

# Arduino Programming in Python

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# Who am I?



Artificial Intelligence MSc - UPM

Informatic Engineering and Software  
Engineering - URJC

Student Developer GSoC - JdeRobot



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# Summary

**Google Summer of Code**

**Problematic**

**State of the art**

**PyOnArduino**

**Demo**



**Global program**

**Bring students into open source development**

**Remote work + meetings**

**JdeRobot – 6 students**

### **Timeline**

- February - Organizations announced
- March - Student applications
- April – Student Projects announced
- April & May – Community Boarding
- May to August – Coding
- June, July & August - Evaluations

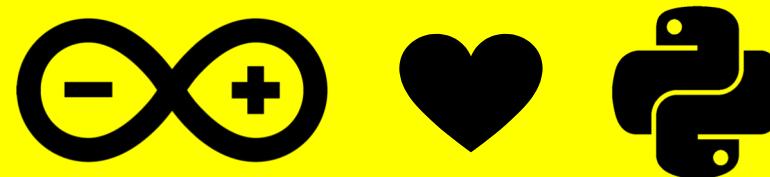


## Problematic

Arduino programming language complexity

Need of easy to use tools for newbies

Code Arduino boards using Python





## State of the art

### **Current solution for the problematic**

Continuous communication between the robot and the PC.

### **Possible approaches**

- Pyxie
- Cython
- LLVM





# PyOnArduino

People:

José María Cañas

Gorka Guardiola

Luis Roberto Morales

Sergio Paniego Blanco

**JdeRobot Robot Programming tool**

**Translate Python-like code to Arduino code**

**Translate, compile and upload the code directly**

```
def loop():
    if halduino.getLineFollowValue() == 0:
        halduino.setSpeedEngines(100, 100)
    elif halduino.getLineFollowValue() == 1:
        halduino.setSpeedEngines(0, 100)
    elif halduino.getLineFollowValue() == 2:
        halduino.setSpeedEngines(100, 0)
    elif halduino.getLineFollowValue() == 3:
        halduino.setSpeedEngines(-100, -100)
```





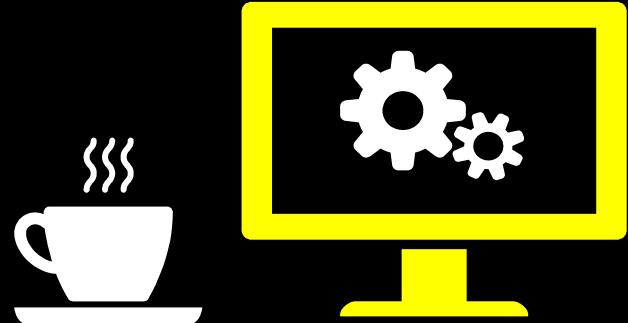
## Supported robots

MBOT

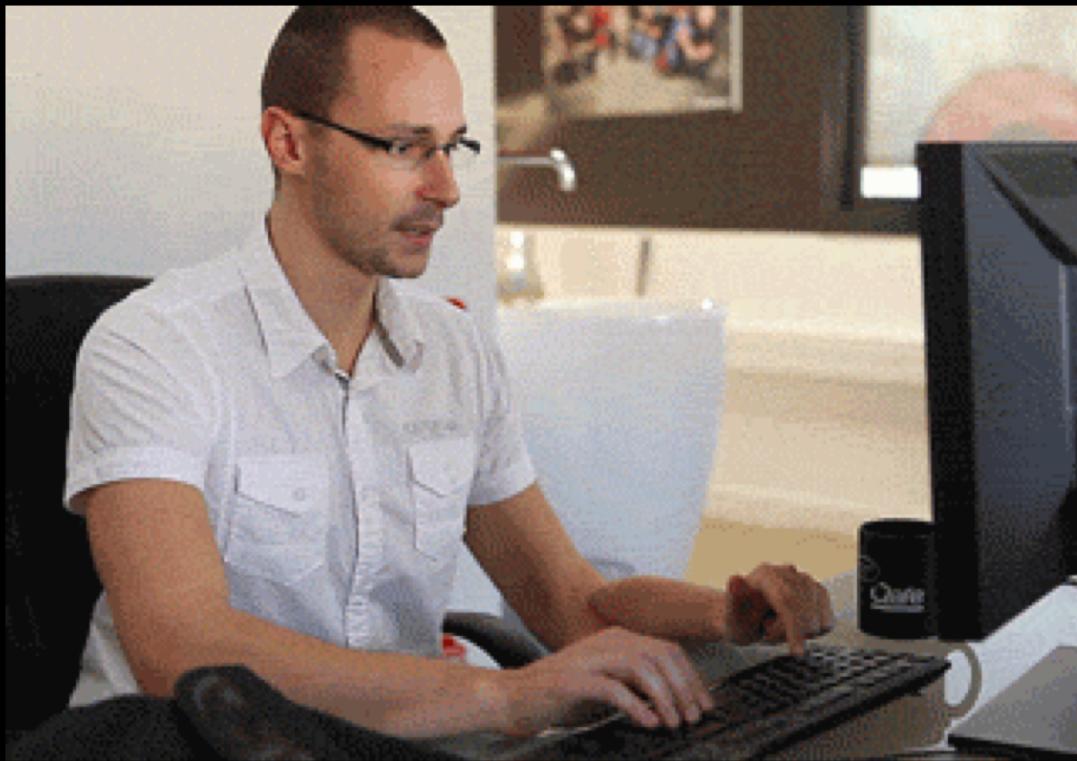


COMPLUBOT





# PyOnArduino's structure





# Translator

**Abstract Syntax Tree**

**Each node – Statement in the code**

**Information for analyzing the code**

**Inessential punctuation and delimiters**

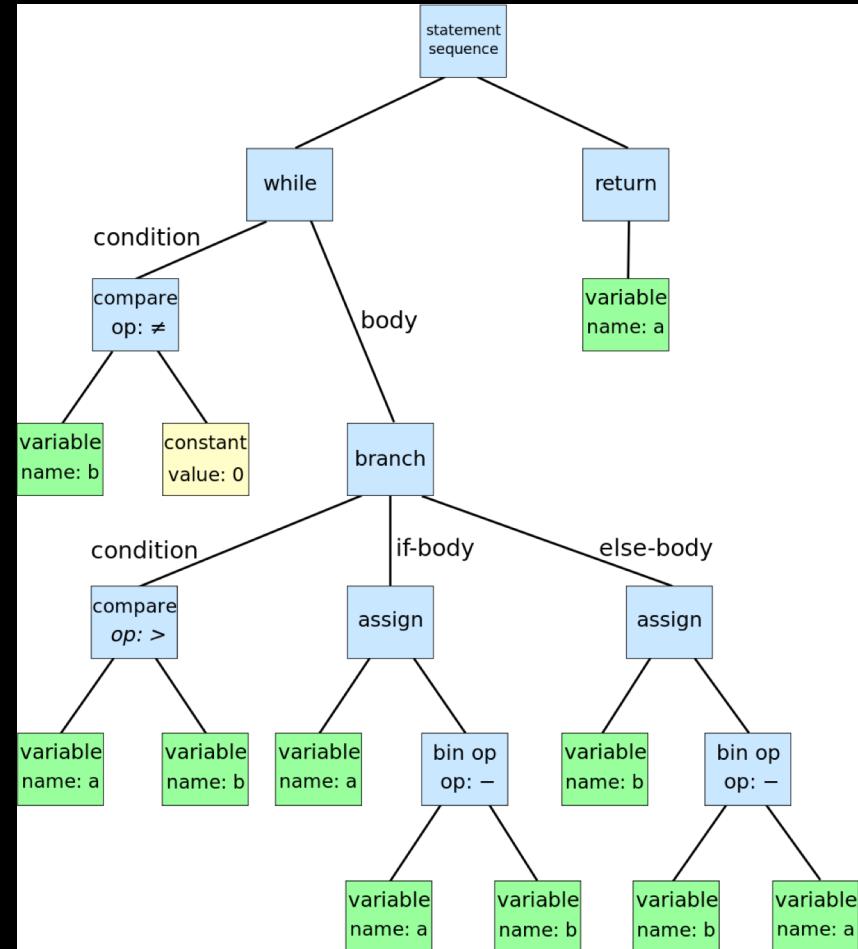
**Python library**

**NodeTransformer and NodeVisitor**

# Abstract Syntax Tree

## Greatest Common Divisor

```
while b ≠ 0
    if a > b
        a := a - b
    else
        b := b - a
return a
```





# Translator

**Abstract Syntax Tree**

**Each node – Statement in the code**

**Information for analyzing the code**

**Python library**

**NodeTransformer and NodeVisitor**

# NodeVisitor & NodeTransformer

```
import ast

class MyVisitor(ast.NodeVisitor):
    def visit_Str(self, node):
        print('String Node: "' + node.s + '"')

class MyTransformer(ast.NodeTransformer):
    def visit_Str(self, node):
        return ast.Str('str: ' + node.s)

parsed = ast.parse("print('Hello World')")
MyTransformer().visit(parsed)
MyVisitor().visit(parsed)
```



# HALduino

**Hadware Abstraction Layer**

**halduino.py**

**Specific halduino for each robot**

**Get rid of Arduino's complexity**



# HALduino example

## Python

```
setSpeedEngines(leftSpeed: int, rightSpeed: int)
```

## Arduino

```
MeDCMotor leftMotor(9);
MeDCMotor rightMotor(10);
void setSpeedEngines(int speedLeft, int speedRight) {
    leftMotor.run(speedLeft);
    rightMotor.run(speedRight);
}
```



# Sensors and actuators supported

## Complubot

Sensor/Actuator	Supported functions
DC Engines	setSpeedEngines (left,right)
Ultrasonic sensors	getUS()
Infrared sensors	getIR[1,2,3,4,5]()
Beep emitter	playBeep(type)
Sound emitter	playMelody(melody)
Screen write	setScreenText(text), cleanScreen()



# Sensors and actuators supported

## mBot

Sensor/Actuator	Supported functions
DC Engines	setSpeedEngines (speed)
Ultrasonic sensors	getUS()
LEDs	setLeds(ledNumber, red, green, blue)
Infrared sensors	getMessage(), sendMessage(message)
Light sensor	getLightSensor()
Button	isButtonPressed(), isButtonReleased()
Buzzer	playBuzzer(tone, length)
External screen	drawString(name), showClock(hour, min)



# Python features supported

Feature	Limitations/Comments
Variable declaration	SUPPORTED
Function declaration	With/without return statement
Operators	+ - * ^ %
Comparators	< <= >= == !=
Logic operators	And or is not
pass	SUPPORTED
loops	While, for(limited)
Sleep()	SUPPORTED
if	If/elif/else
Boolean operations	and or
print	SUPPORTED



# Stop and go code example

## Mbot

```
import HALduino.halduino as halduino

def set_engine(direction: int):
    if direction == 0:
        halduino.setSpeedEngines(0, 0)
        print('STOP!')
    elif direction == 1:
        halduino.setSpeedEngines(100, 100)
        print('Forward')

def loop():
    if halduino.getUS() < 10:
        set_engine(0)
    else:
        set_engine(1)
```



# Stop and go code example Complubot

```
import HALduino.halduino as halduino

def set_engine(direction: int):
    if direction == 0:
        halduino.setSpeedEngines(0, 0)
        print('STOP!')
    elif direction == 1:
        halduino.setSpeedEngines(100, 100)
        print('Forward')

def loop():
    if halduino.getUS() < 30:
        set_engine(0)
    else:
        set_engine(1)
```



# Managing robot's architecture

## Versatility

### Configure robot's ports

```
# Example of an mBot setup

leftMotor = 9
rightMotor = 10
ultrasonicSensor = 3
rgbled = 7
lightSensor = 6
ledMtx = 3
lineFollower = 2
```



# Executing PyOnArduino

**Python 3.x**

**Arduino IDE**

**Arduino Makefile**

```
python3 translator/Translator.py [input-file] [robot]
python3 translator/Translator.py [input-file] [robot] [architecture-file]
```



# Make & Arduino Makefile

**Build automation**

**Directives used by make**

**make upload**

```
# mBot Makefile

ARDUINO_LIBS= Makeblock-Libraries-master Wire SPI
MONITOR_PORT= /dev/cu.wchusbserial1420
BOARD_TAG = uno
ARDUINO_DIR    = /Applications/Arduino.app/Contents/Java
include /usr/local/opt/arduino-mk/Arduino.mk
```



# Problems during development

**Dynamic typing in Python vs Arduino**

**Architectural Stop**

**Variables' type in function declaration**

**Lost parentheses**



# DEMO TIME!

Lets see how PyOnArduino tool works!

Code

Issues 1

Pull requests 0

Projects 0

Wiki

Insights

No description, website, or topics provided.

169 commits

1 branch

0 releases

1 environment

1 contributor

Branch: master ▾

New pull request

Create new file

Upload files

Find file

Clone or download ▾

sergiopaniego	Melody test for Complubot restored	Latest commit d84018d a day ago
.idea	Architectural error for Complubot motor	3 months ago
HALduino	Architectural error for Complubot motor	3 months ago
docs	Hola gif added	3 months ago
examples	Melody test for Complubot restored	a day ago
makefiles	mBot tests added and comments in files	3 months ago
tests	Exception management improved for non-implemented functionality	3 months ago
translator	Exception management improved for non-implemented functionality	3 months ago
.gitignore	Small example generated using ast	5 months ago
README.md	README.md updated	14 days ago

README.md



## PyOnArduino

# Thanks!

**Any questions?**

You can find me at  
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