offering five options: change project size and change project speed, check the latest version of Meta_Processing, select Arduino port and define IP address for IoTControllerAP.

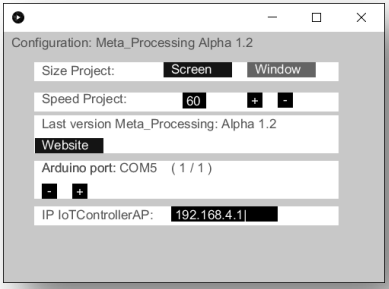


The **Project Size** option has two buttons, Screen to make the application run in full screen or the Window button to open the application in a window, which can be resized manually.

The **Speed** option allows you to change the speed of the project (frames per second).

The **Last version** option allows you to check the latest version of Meta_Processing published on the internet. The information that appears after the colon is the version available for download. If you want to download that new version you can click on the Website button that directs to the Meta_Processing website.

The **Arduino Port** option shows the ports of the devices connected to the computer. In case of connecting an Arduino card through the USB port, the connection port can be selected by clicking on the - or + buttons.(For more information see Chap. 4)



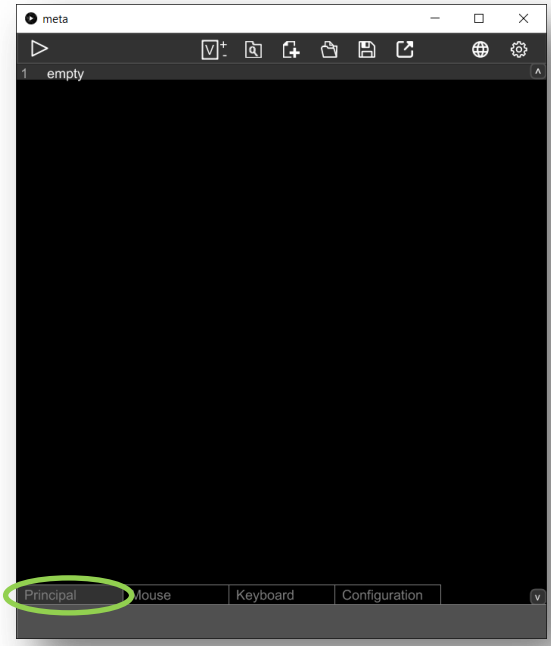
The **IP IoTControllerAP** option allows you to change the IP address of the ESP card by running IoTControllerAP.

1.16. Functions: Principal, Keyboard, Mouse and Configuration

To write the code in Meta_Processing, four functions can be used: Principal, Mouse, Keyboard and Configuration. Each of these functions is selected by clicking on its corresponding tab.

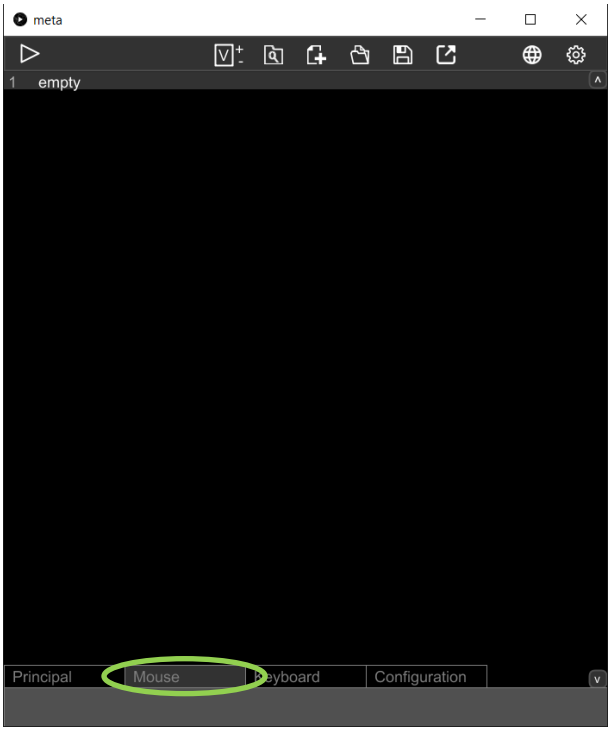
1.16.1. Principal

The code that is written to the **Principal** tab runs in an infinite loop, until the application window is closed.



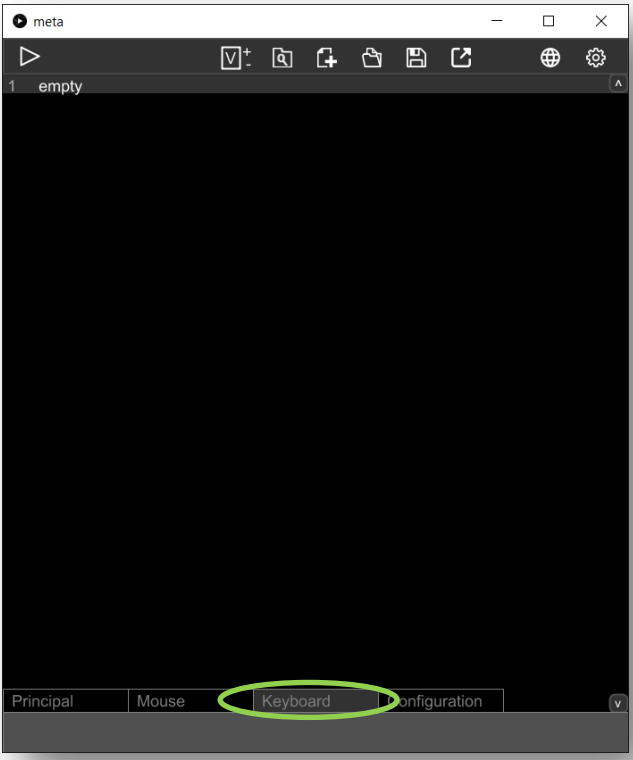
1.16.2. Mouse

The code that is written on the **Mouse** tab is executed the moment any mouse button is pressed.



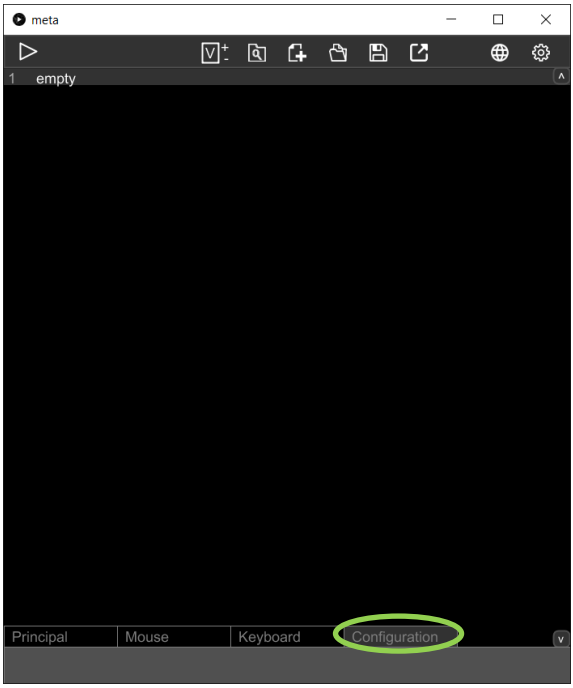
1.16.3. Keyboard

The code that is written on the Keyboard tab runs the moment any key is pressed.



1.16.4. Configuration

The code that is written in the Configuration tab is executed only once at the moment the application is opened, it is the first function that is executed, before Principal, Mouse or Keyboard. It is used to set the initial configuration of the application (such as initialize variables).



1.17. Keyboard shortcuts: ctrl + c, ctrl + x, ctrl + v, ctrl + z

From this version of Meta_Processing is added support for the keyboard shortcuts: ctrl+c, ctrl+x, ctrl+v, ctrl+ z.

The **ctrl+c** shortcut allows you to copy the line of code that is being pointed by the mouse cursor.

The **ctrl+x** shortcut allows you to cut the line of code that is being pointed by the mouse cursor.

The **ctrl+v** shortcut allows you to paste the line that has been copied or cut at the position of the line of code that is being pointed by the mouse cursor.

The **ctrl+z** shortcut allows you to undo delete line. If you delete a line by mistake, you can retrieve the deleted line by pressing ctrl+z. It only applies to the last line deleted.

2. BASIC INSTRUCTIONS

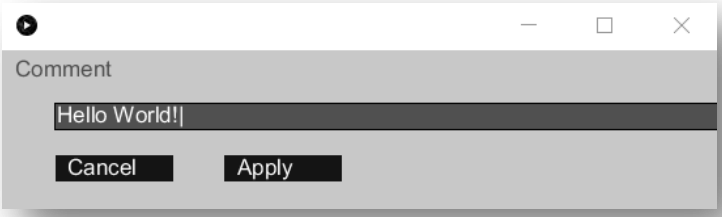
This section will cover the basic instructions for programming with Meta_Processing. As explained in point 1.8. to add an instruction you must click on the word that says **empty**.

Then, a new window will open showing all the instructions available in Meta_Processing organized by categories like this:

2.1. Document the code

Documenting the programming code is one of the first things anyone who wants to learn to program must learn. For this purpose, all programming languages allow adding comment lines. The main feature of this line of code is not executed; it's just there to give the developer information on how that part of the code works. To add a comment, click on the **comment** option in the **Document** category.

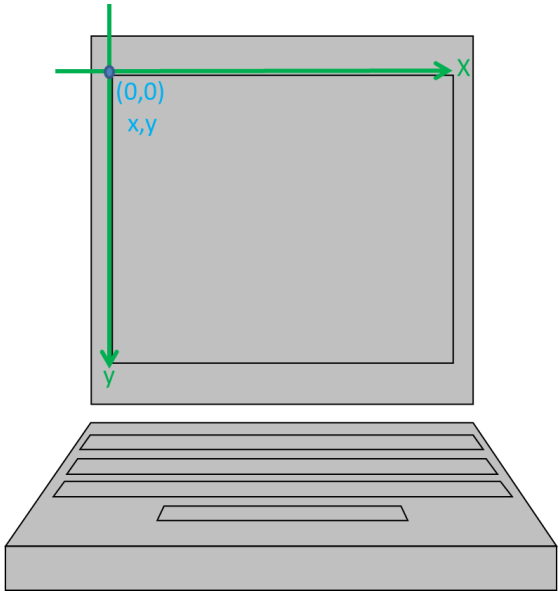
Then a new window will open in which you write the comment and click **Apply**.



2.2. Screen coordinates

In order to make graphics on the screen, it is necessary to first know how the screen coordinates work in Meta_Processing. The positions on the screen are measured in pixels and each screen has a certain number of pixels on the X axis and on the Y axis.

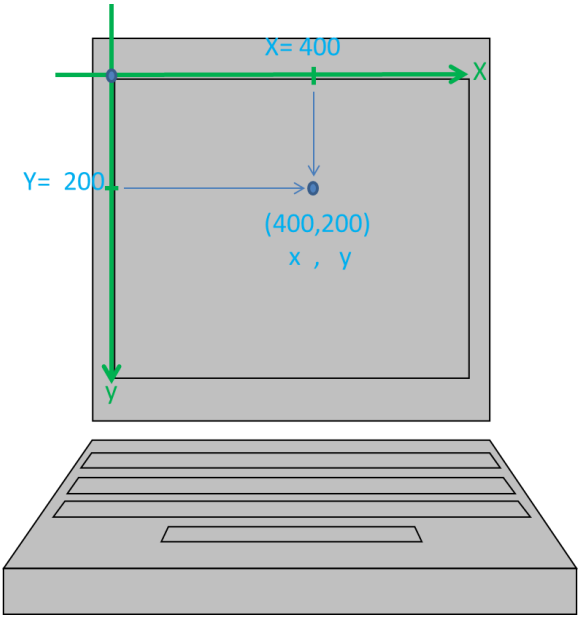
As can be seen in graph 1, the upper left corner of the screen is the point of origin of the coordinate system. This point is position 0 on the X axis and position 0 on the Y axis. Coordinates are always arranged first with value on X axis, then a comma and then the value on the Y axis, so this point is (0,0).



Graph 1 Origin point in the coordinate system

The positions on the X axis increase from left to right and the positions on the Y axis increase from top to bottom. Figure 2 shows an example to better illustrate this concept.

If you want to locate the point (400,200) on the screen, what you do is count 400 pixels to the right from the point (0,0) of the screen and count 200 pixels down from the point (0,0) of the screen. This is how the point (400,200) is located.



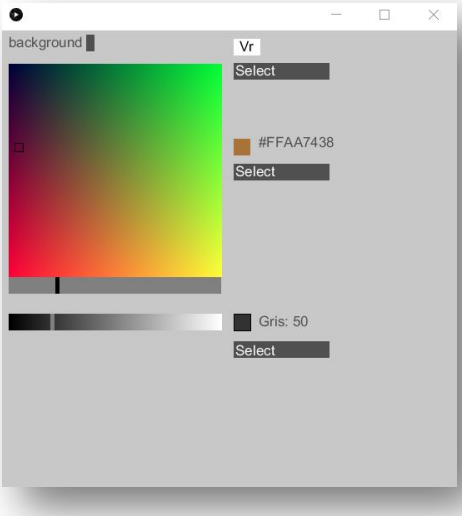
Graph 1 Point at position 400 in X and 200 in Y on the screen

2.3. On-screen graphics instructions

Some of the instructions to display on the screen include: line, triangle, rectangle, ellipse, text, image. Next pages will explain how to use each of them.

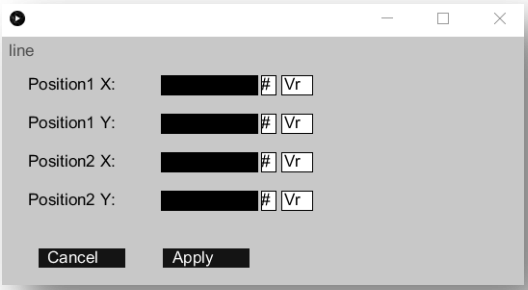
2.3.1. background

The **background** instruction is used to define the background color of the entire window of the application. This instruction erase everything that is being displayed on the screen and leaves the entire screen with the selected color.



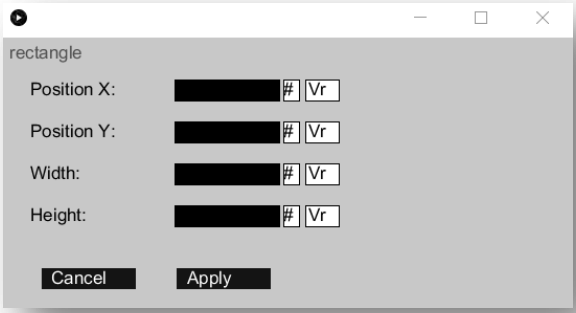
2.3.2. line

The **line** instruction is used to draw a line on the screen. Tracing a line requires defining the (x,y) position of the point where the line begins and the (x,y) position of the point where the line ends.



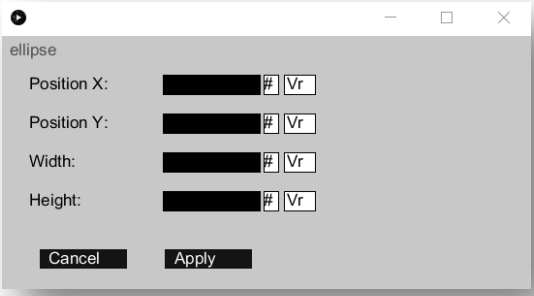
2.3.3. rectangle

The **rectangle** instruction is used to draw a rectangle on the screen. To use this instruction you must define in the first two boxes the position x,y of the upper left corner from where the square will be drawn, and in the next two boxes must be defined its width and height.



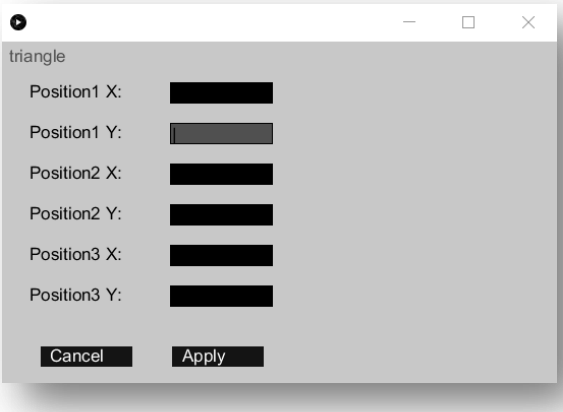
2.3.4. ellipse

The **ellipse** instruction is used to draw an ellipse on the screen. To use this instruction you must define in the first two boxes the center point x,y from where the ellipse will be drawn, and in the next two boxes define its width and height.



2.3.5. triangle

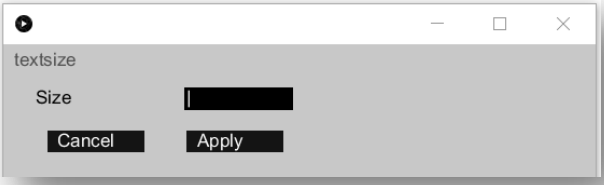
The **triangle** instruction is used to draw a triangle on the screen. To draw any triangle it is required to define the three points corresponding to each of its corners. To use this instruction, the position of the first point must be defined in the first two boxes, the position of the second point must be defined in the following two boxes, and the position of the third point must be defined in the last two boxes.



2.3.6. texsize

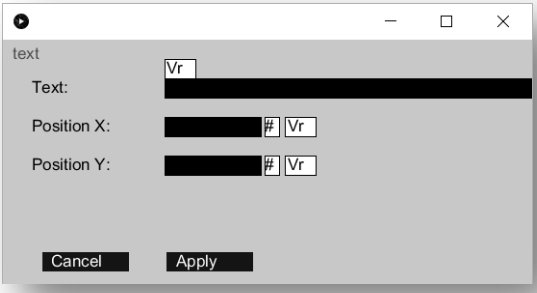
The **textsize** instruction is used to define the size of the font when displaying text on the screen. To use this instruction, the size box must be filled with the number corresponding to the font size to be applied.

For this statement to take effect, it must be added before the **text** instruction.



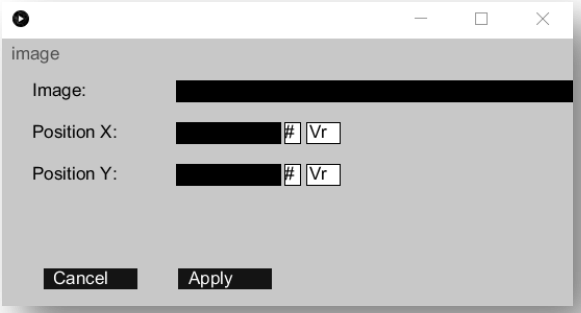
2.3.7. text

The **text** instruction is used to display text on the screen. To use this instruction, you must write in the first box the text you want to display, and define in the next boxes the x, y position of the lower left corner from where the text will start to be displayed on the screen. If you want to display the content of a variable, you can click on the Vr button located above the first box.



2.3.8. image

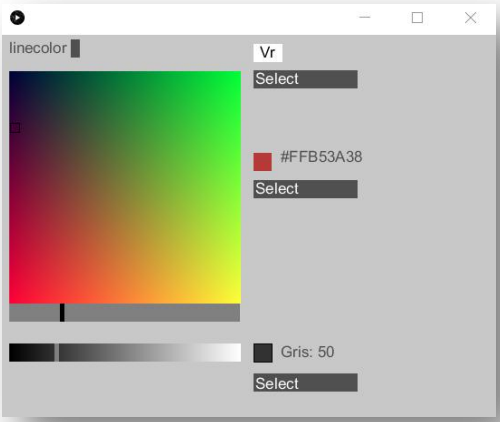
The **image** instruction is used to display an image on the screen. To use this instruction, you must first save the image you want to use inside the project's **data** folder, then select the image that was saved in the data folder, and after that in the next two boxes define the x, y position of the upper left corner from where the image will begin to be displayed on the screen.



2.3.9. linecolor

The **linecolor** instruction is used to define the color of the lines and the border color of the rectangular, ellipse and triangle figures. To assign the line color using this instruction you can, use the color picker, or the grayscale picker and click the **Apply** button. You can also use a variable to dynamically change the color. For this instruction to take effect, it must be added before

the instructions with which to draw lines or figures on the screen.

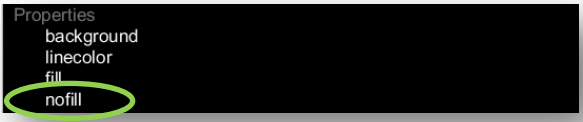


2.3.10. fill

The fill instruction is used to define the fill color of the rectangle, ellipse and triangle figures. To assign the fill color using this instruction you can, use the color picker, or the grayscale picker and click the Apply button. You can also use a variable to dynamically change the color. For this instruction to take effect, it must be added before the instructions with which to draw figures on the screen.

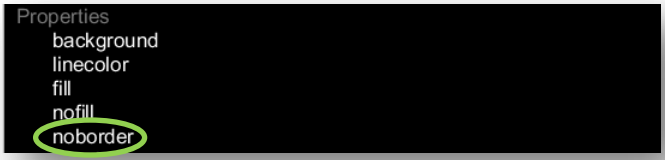
2.3.11. nofill

The **nofill** instruction is used to remove the filling of the rectangle, ellipse and triangle figures. This will look transparent and only its edge will be seen. To use this instruction, it is only necessary that in the add instruction window, you click on the **nofill** instruction within the **Properties** category and this line will automatically be added to the project code.



2.3.12. noborder

The **noborder** instruction is used to remove the border of the rectangle, ellipse and triangle figures. If this statement is added before the **line** instruction then the line will not be displayed. To use this instruction, it is only necessary that in the add instruction window, you click on the instruction **noborder** within the **Properties** category and this line will automatically be added to the project code.



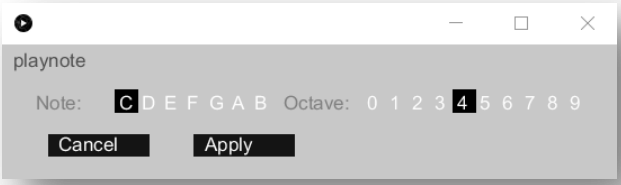
2.4. Multimedia instructions

Some of the multimedia instructions that can be used with Meta_Processing include: **playnote**, **sound** and **video**. The next pages will explain how to use each of them.

2.4.1. playnote

The **playnote** instruction is used to reproduce the sound of a note on the musical scale. To use this instruction, you must select the note that you want to play and then

select the octave that you want the note to sound. Finally, click on the **Apply** button.



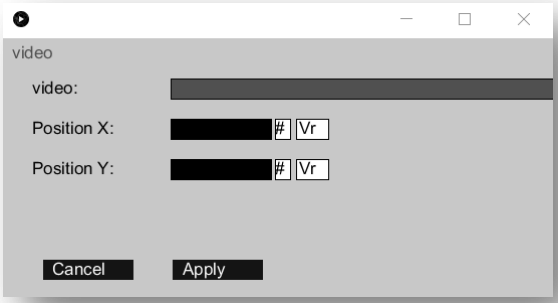
2.4.2. sound

The **sound** instruction is used to play a sound file in wav or mp3 format. To use this instruction you must first save the sound file you want to use inside the project's **data** folder, then click on the **Select** button to choose the file that was previously saved in the data folder and finally you must click the **Apply** button.

2.4.3. video

The **video** instruction is used to play on the screen a video file in mov, avi or mpg format. To use this instruction you must first save inside the project's **data**

folder the video file you want to use, then select the file that was saved in the data folder and finally click the Apply button.

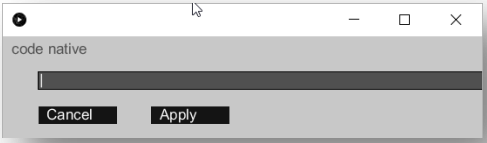


2.5. Advanced Instructions

At the moment the only advanced instruction available for Meta_Processing is: *native code*. How to use it will be explained below.

2.5.1. native code

The native code instruction is used to add lines of code that are not available with Meta_Processing, but are native for Processing or Java languages. To use this instruction you must write in the first box, the line of code that you want to add and then click on the Apply button.



An example could be using the Processing instruction called **println** that allows displaying text in the terminal. If the following line of code is added:

```
println (mouseX);
```

The current mouse position on the x-axis would be displayed in the Meta_Processing terminal window.

3. VARIABLES, CONDITIONALS AND CYCLES

This section will address the concepts of variables and conditionals and cycles, which are fundamental when you are learning to program.

3.1. Variables

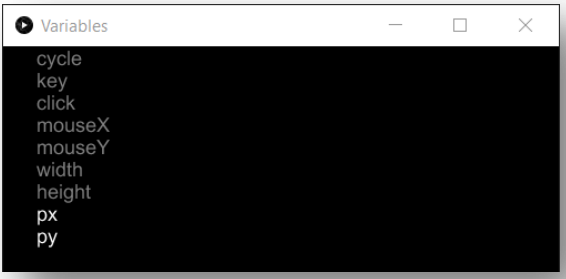
A variable is a memory space reserved for storing a value that changes while the program is on execution. In Meta_Processing there are two types of variables: System variables and variables created by the user.

The system variables are: **cycle**, **key**, **click**, **mouseX**, **mouseY**, **width** and **height**. The **cycle** variable is used to count the number of cycles performed within the *for* structure. The variable **key** stores the value of the last key pressed on the keyboard. The variable **click** stores the value of the last button pressed on the mouse. The variable **mouseX** stores the current mouse position on the X axis. The variable **mouseY** stores the current mouse position on the Y axis. The variable **width** stores the value of the width of the screen in which the code is executing. And the variable **height** stores the value of the height of the screen in which the code is running.

3.1.1. How do you look at the list of variables?

To see the variables list of the project, click on the **variable** icon.

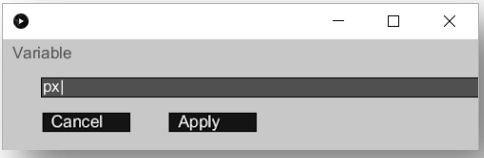
In the window that opens you will see the variables that are being used. The ones shown in gray are the system variables and the ones shown in white are the variables created by the user.



3.1.2. How is a variable created?

To create a variable, click on the plus (+) icon next to the **variable** icon.

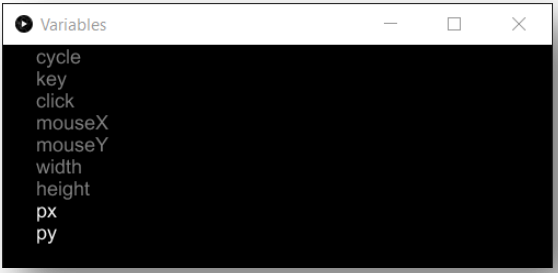
In the window that opens, you must write the name that you want to give of the variable to be created, in this example it is given the name px.



3.1.3. How is a variable removed?

To remove a variable, click on the minus icon (-) next to the **variable** icon.

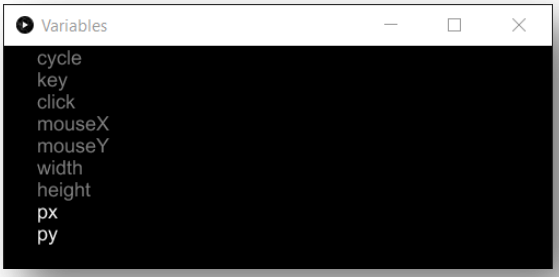
In the window that opens, click on the name of the variable to be removed. Only variables that have been created by the user can be removed, that is, only variables with white color can be removed. Variables in gray are system variables and cannot be removed.



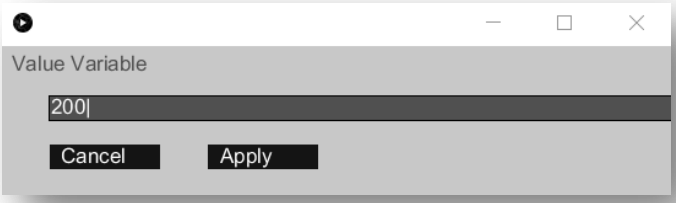
3.1.4. How is a variable initialized?

To initialize a user-created variable, click on the **variable** icon.

In the window that opens, click on the variable that you want to initialize.



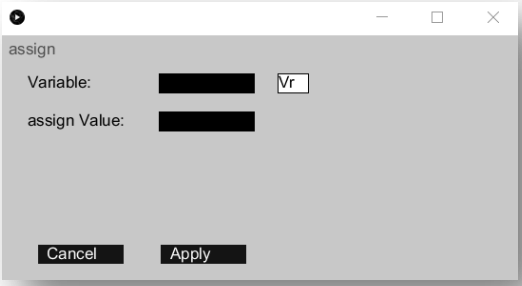
Once this is done, another window will appear in which you must write the value with which you want to initialize the variable. In this example, the variable is initialized with the value 200.



3.1.5. How to assign a new value to a variable?

Within the code you can assign a new value to a variable, for this you must add the **assign** instruction found within the **Mathematics** category in the add instruction window.

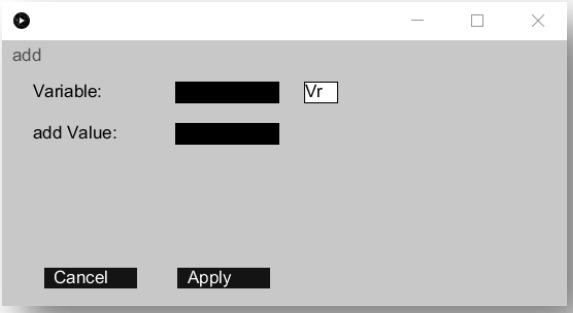
Inside the window that opens, in the first box select the variable you want to assign a new value and in the second box enter the value to be assigned.



3.1.6. How do you add a value to a variable?

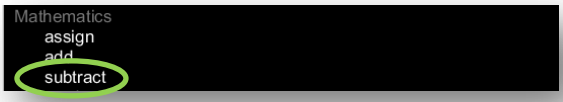
Within the code you can add a value to a variable, for this you must aggregate the **add** instruction found within the **Mathematics** category in the add instruction window.

Inside the window that opens, in the first box select the variable you want to add the value and in the second box enter the value to be added.

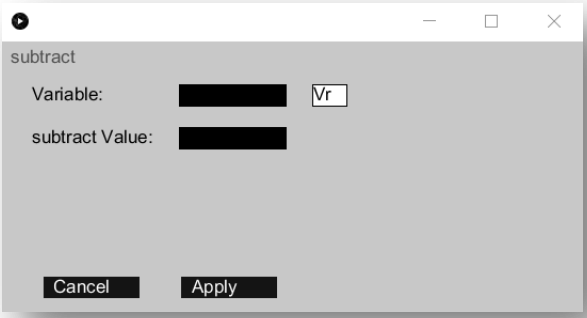


3.1.7. How subtract a value from a variable?

Within the code you can subtract a value from a variable, for this you must add the **subtract** instruction that is within the **Mathematics** category in the add instruction window.

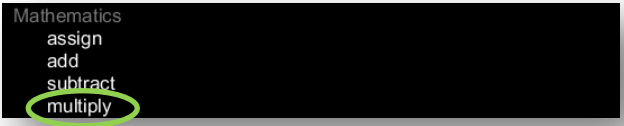


Inside the window that opens, in the first box select the variable you want to subtract the value and in the second box enter the value to be subtracted.

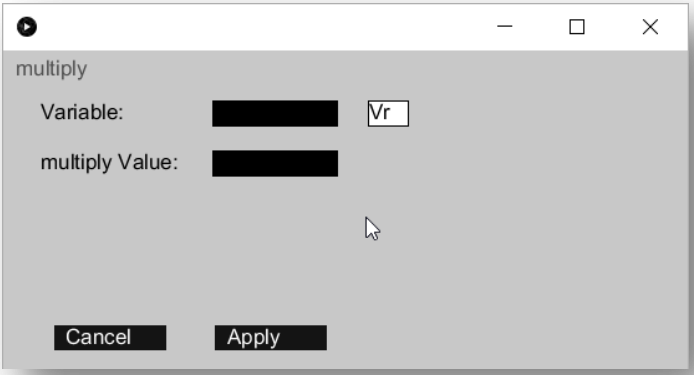


3.1.8. How to multiply a variable?

Within the code you can multiply a variable by a value, for this you must add the **multiply** instruction found within the **Mathematics** category in the add instruction window.



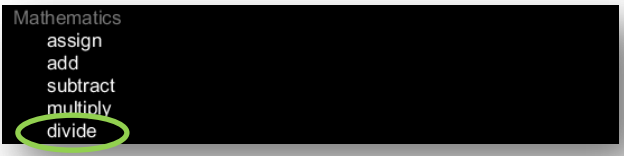
Then in the window that opens, in the first box select the variable you want to be multiplied by the value and in the second box enter the value by which the variable is to be multiplied.



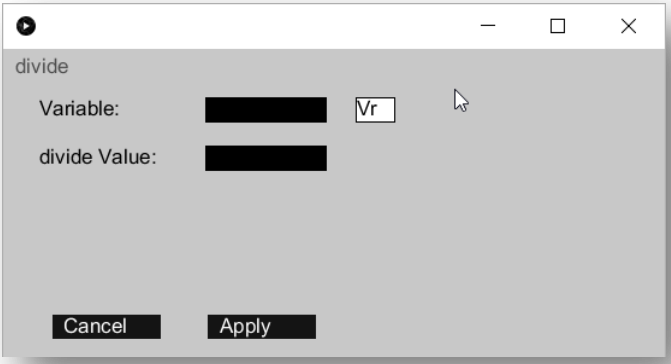
3.1.9. How to divide a variable?

Within the code, you can divide a variable by a value. To do this, you must add the **divide** instruction found

within the **Mathematics** category in the add instruction window.

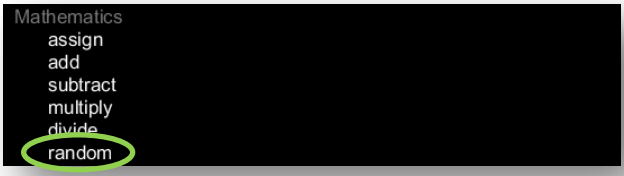


Then in the window that opens, in the first box select the variable you want to be divided by the value and in the second box enter the value by which the variable is to be divided.

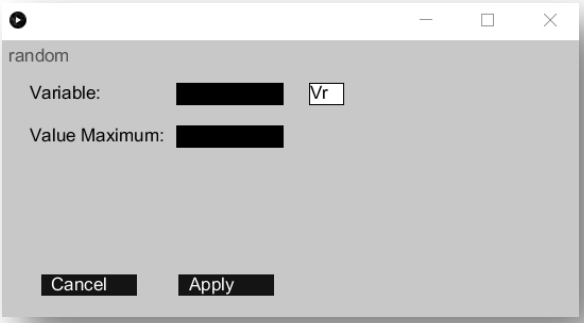


3.1.10. How assign a random value to a variable?

Within the code you can assign a random value to a variable, for this you must add the **random** instruction that is within the **Mathematics** category in the add instruction window.

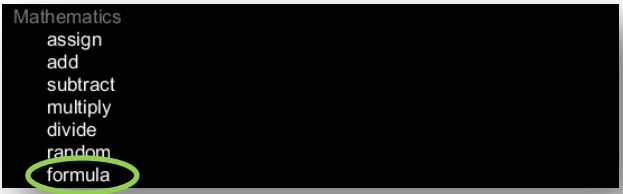


Inside the window that opens, in the first box select the variable you want to assign the random value and in the second box enter the maximum value that would be generated randomly. A random value would be generated between 0 and the maximum value defined inside the instruction.



3.1.11. How to add a mathematical formula?

Within the code you can add a mathematical formula to do more advanced operations, for this you must add the **formula** instruction that is within the **Mathematics** category in the add instruction window.



Then in the window that opens, in the first box you must write the formula that you want to add and then click on the **Apply** button.

An example could be calculating the average between three values:

```
average = (value1 + value2 + value3) / 3;
```

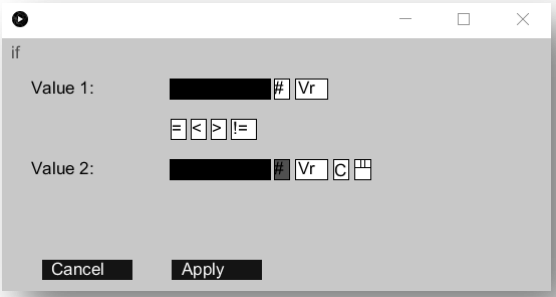
Then the result of this mathematical operation would be stored in the variable called: average.

3.2. Conditionals

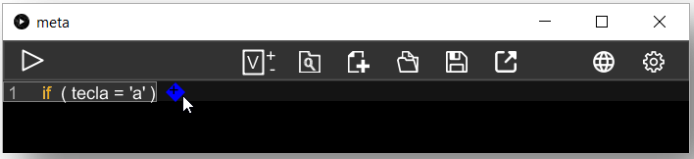
Conditions are a type of algorithmic structures that allow the program to make decisions as a condition is met.

To add a condition, you need add the **if** instruction that is within the **Structures** category in the add instruction window.

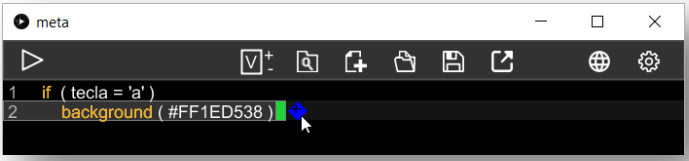
Then in the window that opens in the first box you can write a value or select a variable. Then an operator must be selected, which can be equal (=), less than (<), greater than (>) or different (i=). And in the second box you can write a value, select a variable, choose a key or choose one of the mouse buttons.



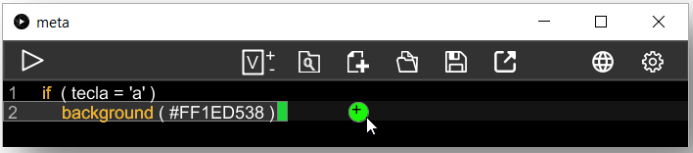
Once the **Apply** button is clicked, the condition can be seen in the Meta_Processing code window. To add an instruction inside the condition, you must move the mouse cursor until a blue diamond appears with the plus (+) character inside it.



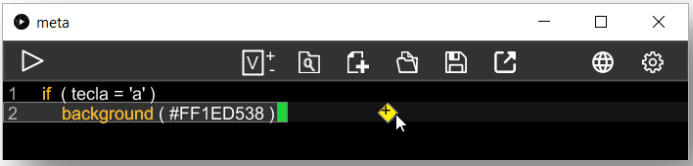
Once clicked the new empty line of code will appear and click to assign the desired instruction. If you want to create one more instruction inside the condition, then you must move the mouse cursor until a blue diamond appears with the plus (+) character inside it.



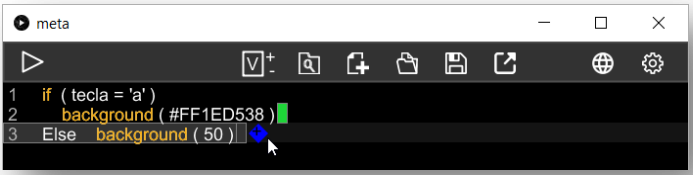
If once you finish adding the instructions inside the condition, what you want is to add another line of code but outside the condition, then you must move the mouse cursor until a green circle appears with the plus character (+) inside.



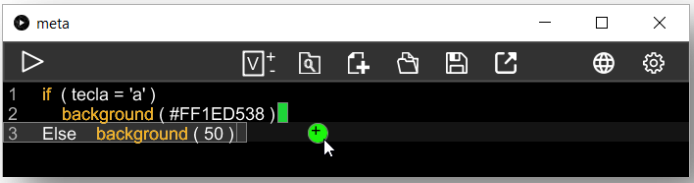
If, on the contrary, what you want is to add a line for the case when said condition is not met, then you can add lines within the Else. For this you must move the mouse cursor until a yellow diamond appears with the plus (+) character inside it.



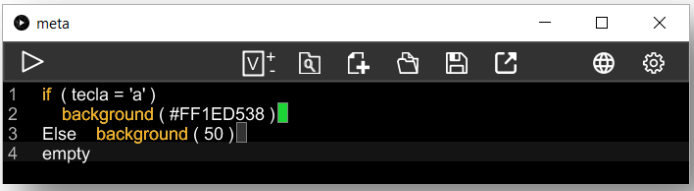
Once the instruction you want to use is selected, you would see that the word **Else** appears before the instruction. For when you want to add more instructions inside the **Else**, you must move the mouse cursor until a blue diamond appears with the plus (+) character inside it**.**



If, on the other hand, you want to add another line of code but outside the **Else**, then you must move the mouse cursor until a green circle appears with the plus (+) character inside it.



When you do this then a new empty line will appear outside the condition's instructions.



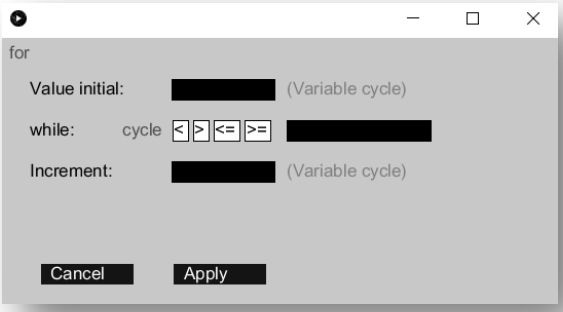
3.1. Cycles

Cycles in programming are a type of algorithmic structures that execute a set of instructions multiple times as long as a condition is met. Cycles are very useful for repetitive tasks, an example of use could be when you want to draw a grid, you could do it by writing the code

to draw line by line, or you could do it by creating a cycle to draw all the horizontal lines and creating another cycle to draw all the vertical lines. If the grid is 3 lines x 3 lines, it is not difficult to draw line by line, but if the grid is 1000 x 1000, then with two cycles the task can be performed, and makes the code look optimized and simplified.

To add a cycle, the instruction for must be selected within the Structures category in the add instruction window.

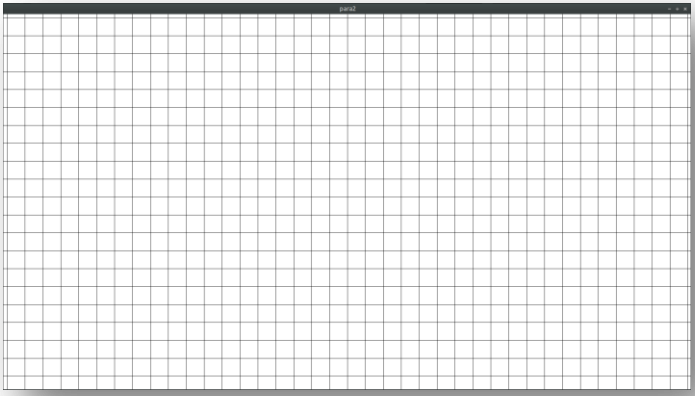
Then in the window that opens you can write in the first box the initial value for the system variable called cycle. Below this box, the operator can be selected to compare the value of cycle variable with a value that must be added in the second box. Finally, in the third box it is defined how much the cycle variable is going to be increased every time the cycle *for* is restarted.



An example of using the structure for can be drawing a grid. The following code can be written in the mouse tab, so when you press any of its buttons draw the grid.

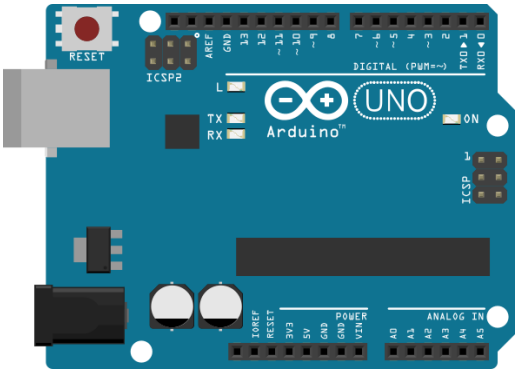
```
1  background ( 255 )
2  for ( desde 10 ; while cycle < 1920 ; Increment 50 )
3     line ( ciclo , 0 , ciclo , alto )
4  for ( desde 10 ; while cycle < 1080 ; Increment 50 )
5     line ( 0 , ciclo , ancho , ciclo )
```

The output you get from running this 5-line code should be similar to this:


para2

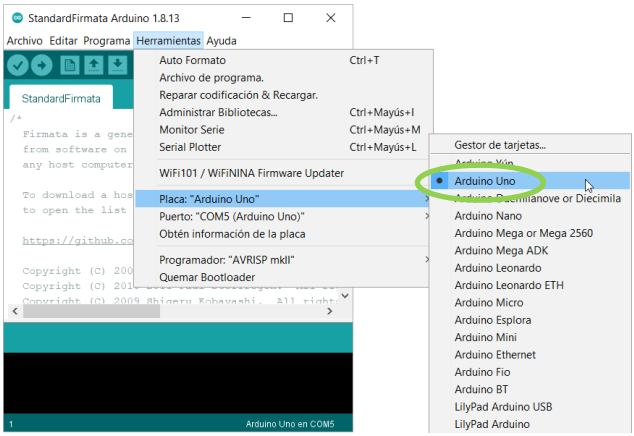
4. ARDUINO WITH META_PROCESING

To use an Arduino board with Meta_Processing, the Ardunio requires the Firmata library to be loaded. In this way you can establish communication through the USB port with the board and control several of its main functions. Turn pins on and off, digital readout of a pin, analog readout of a pin, and control servos.

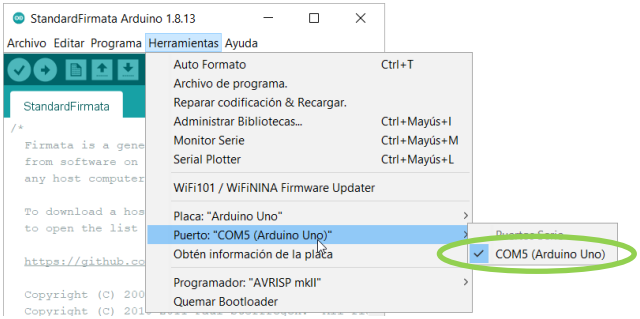


4.1. Installation of the Firmata library on an Arduino board

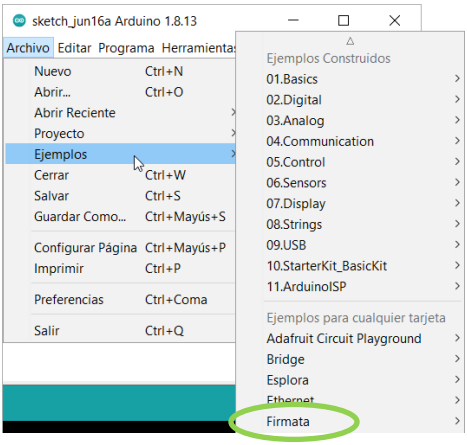
To load the Firmata library on the board the first step is to open the Arduino IDE and choose the Arduino board to which the Firmata library will be loaded.



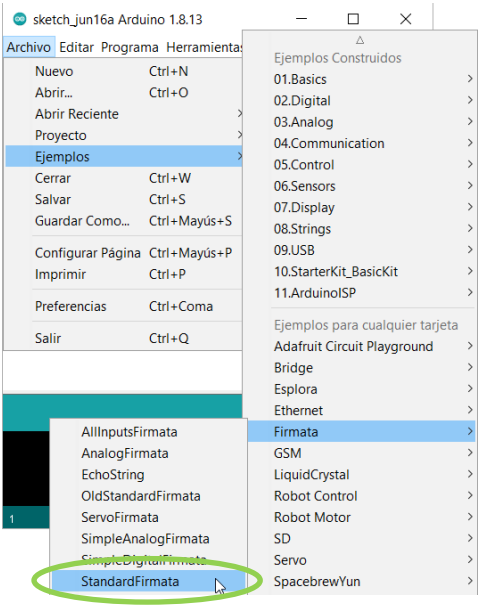
Then you must choose the port to which the Arduino board is connected.



Then you need to open the Firmata library **examples**, which are accessed from the **file** menu.

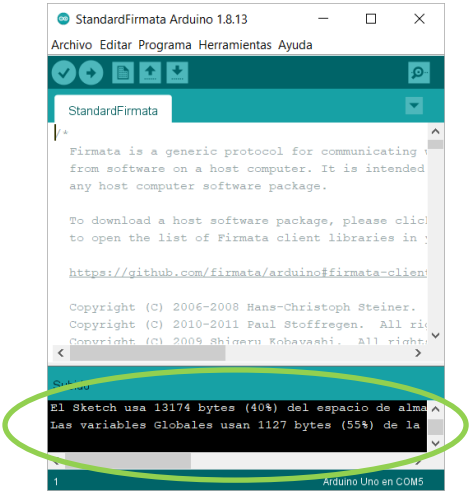


Then you must click on the **Firmata** option to see all the sample files of this library, and open the example: **StandardFirmata**



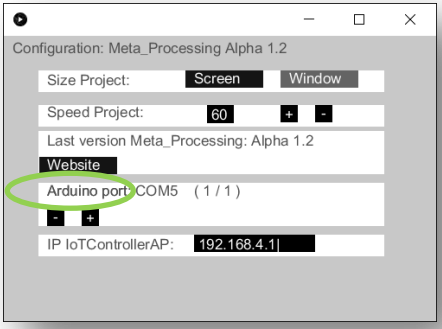
With the example open, click on the upload icon.

When you finish uploading the library to the Arduino board you should see something like this:



The next step is to open Meta_Processing and select the port to which the Arduino board is connected. For this, you must click on the configuration icon to open the configuration window.

In the window that opens you can see that the fourth option is: Arduino port.



To select the connection port with the Arduino board, click on the - or + buttons. When the Arduino is connected to the USB port, the first value displayed is the port name, and right next to it is a parenthesis with two values. The first value indicates the current port number and the value followed by / is the total ports. If there is no connected device, the port name is not shown, and the port numbers would say: (0/0).

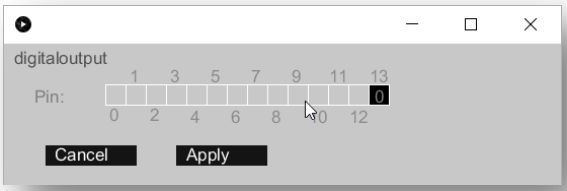
4.2. Arduino instructions

The Arduino instructions that can be used with Meta_Processing Alpha 1.1 are: **digitaloutput**, **digitalinput**, **analoginput**, and **servo**. The following will explain how to use each of them.

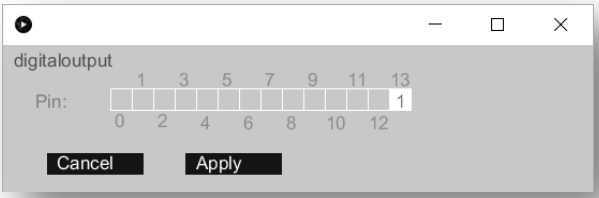
4.2.1. digitaloutput

The **digitaloutput** instruction is used to turn on or off a specific pin on the Arduino board. If a pin is turn on it means that this pin will supply a voltage greater than 3 volts to the device that is connected to that pin. On the contrary, turning off a pin means that this pin will supply a voltage less than 1.5 volts to the device that is connected to that pin.

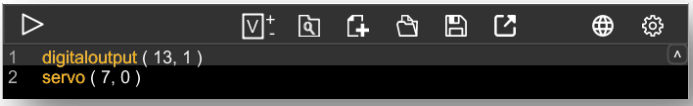
To use this instruction, click on the box corresponding to the pin of the Arduino that you want to turn on or off. When the background of the box is black that pin is turned off, if the color is white that pin is turned on. Example pin 13 off:



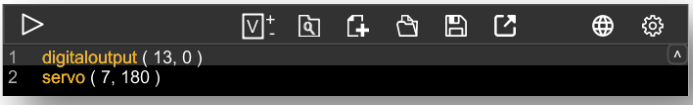
Example pin 13 on:



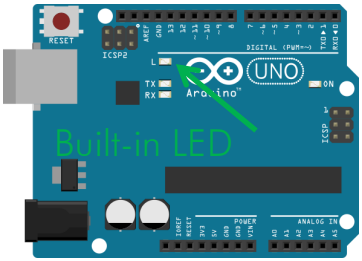
If you wanted to create a project that turns pin 13 on when the mouse is clicked and turns off when any key is pressed, the following code would need to be added in the **Mouse** tab:



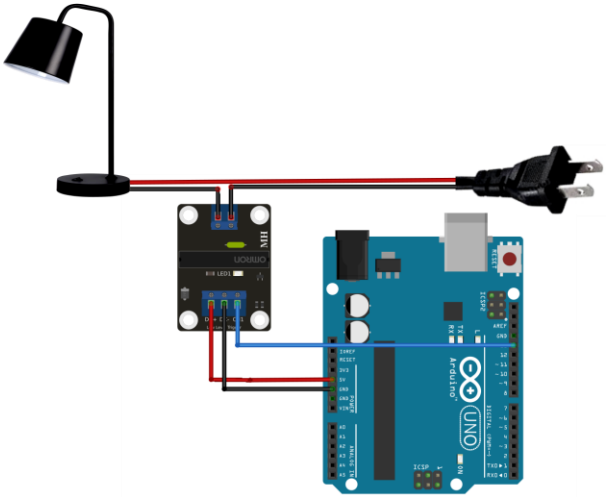
And in the **Keyboard** tab the following code would need to be added:



To use the previous code it would not be necessary to build any circuit with the Arduino, since there is a Led that is built-in in all Arduino Uno boards and by default is connected to pin 13.

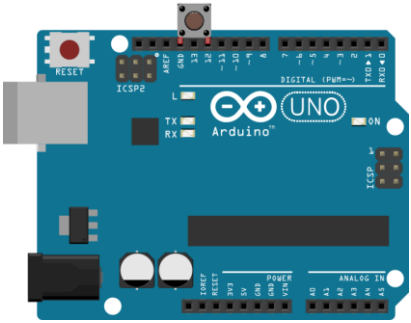


Below is a circuit that could be built to turn on and off a lamp connected to 110 volts, using the same code. This would require a solid state relay module for the Arduino.



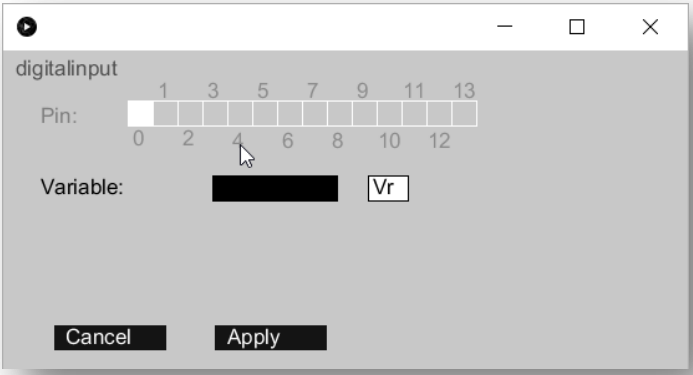
4.2.2. digitalinput

The **digitalinput** instruction is used to read the status of a digital pin on the Arduino board. This instruction was created to be able to connect a push-button directly to any digital pin, without needing to build an additional circuit (Pull Up). One of the push-button terminals must be connected to the GND pin and the other to the digital pin that you want to use. In this example pin 12:



This instruction stores in a variable the state of the digital pin, if it is 1 it means that the button is pressed, if on the contrary it is 0 it means that the button is not being pressed.

To use this instruction, you must click on the box corresponding to the pin of the Arduino that you want to read and in the second box, you must select the variable that will store the state of the pin.



If you wanted to create a project with a button that changes the background color to green each time the button is pressed, and when the button is not pressed the background color turns red, the following code would need to be added in the **Principal** tab:

```
1  digitalinput ( 12, x )
2  if  ( x = 1 )
3     background ( #FF15ED38 )
4  Else    background ( #FFDC3338 )
```

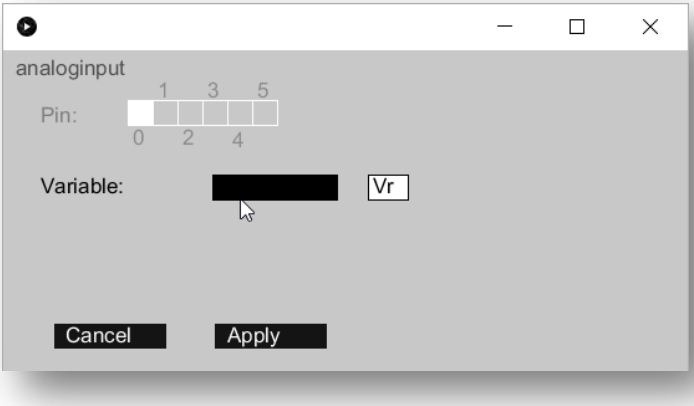
To use this example code, you must have one button terminal connected to the GND pin of the Arduino and the other terminal to pin 12 of the Arduino.

4.2.3. analoginput

The **analoginput** instruction is used to read the status of an analog pin on the Arduino board. The range of values that can be obtained from this reading is between 0 and 1023.

This instruction stores the state of the analog pin in a variable, where 0 would be equivalent to a reading of a voltage less than 0.0049 volts and 1023 to a reading of a voltage of 5 volts.

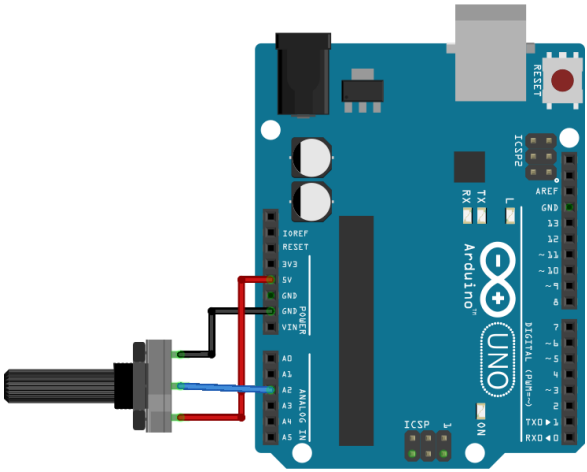
To use this instruction, you must click on the box corresponding to the analog pin of the Arduino that you want to read and in the second box, you must select the variable that will store the state of the pin.



If you wanted to create a project with a potentiometer connected to analog pin 2 so when it turns, the background color changes, the following code would need to be added in the **Principal** tab

```
1  analoginput ( 2, giro )
2  if  ( giro > 100 )
3     background ( 218 )
4  if  ( giro > 400 )
5     background ( 158 )
6  if  ( giro > 600 )
7     background ( 87 )
```

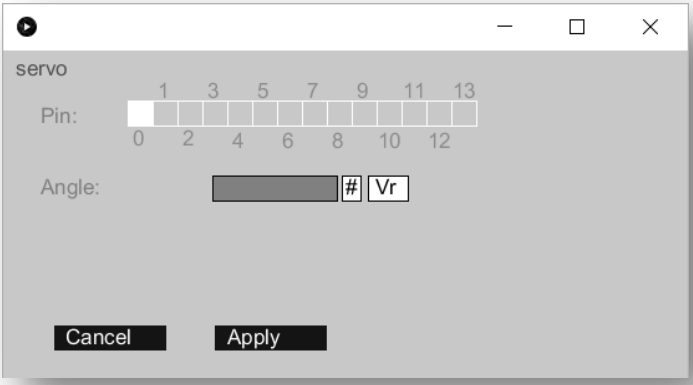
The circuit necessary to use the previous example code would be the following:



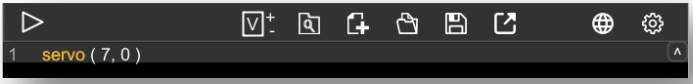
4.2.4. servo

The **servo** instruction is used to control the angle at which you want to rotate a servo motor connected to one of the digital pins of the Arduino board.

To use this instruction, click on the box corresponding to the pin of the Arduino to which the servomotor is connected, and in the second box, select the value of the angle to which you want to rotate the servomotor.

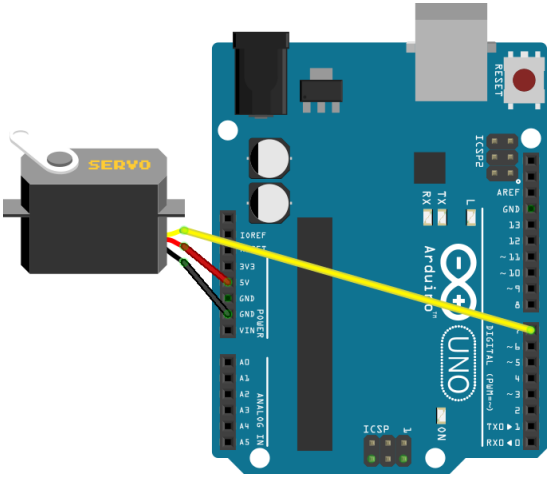


If you want to create a project with a servo motor connected to digital pin 7 so that it rotates in one direction when the mouse is clicked and it rotates in the opposite direction when any key is pressed, the following code would need to be added in the **Mouse** tab:



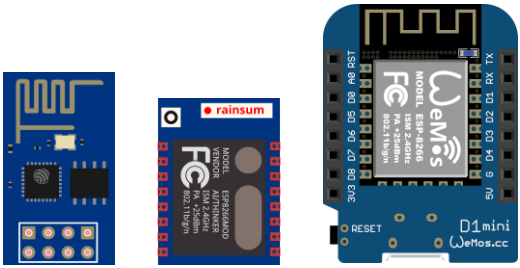
And in the **Keyboard** tab the following code would need to be added:

The circuit necessary to use the previous example code would be the following:



5. ESP BOARD WITH META_PROCESING

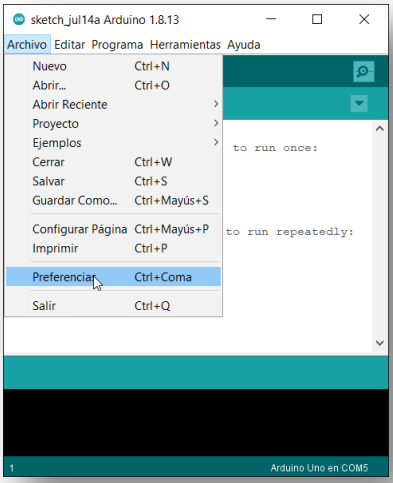
To use an ESP board with Meta_Processing requires that the ESP be loaded with the IoTControllerAP library[3]. This library allows the ESP board to function as an Access Point named IoTController (no password required). In this way, direct WiFi communication with the board can be established and several of its main functions can be controlled: turning pins on and off, digital and analog reading of a pin, and control of servos.



[3] https://github.com/hiteclab/IoTControllerAP

5.1. Installing the IoTControllerAP library on an ESP board

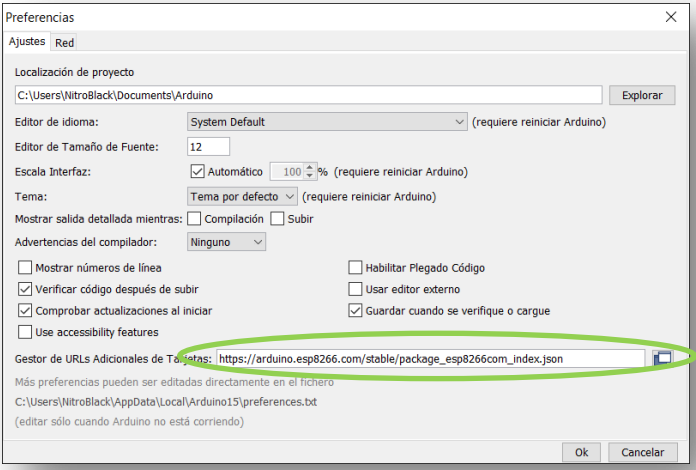
To load the **IoTControllerAP** library on the ESP board, the first step is to open the Arduino IDE and install the driver for these boards. For this it is necessary to click on the **Preferences** option within the **File** menu.



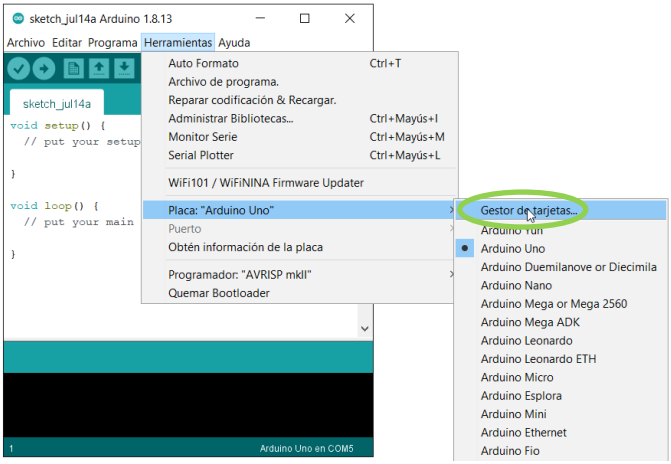
In the window that opens, you must add in the option **Additional Borad URL Manager**, the line:

https://arduino.esp8266.com/stable/package_esp8266com_index.json

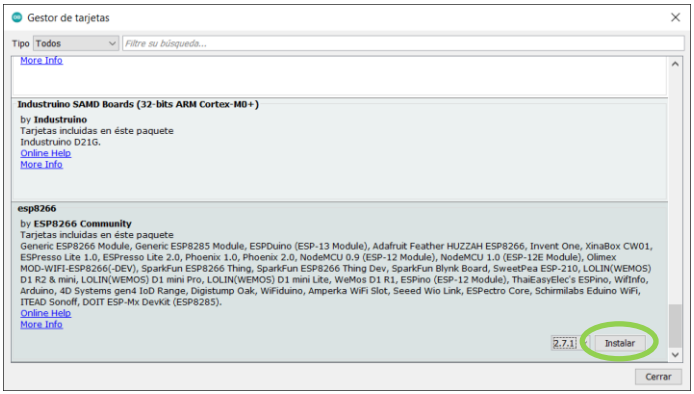
As it's shown in the following:



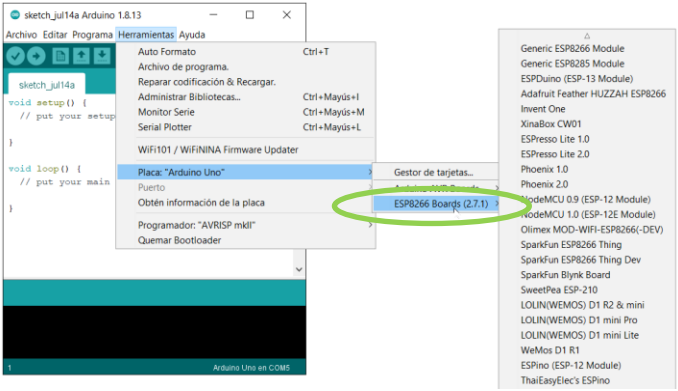
Then you must click on the **Board** option in the **Tools** menu, in the menu that opens you must click on the **Board manager** option:



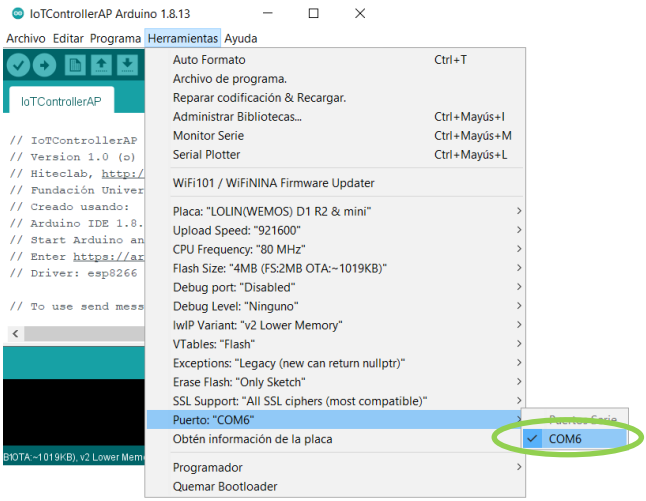
In the window that opens, search for the driver for the **esp8266** board, select version **2.7.1** and click over the **Install** button.



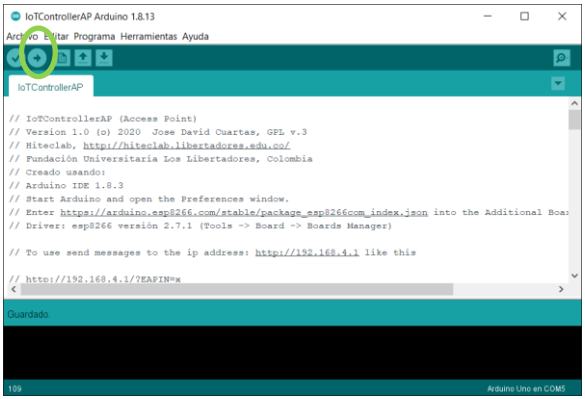
Once this is done, you can choose the ESP board to which the **IoTControllerAP** library will be loaded.



Then you must choose the port to which the ESP board is connected.

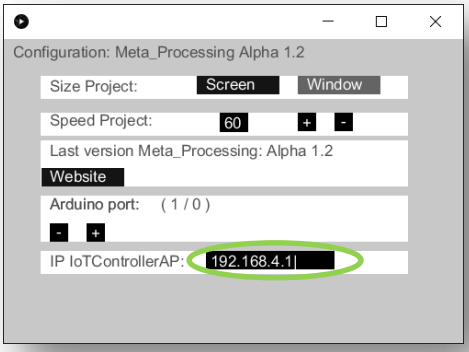


Next, download the **IoTControllerAP** library from https://github.com/hiteclab/IoTControllerAP, then open the **IoTControllerAP.ino** code, and click on the **upload** icon.



Once the IoTControllerAP controller is loaded on the ESP board, your computer must be connected via WiFi to the ESP board. Search the Access Point **IoTController** and click connect (No password required). Then you must open Meta_Processing and click on the **configuration** icon and in the configuration window confirm that the IP address of the ESP board is 192.168.4.1.

In the window that opens you can see that the fifth option is: **IP IoTControllerAP**.



There you can change the IP address of the board with the IoTControllerAP library, by default it is: 192.168.4.1

5.2. IoTControllerAP Instructions

The IoTControllerAP instructions that can be used with Meta_Processing Alpha 1.2 are: digitaloutput, digi-

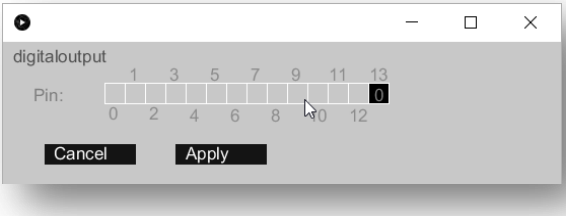
talinput, analoginput, and servo. The following will explain how to use each of them.

5.2.1. digitaloutput

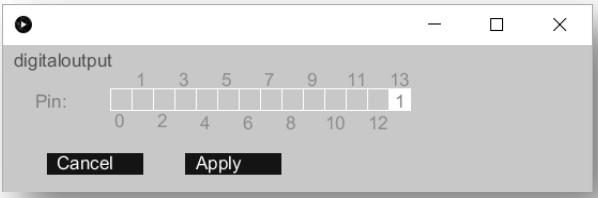
The **digitaloutput** instruction is used to turn on or off a specific pin on the ESP board. If a pin lights up, this pin will supply a voltage greater than 3 volts to the device that is connected to that pin. Conversely, if a pin is turned off, it means that this pin will supply a voltage less than 1.5 volts to the device that is connected to that pin.

To use this instruction, click on the box corresponding to the pin of the ESP you want to turn on or off. When the background of the box is black then that pin is turned off, if the color is white then that pin is turned on.

Example pin 13 off:



Example pin 13 on:



If you wanted to create a project that turns on pin 12 when the mouse is clicked and turns off when any key is pressed, the following code should be added in the Mouse tab:

```
1  digitaloutput ( 12, 1 ) IoTControllerAP
```

And in the Keyboard tab the following code should be added:

```
1  digitaloutput ( 12, 0 ) IoTControllerAP
```

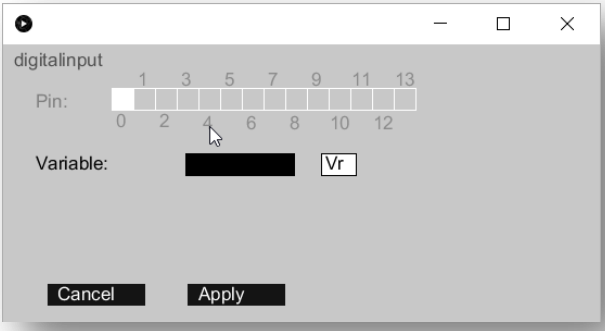
To use the previous code it would be necessary to connect a LED to pin 12 of the ESP board.

5.2.2. digitalinput

The **digitalinput** instruction is used to read the status of a digital pin on the ESP board. This instruction was created to be able to connect a button directly to any digital pin, without needing to build an additional circuit (Pull Up). One of the push-button terminals must be connected to the GND pin and the other to the digital pin that you want to use.

This instruction stores in a variable the state value of the digital pin, if is 1 it means that the button is pressed, if on the contrary is 0 it means that the button is not being pressed.

To use this instruction, you must click on the box corresponding to the ESP pin you want to read and in the second box, you must select the variable that will store the state value of the pin.



If you wanted to create a project with a button that changes the background color to green each time the button is pressed, and when the button is not pressed, the background color turns red, the following code should be added in the **Principal** tab:

```
1  digitalinput ( 4, esp ) IoTControllerAP
2  if  ( esp > 0 )
3     background ( #FF52D938 )
4  Else    background ( #FFD24638 )
```

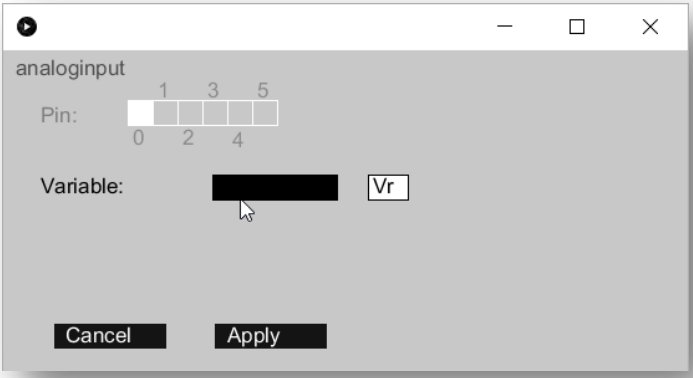
To use this example code, you must have one terminal of the button connected to the GND pin of the ESP and the other terminal to pin 4 of the ESP board.

5.2.3. analoginput

The **analoginput** instruction is used to read the status of an analog pin on the ESP board. The range of values that can be obtained from this reading is between 0 and 1023.

This instruction stores the state of the analog pin in a variable, where 0 would be equivalent to a reading of a voltage less than 0.0049 volts and 1023 to a reading of a voltage of 5 volts.

To use this instruction, you must click on the box corresponding to the analog pin of the ESP that you want to read and in the second box, you must select the variable that will store the state of the pin.



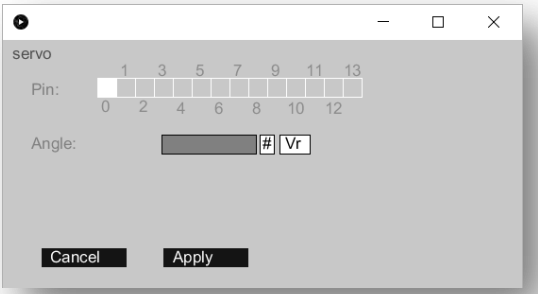
If you want to create a project with a potentiometer connected to the analog pin 0 and that when it turns, the background color changes, in the **Principal** tab you should add the following code:

```
1  analoginput ( 0, giro ) IoTControllerAP
2  if  ( giro > 100 )
3     background ( 218 )
4  if  ( giro > 400 )
5     background ( 158 )
6  if  ( giro > 600 )
7     background ( 87 )
```

5.2.4. servo

The **servo** instruction is used to control the angle at which you want to rotate a servo motor connected to any of the digital pins on the ESP board.

To use this instruction, click on the box corresponding to the pin of the ESP to which the servo motor is connected, and in the second box, select the value of the angle at which you want to rotate the servo motor.



If you wanted to create a project with a servo motor connected to digital pin 4 so that it rotates in one direction when the mouse is clicked and it rotates in the opposite direction when any key is pressed, the following code could be used.

In the **Mouse** tab should be added:

```
1  servo ( 4, 0 ) IoTControllerAP
```

And in the **Keyboard** tab should be added:

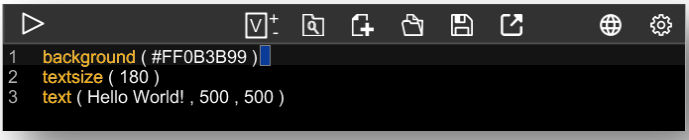
```
1  servo ( 4, 180 ) IoTControllerAP
```

6. CODE EXAMPLES WITH META_PROCESSING

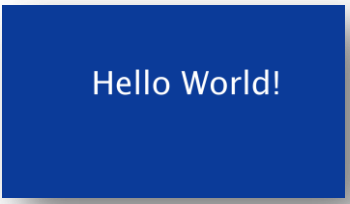
Below are a number of examples of how to use Meta_Processing. The first of them allows us to experiment with the keyboard function, the second allows us to draw circles on the screen when pressing the mouse. The third is an example of how an animation can be created. The fourth shows us three ways to program a piano. And the last one shows us how to create a simple mini game.

6.1. Basic example with the Keyboard

The following code must be written on the Keyboard tab, so it will be executed at the moment any key is pressed.

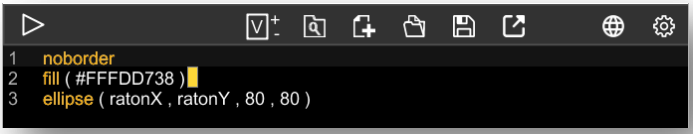


The ideas is that when you press any key, the screen turns blue and a white text appears on the screen.



6.2. Basic example with the Mouse

The following code should be written on the Mouse tab so it will be executed at the moment any of the mouse buttons are pressed.

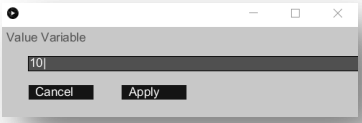


```
1  noborder
2  fill ( #FFFDD738 )
3  ellipse ( ratonX , ratonY , 80 , 80 )
```

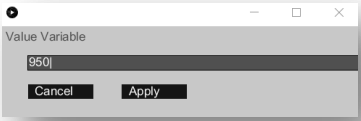
The ideas is that after pressing any of the mouse buttons yellow circles will be drawn on the screen.

6.3. Animation

This is an example of how you can make an animation in Meta_Processing. First, you need to create two variables, one called **px** and the other called **py**. The **px** variable must be initialized, with the value 10.



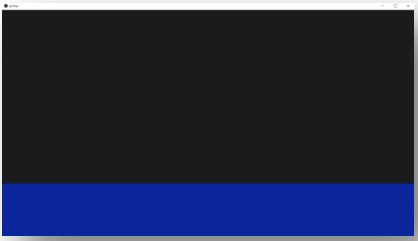
And the variable **py** must be initialized with the value 950.



Then the following code should be added in the **Principal** tab:

```
1  background ( px )
2  add ( px , 0.5 )
3  subtract ( py , 0.5 )
4  fill ( #FFF2E138 )
5  ellipse ( 200 , py , 200 , 200 )
6  fill ( #FF0B259A )
7  rectangle ( 0 , 800 , ancho , 400 )
```

After clicking on the **run** icon you will see that the animation begins by recreating a night scene in the sea, and it will slowly dawn until the firmament is fully illuminated.

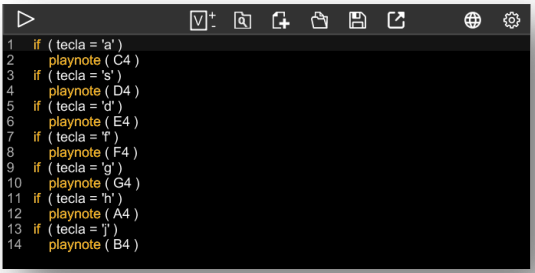


6.4. Piano

Below are three examples of how to make a piano in Meta_Processing. The first is a simple piano, the second is a piano that also changes the color of the screen, and the third is a piano that changes the color of the screen and displays text with the note being played.

6.4.1. Simple piano

To program this piano, the following code must be added in the Keyboard tab:

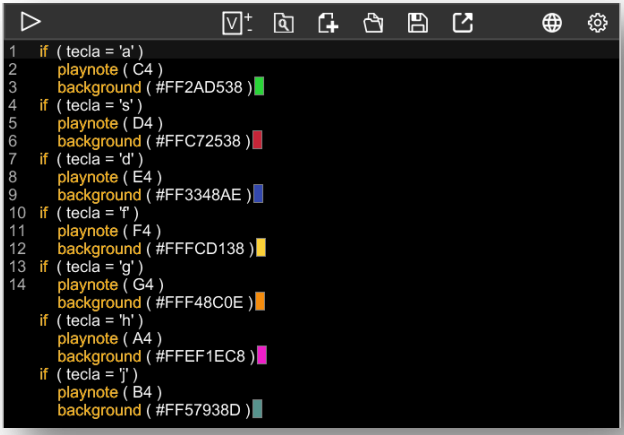


```
1  if ( tecla = 'a' )
2     playnote ( C4 )
3  if ( tecla = 's' )
4     playnote ( D4 )
5  if ( tecla = 'd' )
6     playnote ( E4 )
7  if ( tecla = 'f' )
8     playnote ( F4 )
9  if ( tecla = 'g' )
10    playnote ( G4 )
11 if ( tecla = 'h' )
12    playnote ( A4 )
13 if ( tecla = 'j' )
14    playnote ( B4 )
```

With this code you can play the 7 musical notes using the keys a, s, d, f, g, h, j. To make it work properly the keyboard cannot be in uppercase mode.

6.4.2. Piano colors

To program this piano, the following code must be added in the Keyboard tab:

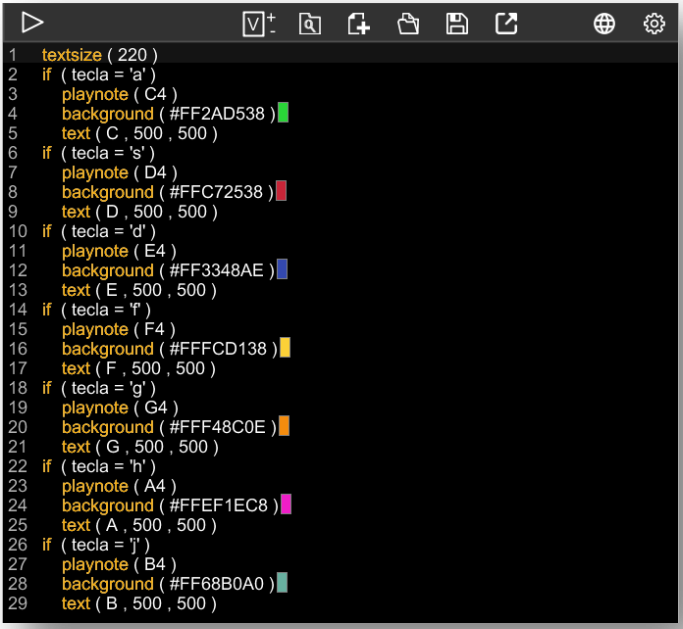


```
1   if ( tecla = 'a' )
2      playnote ( C4 )
3      background ( #FF2AD538 )
4   if ( tecla = 's' )
5      playnote ( D4 )
6      background ( #FFC72538 )
7   if ( tecla = 'd' )
8      playnote ( E4 )
9      background ( #FF3348AE )
10  if ( tecla = 'f' )
11     playnote ( F4 )
12     background ( #FFFCD138 )
13  if ( tecla = 'g' )
14     playnote ( G4 )
       background ( #FFF48C0E )
    if ( tecla = 'h' )
       playnote ( A4 )
       background ( #FFEF1EC8 )
    if ( tecla = 'j' )
       playnote ( B4 )
       background ( #FF57938D )
```

With this code you can play the 7 musical notes using the keys a, s, d, f, g, h, j. To make it work properly the keyboard cannot be in uppercase mode.

6.4.3. Piano colors and notes on screen

To program this piano, the following code must be added in the Keyboard tab:



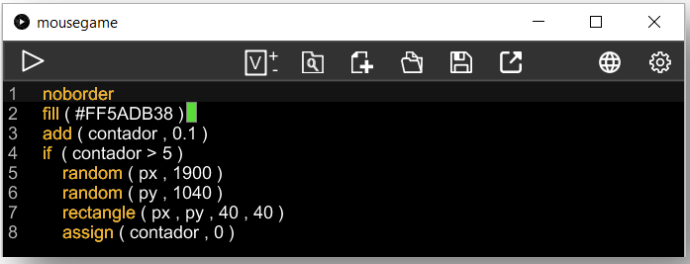
```
1   textsize ( 220 )
2   if  ( tecla = 'a' )
3       playnote ( C4 )
4       background ( #FF2AD538 )
5       text ( C , 500 , 500 )
6   if  ( tecla = 's' )
7       playnote ( D4 )
8       background ( #FFC72538 )
9       text ( D , 500 , 500 )
10  if  ( tecla = 'd' )
11      playnote ( E4 )
12      background ( #FF3348AE )
13      text ( E , 500 , 500 )
14  if  ( tecla = 'f' )
15      playnote ( F4 )
16      background ( #FFFCD138 )
17      text ( F , 500 , 500 )
18  if  ( tecla = 'g' )
19      playnote ( G4 )
20      background ( #FFF48C0E )
21      text ( G , 500 , 500 )
22  if  ( tecla = 'h' )
23      playnote ( A4 )
24      background ( #FFEF1EC8 )
25      text ( A , 500 , 500 )
26  if  ( tecla = 'j' )
27      playnote ( B4 )
28      background ( #FF68B0A0 )
29      text ( B , 500 , 500 )
```

With this code you can play the 7 musical notes using the keys a, s, d, f, g, h, j. To make it work properly the keyboard cannot be in uppercase mode.

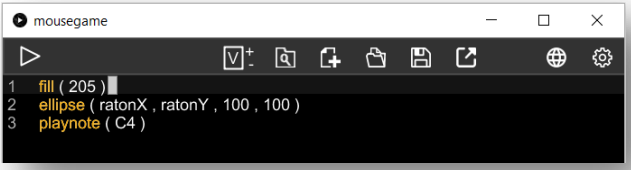
When the piano is executed would look like this:

6.5. Mini Game

This is an example of how you can make a mini game in Meta_Processing. The following code must be added in the **Principal** tab:

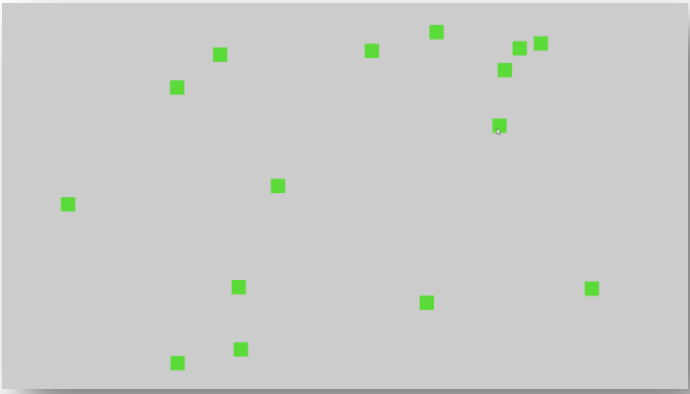


And in the Mouse tab you must add the following code:



The game consists of a series of green squares that appear randomly on the screen. The purpose of the game is to try to make disappear all the green squares by clicking on them.

When the game is executed would look like this:



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Meta_Processing, is a meta-programming environment based on the Processing language. It was created by the author of this book in order to provide the programming beginner with a tool to create code using their native language. With Meta_Processing you can write and read the same code in 14 different tongues: Spanish, Française, Hindi, Japanese, Italiano, Chinese, Português, English, Punjabi, Kannada, Bengali, Tamil, Korean, Russian, and German. It is a programming environment designed to offer a friendly experience, which prevents the user from making common syntax errors. Meta_Processing is free software released under the GPL v3 license.

For years there have been fantastic programming language initiatives for children such as Logo and Scratch (developed in the United States by MIT) or Pilas Bloques (developed in Argentina by the Program.ar initiative). However, Meta_Processing targets other types of users who want to learn to program without feeling that they are using tools designed for children. It could also be used by children and young people who do not want to use tools with child-like interfaces.

Professor Jose David Cuartas is the director and founder of the Hypermedia laboratory (Hitec Lab) at the Fundación Universitaria Los Libertadores. He is a Visual Designer and a PhD in Design and Creation from the Universidad de Caldas. He is a promoter of the use and development of free software for environments like art, design and entertainment. His research work focuses on exploring strategies to promote Hacker and Maker cultures in the university academic context, seeking that inexperienced people would discover the creative opportunities that exist when they learn to program. From the Hipermedia laboratory, he is one of the mentors of the initiative called: "Women in technology", which seeks to bring the female audience closer to the Hacker and Maker cultures and contribute to demystifying technologies. Professor Cuartas is the author of the series of three books called Digitopolis, which is available for free download at google books. The first book in the series (Digitopolis I), allows the reader to learn to program using the Processing language. The second book (Digitopolis II), is a guide to learn how to develop 2D videogames with Gdevelop. And the third book (Digitopolis III), is for those interested in learning how to create virtual tours in Blender 3D.

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