Emerging pedagogies & technologies in educational robotics: towards a paradigm shift

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EDUMOTIVA, Greece

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Educational robotics: current situation

- education systems are not yet able to efficiently integrate robotics into curriculum paths
- robotic technologies are often simply used to reinforce the old ways of teaching
- educational robotics kits are often
  - expensive and proprietary, or cheap and unreliable
  - invisible mechanisms: robots work as the extension of the self, almost unseen to the user

Learners as consumers

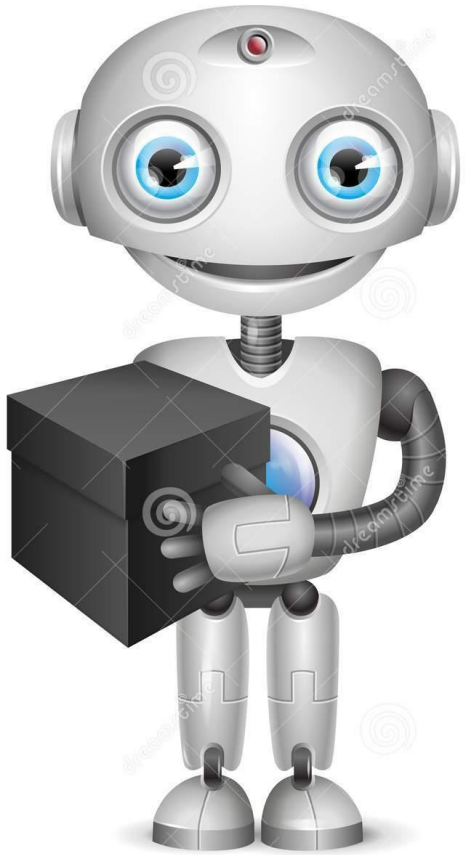
- ready-made pre-fabricated robots
- teaching/learning materials that define what is best for learners treating them just as consumers
- Learners have simply to follow step-by-step recipes to assembly and/or program a predefined robotic model
- poor learning results, superficial and trivial knowledge acquisition

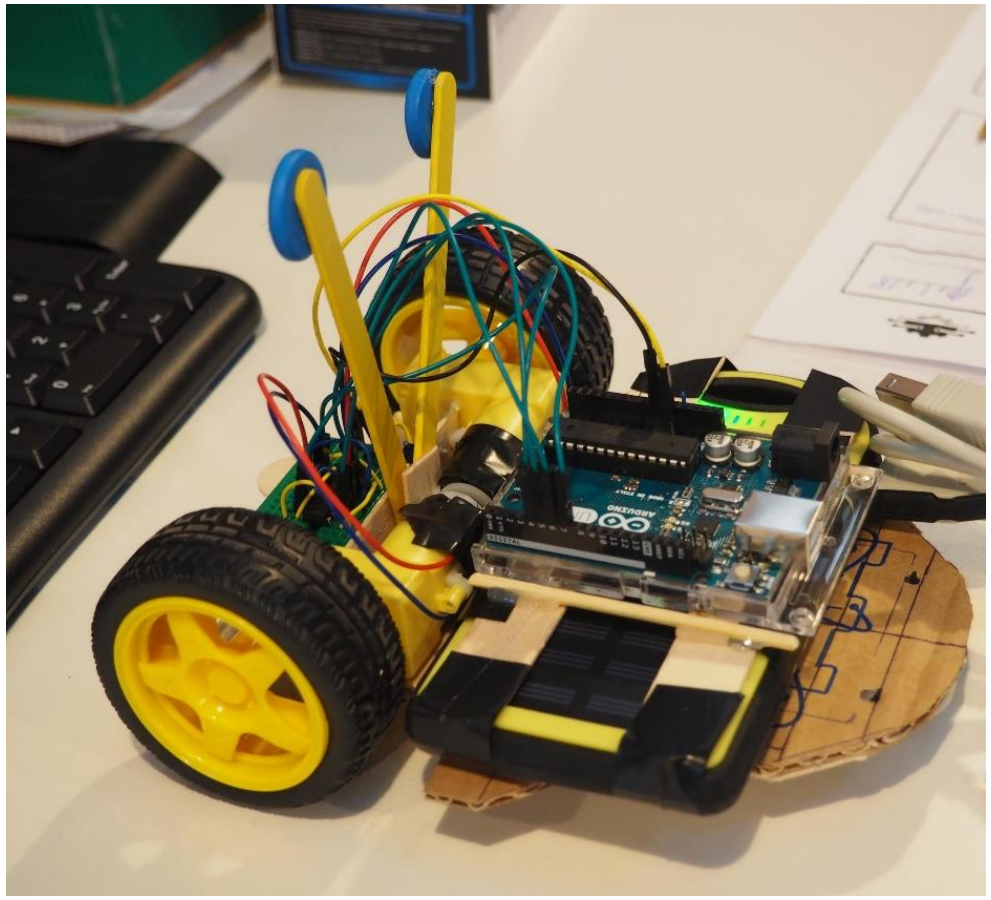
a “Jobs” Culture or a Literacy Culture?

- “robotics should address only talented youth or science- and technology-oriented students”
- fluency with robotics is just a vocational skill
- “professional” platforms & technologies designed for professionals/hobbyists
- programming languages for professionals (C++ etc)

- fluency with robotics is no longer just a vocational skill, but knowledge and skills valuable for every citizen.
- “professional” platforms **are not appropriate for schools** because they introduce a plethora of technical details that are foreign to the main learning goal and end up unnecessarily frustrating students even before they can accomplish the simplest of projects.
- Techs **specifically designed for children.**
- The same goes for programming languages

“black box” or “white box” paradigm?

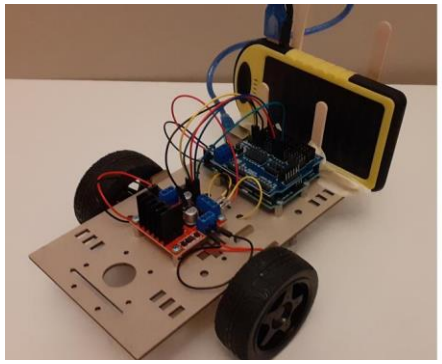


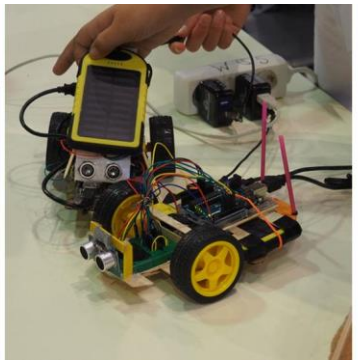


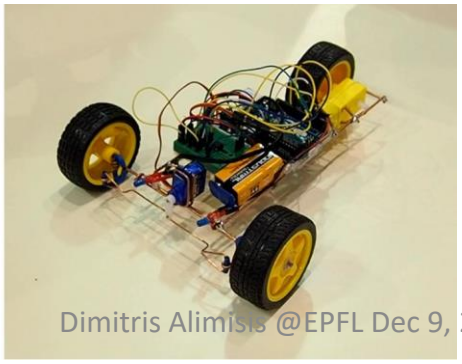
Scenarios from everyday life or missions to Mars?

Let's create our scenario:

- Can you describe what an autonomous vehicle is? *Search for information online with your team and write your answers below….*
- What do you know about the voice assistant applications embedded in cars? Do you know if AI technologies have been used to optimize these applications? *Search with your team for information online and write your answers below….*
- Can you think of some real-world cases where the voice commands for controlling and/or navigating an autonomous car could be useful or necessary? *Discuss with your team and document your thoughts below…*
- Sketch your autonomous car or/and list the main components that it consists of.







World Robot Olympiad 2014: Robots and Space

The black velvet sky studded with stars fills humankind with awe. From one side, stars are beautiful, unattainable and cold but from other side they saved the lives of brave travelers…

…The mission of World Robot Olympiad 2014 teams is to create and design robots which will assist to humankind in resolving different tasks in Space.

Towards a paradigm shift: the Maker Movement in robotics education …

Enriching edurobotics with the makers culture…

- Papert’s constructionism

  “learning can happen most effectively when people are active in making tangible objects in the real world”

  constructionism is connected with experiential learning and builds on Jean Piaget's epistemological theory of constructivism

- Do-it-Yourself (DIY) ethos
- Learners as makers!

Towards a paradigm shift: **The Maker Movement** in robotics education

- “Kids make their own robots”
- Open explorations, tinkering
- passion projects

Robotics + 3D Printing + DIY electronics + crafting + creativity + …

Transforming the robotics lab to a maker space…

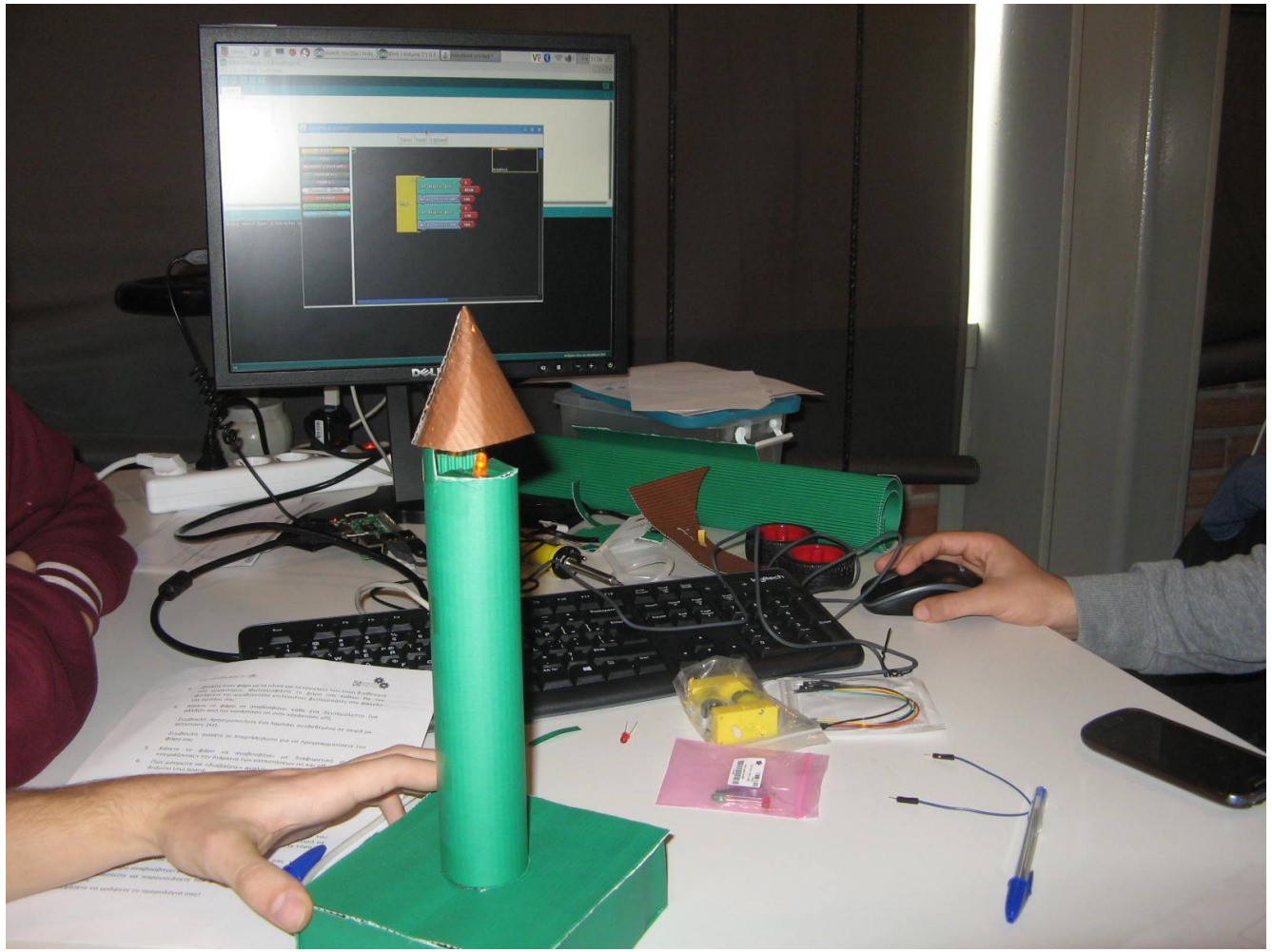
Makerspace: one lab, multiple places

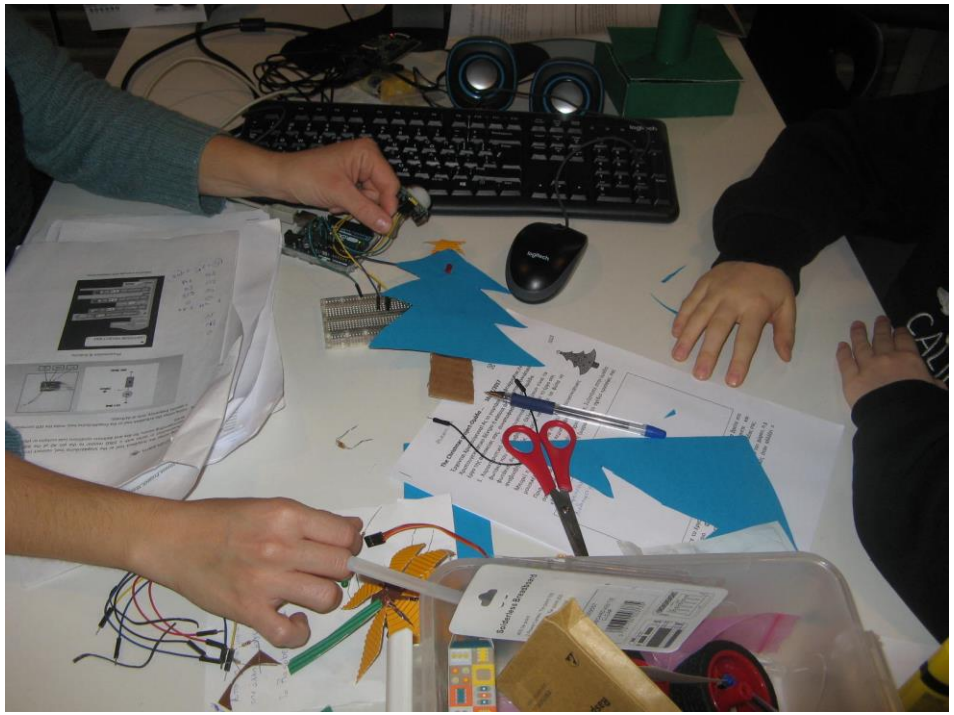
- Ideation & planning
- constructions
- crafting
- coding
- robotics
- presentations
- sharing

(by “Maker Days for Kids”, Designing a Makerspace for Children – Let’s Do It, Sandra Schön , Martin Ebner and Maria Grandl)

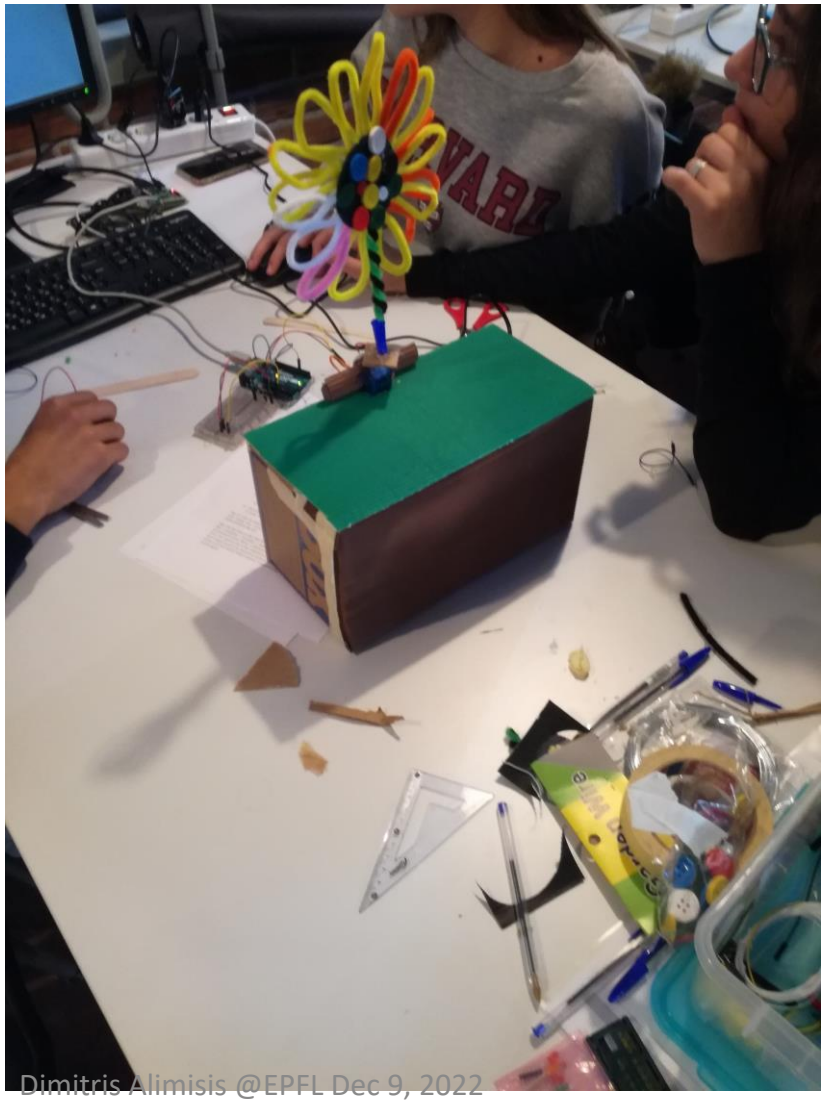
The eCraft2Learn Makerspace @Technopolis City of Athens

arts & crafts

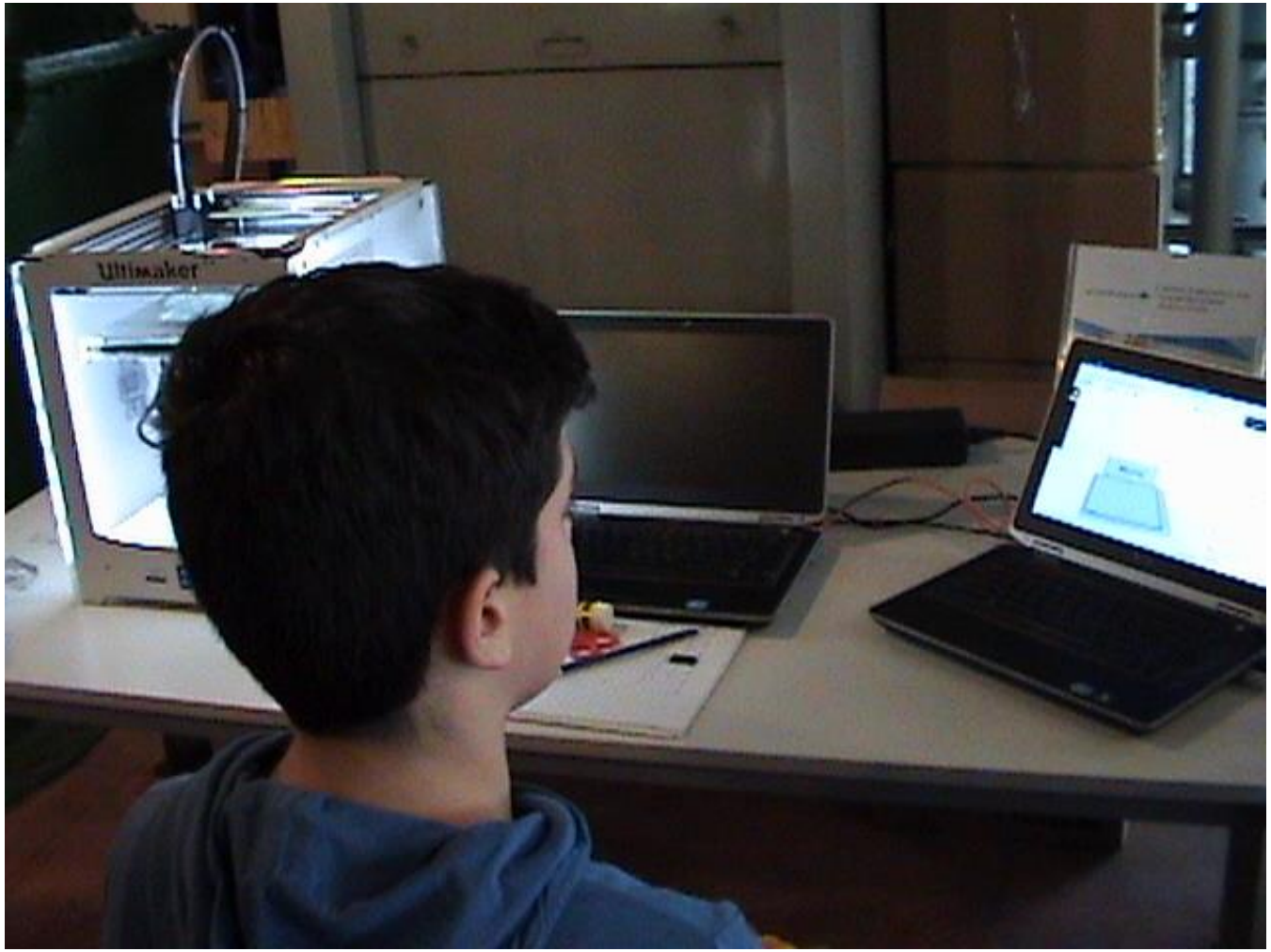




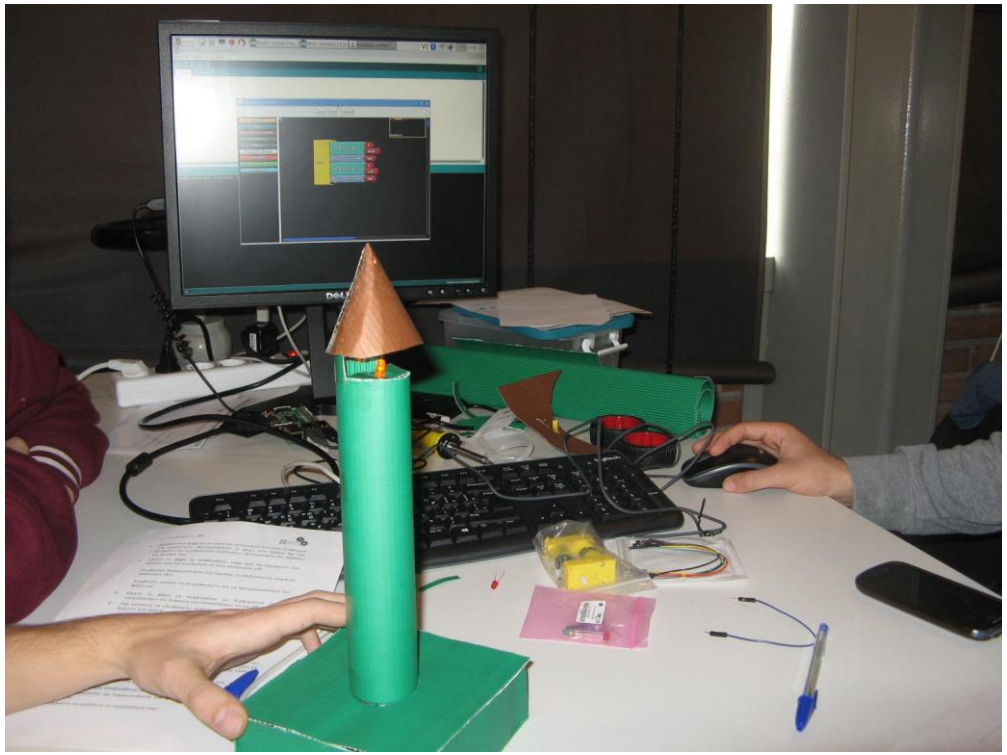
arts & crafts

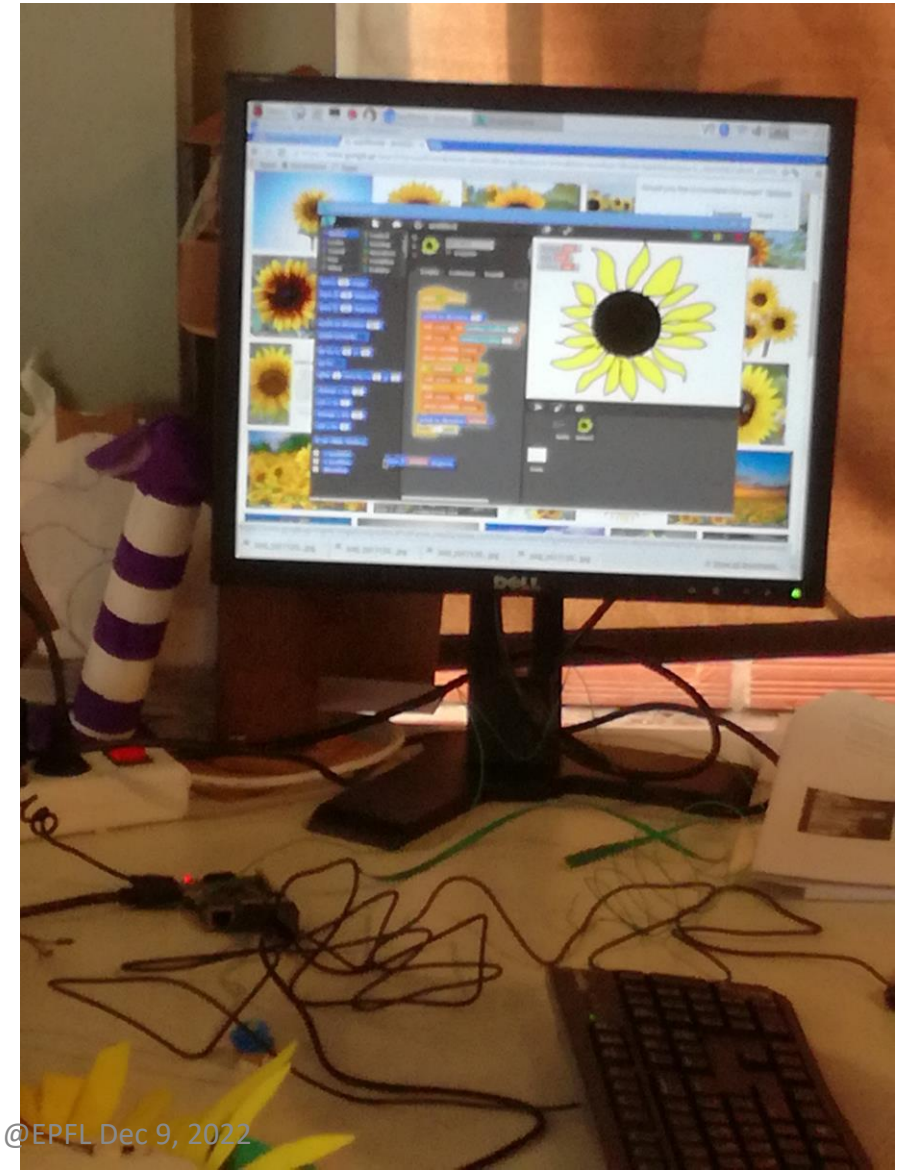


3D modelling & Printing…



Coding…





learning methodology…

- Imagine and plan
- https://drive.google.com/open?id=1sv8ibw8RB-HUoDNg-dc7LWWbu5-MUbPF
- construct and program

  https://drive.google.com/open?id=1-9Ad1HTOe7ony-m-hYkzuQBMQGUzmnNI
- Test and experiment
  https://drive.google.com/open?id=11ujdEYCBQ-IH8mbHVuU4e6XUEgmrYU5L
- Share

Assessment versus “instinct”

- Robotics education benefits are often considered as self-evident
- it is a common and dangerous trap to promise that students’ science scores will automatically improve as a result of a robotics class.
- Need for new assessment approaches and tools.
- Long-term results and benefits

THE INBOTS RESULTS

HTTPS://CORDIS.EUROPA.EU/PROJECT/ID/780073/RESULTS

- **Curricula** based on novel pedagogical methods including learning scenarios addressing several interdisciplinary topics https://edumotiva.eu/edumotiva/curricula-oers
- **Open educational resources** for learners and teachers including a variety of materials and resources where users can select the suitable ones based on their needs and interests and use within their robotics projects https://drive.google.com/file/d/1-mkF7dqY3ScKpEAfIbbMkovUyNYT2Ni2/view
- **Promotion of learning activities** focused on interactive robotics either in schools or in non-formal education settings ensuring that curricula and resources become accessible by learners and teachers

Which technologies?

Alimisis, D. Technologies for an inclusive robotics education. Open Research Europe 2021, 1:40 (open access https://doi.org/10.12688/openreseurope.13321.2)

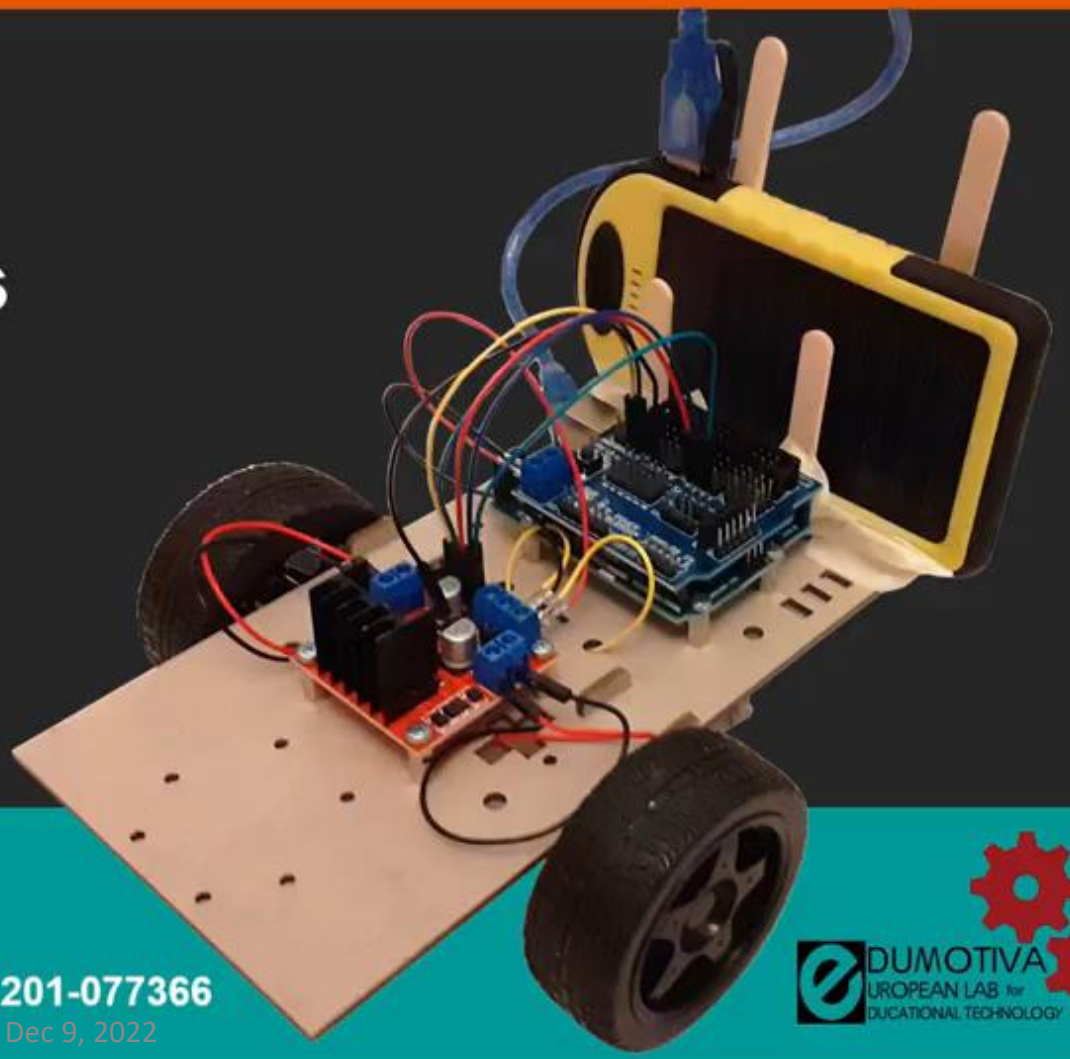
- Arts-and-crafts robots or LEGO ® MINDSTORMS?
- Technologies designed for professionals and hobbyists or for learners?
- Should technologies prepare students for engineering jobs or develop personal expression and skills?
- Should more time be spent on technicalities or on creative tasks?
- The Cost matters!

Comparing the performance of platforms popular in educational robotics against the criteria set (at an ordinal scale: excellent, good, average, poor, very poor).

Criterion	LEGO Mindstorms	Arduino	Micro:bit
enables students to build DIY robots from scratch.	poor	excellent	excellent
offers transparency of their underlying structure.	poor	excellent	excellent
is designed for learners and not for professionals or hobbyists.	excellent	poor	good
does not require prior knowledge of the technology from outside the classroom.	excellent	very poor	good
emphasises personal expression and skills development for all instead of preparing students for engineering jobs.	good	average	excellent
allows for more time to be spent on creative tasks and less on technicalities.	excellent	poor	good
demystify robots and helps children understand how their robot works.	good	excellent	excellent
is of low cost for schools.	very poor	excellent	excellent

The DIY robotic car that is controlled through voice commands

Videos of crafting process



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Grant number: 2020-1-DE03-KA201-077366

Which programming languages and tools?

Comparison of three tools for programming the task “turn on the LED”

Programming language	Lighthouse project/task: turn on the LED
Arduino C	digitalWrite(9, HIGH);
Mblock	
Open Roberta Lab	

Which programming languages and tools?

Comparison of three tools for programming the task “play note”.

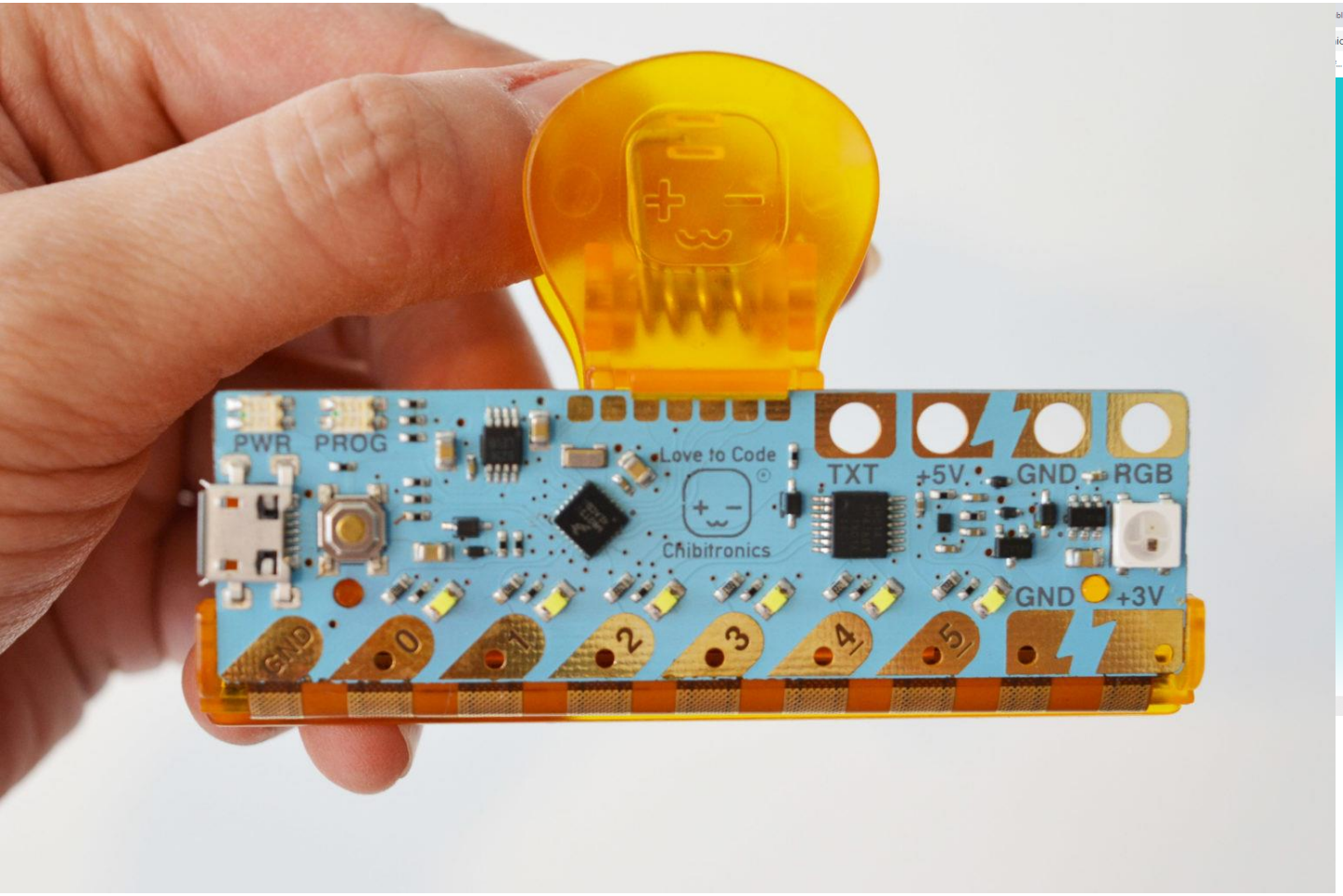
Programming language	Theremin project/task: play note
Arduino C	tone(buzzer_buzzer, 300, 100)
Mblock	
Open Roberta Lab	

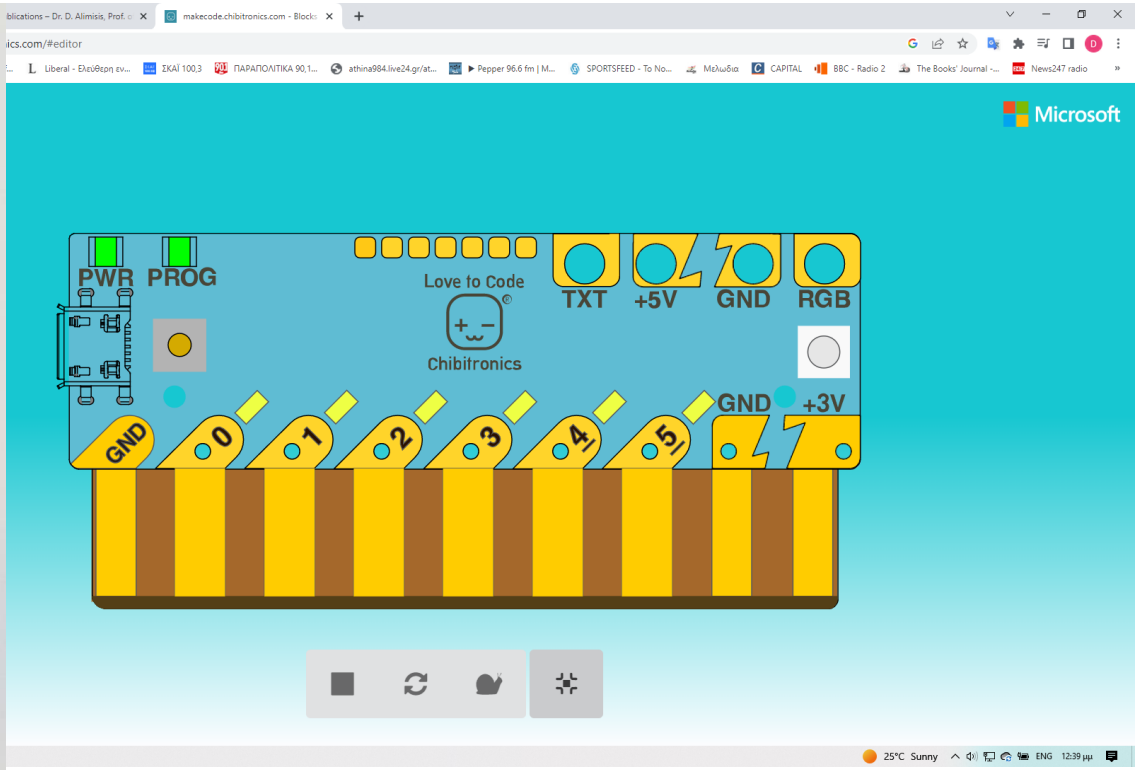
Which programming languages and tools?

Comparison of three tools for programming the task “rotate the servo motor”

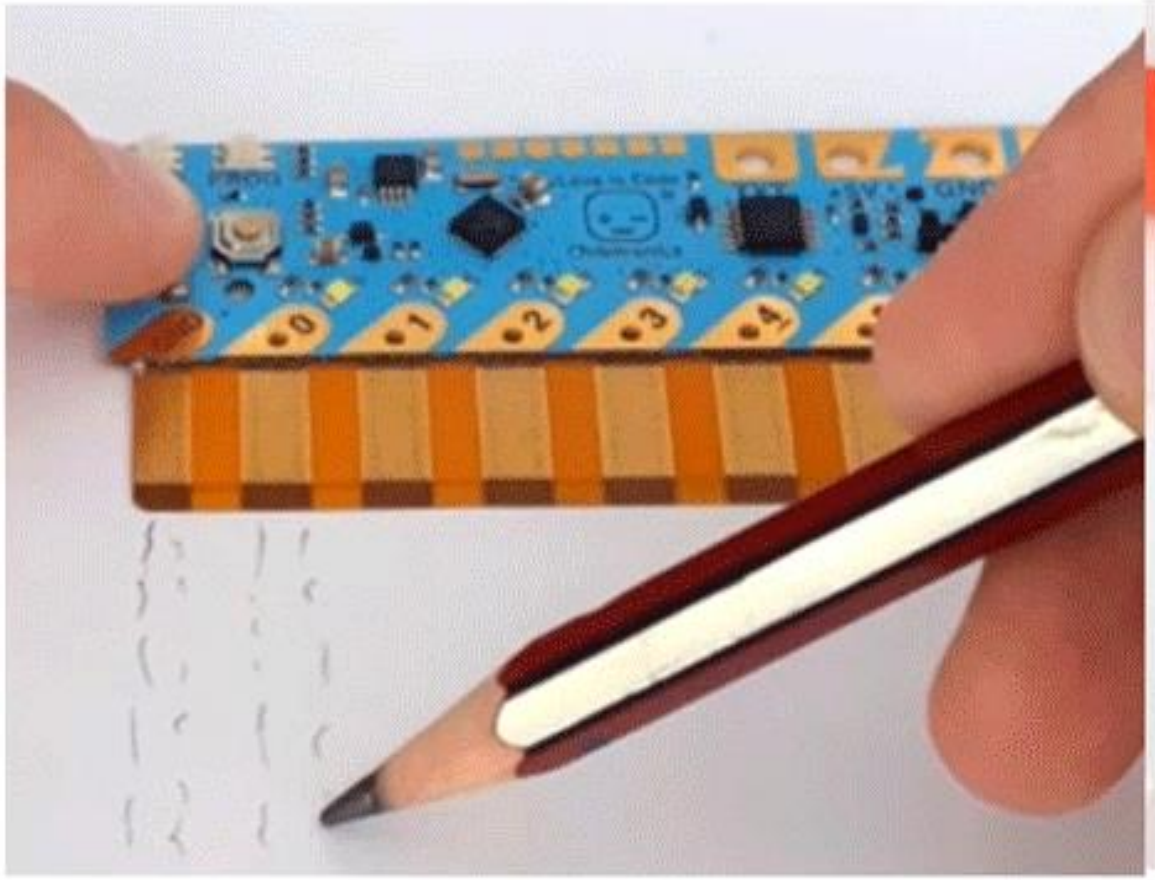
Programming language	**Sunflower project/task: rotate the servo motor**
Arduino C	servo_Sunflower.write(90)
Mblock	
Open Roberta Lab	

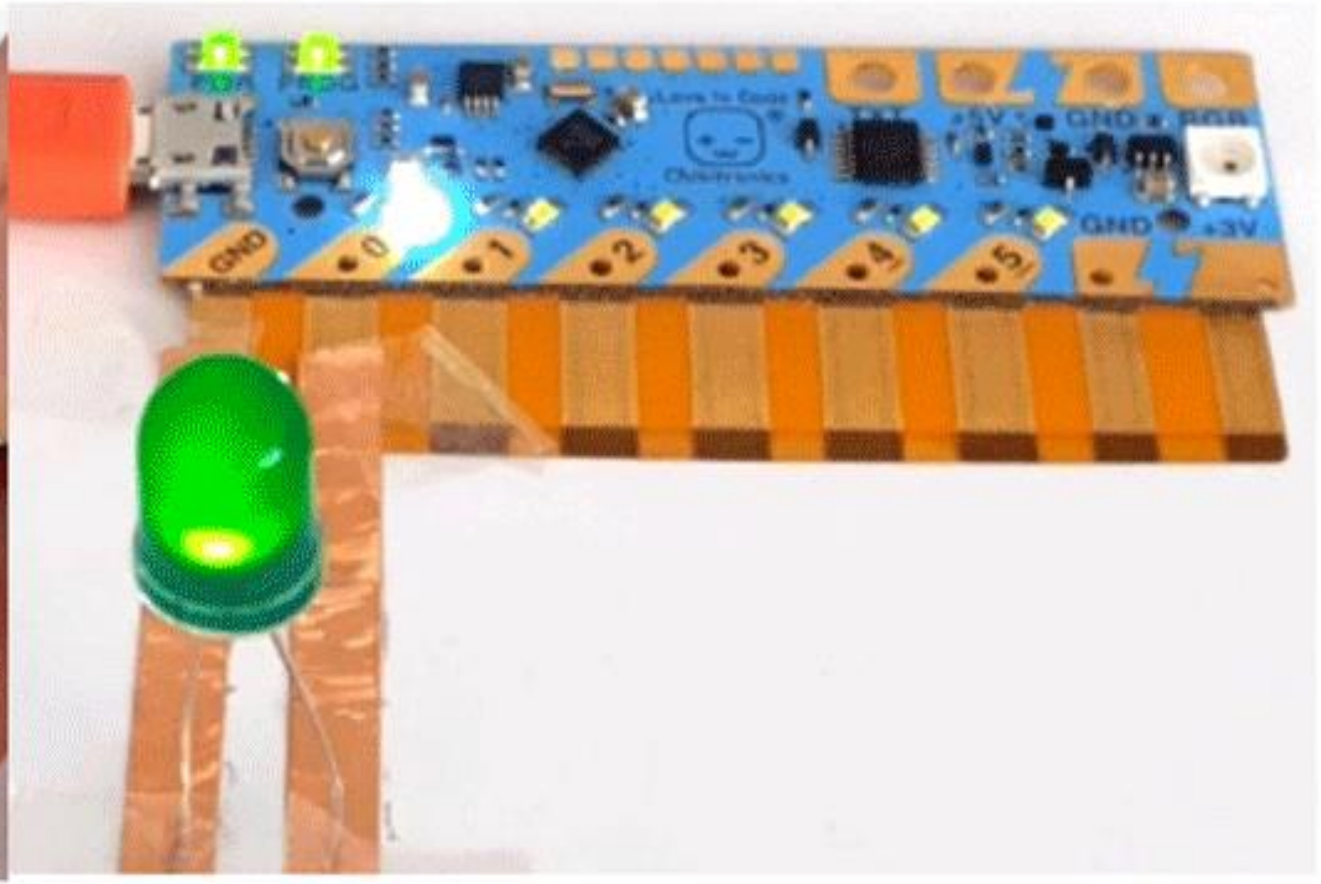
Chibi Chip - part of the [Love to Code](#) kit from [Chibitronics](#)





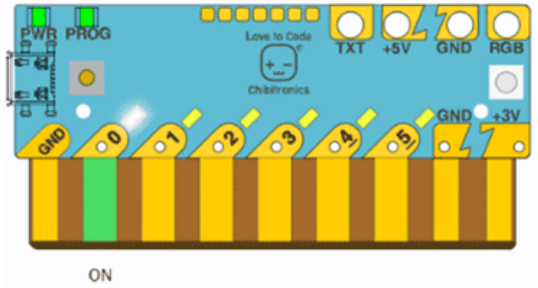
Making a simple LED circuit with Chibi Chip board and strips of copper tape as conductive material

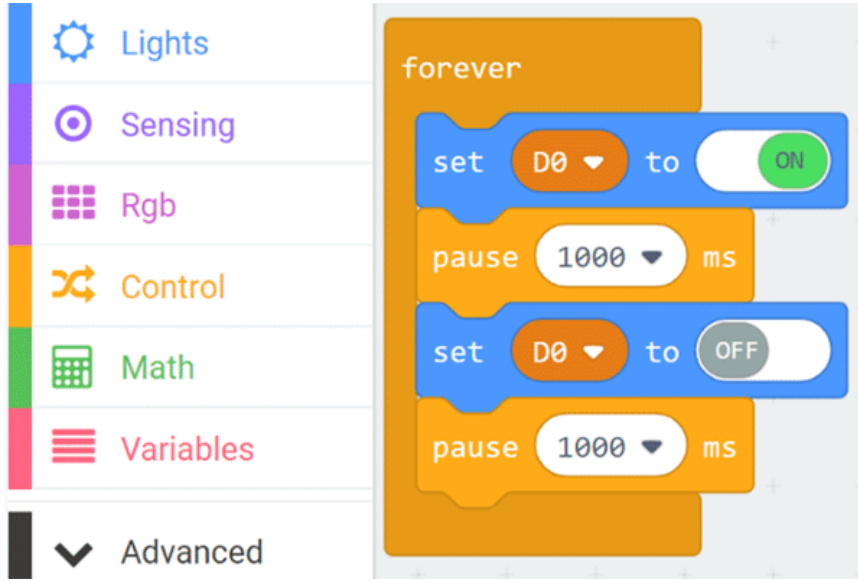




The lighthouse project with Chibi Chip board, an LED circuit and some crafting

Simulation of the Chibi Chip board (left) and the code for the lighthouse blinking with MakeCode (right)





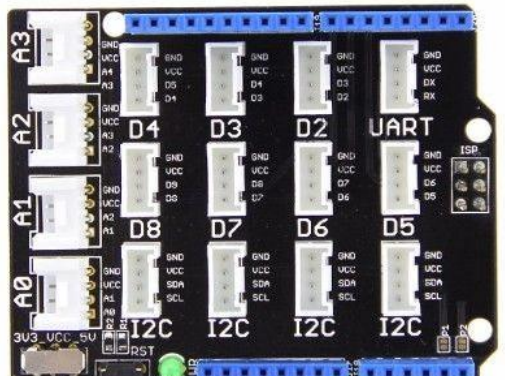
Grove shield and modules

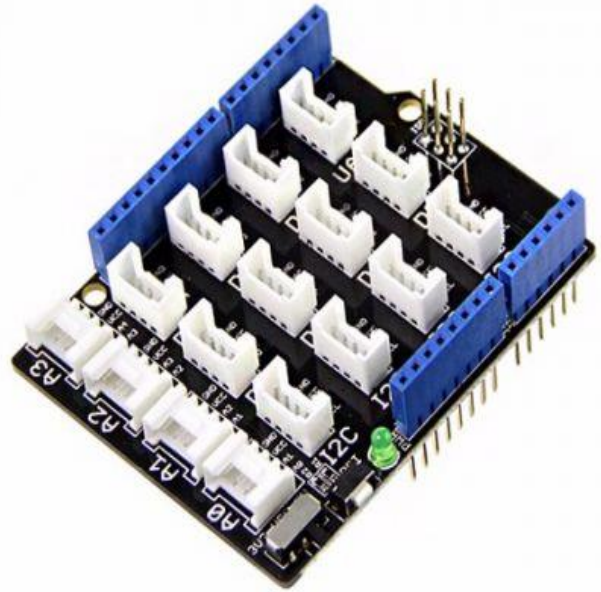
a simple way to connect with Arduino and other boards

on-board Grove Connectors: easily connect with Grove modules

no breadboard and jumper wires

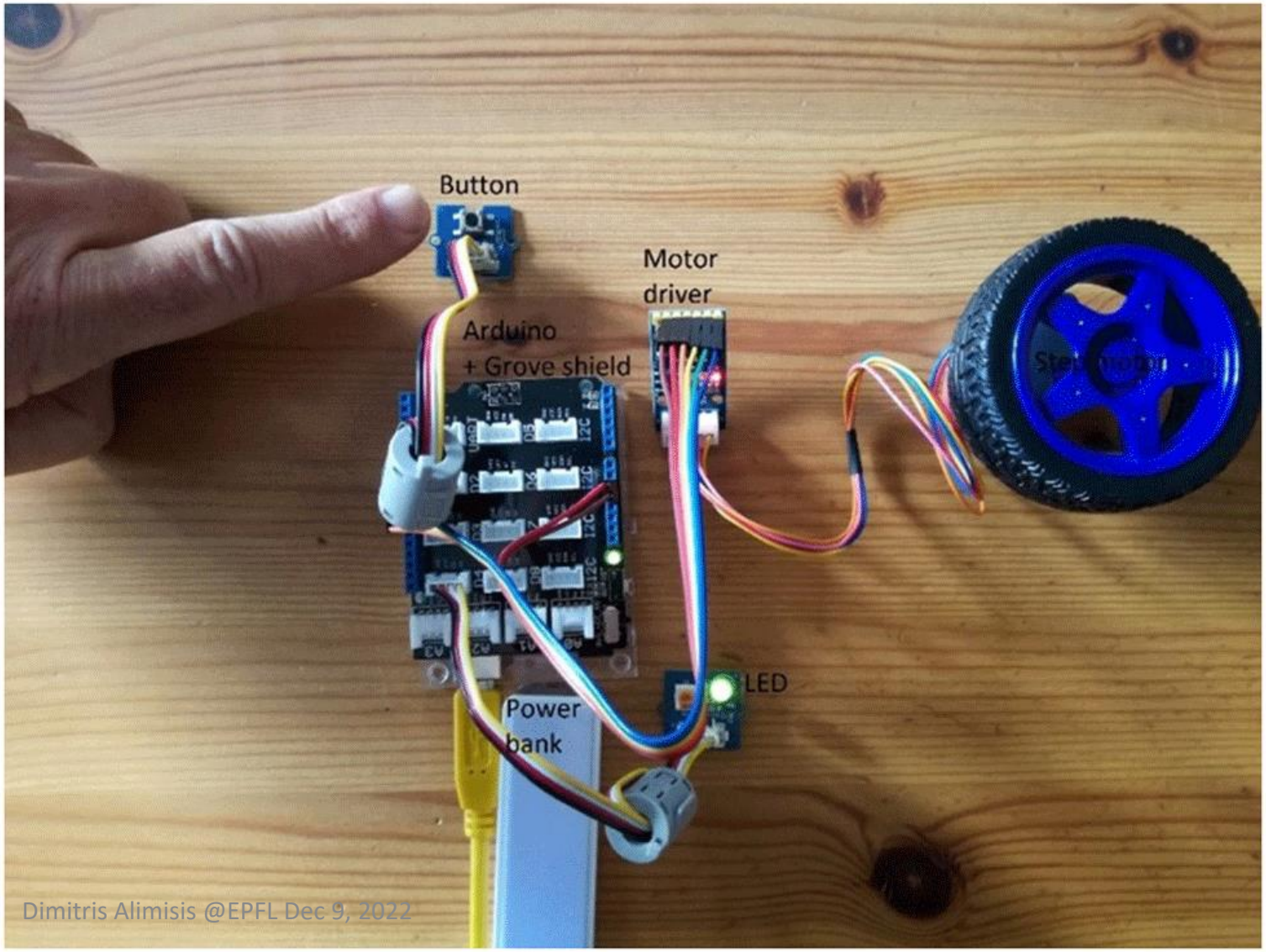
Grove makes it easier to connect, experiment, and simplify the prototyping process. No jumpers or soldering required.





design a robotic car

2. Combining Arduino board with **Grove shield and modules** to design a robotic car so that when a button is pressed its lights turn on and it moves forward



Jacdac

https://microsoft.github.io/jacdac-docs

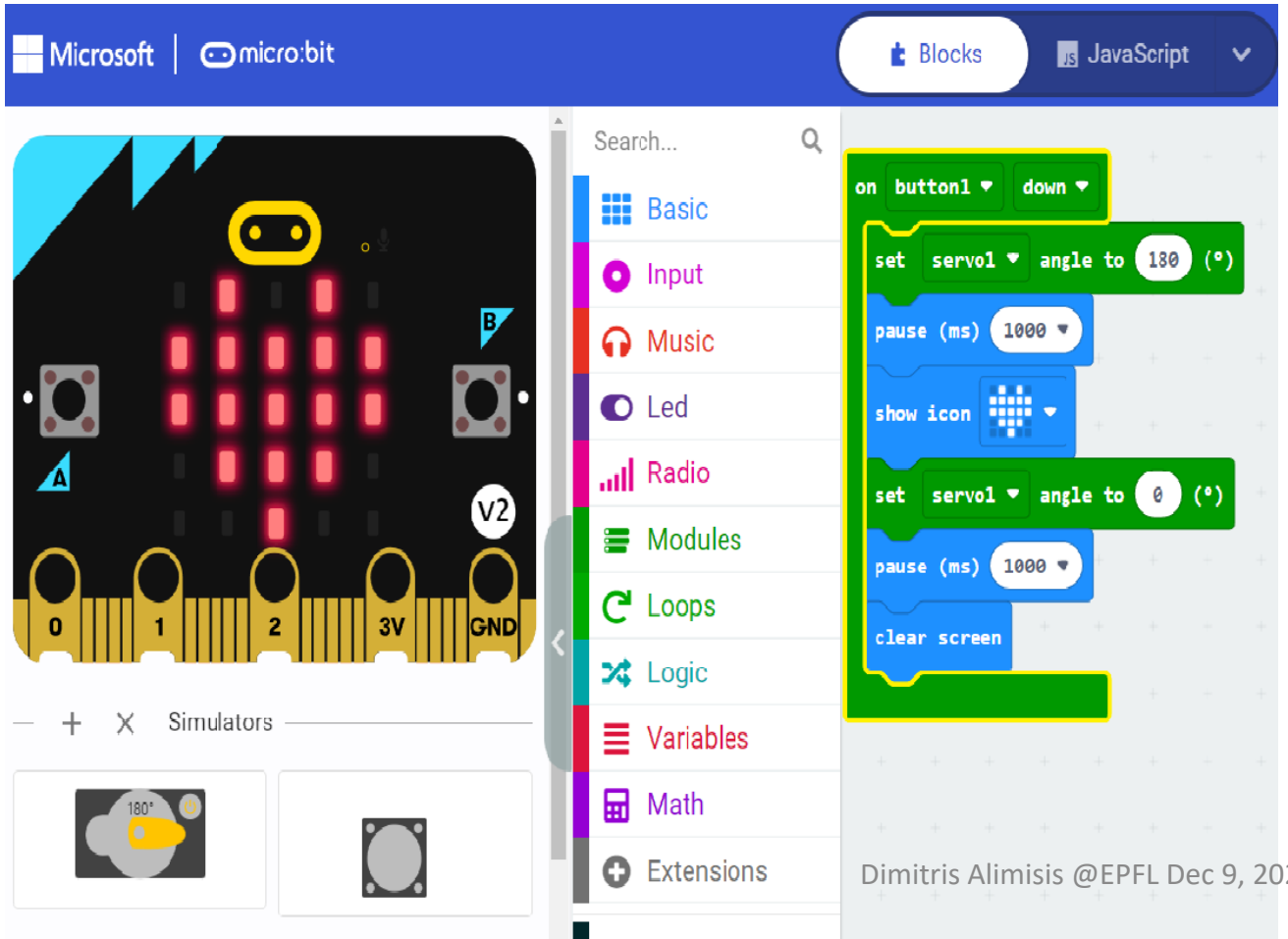
Jacdaptors allow Jacdac to integrate with micro:bit, Raspberry Pi, and other ecosystems

modular accessories with plug-and-play cables;

Jacdac - With or without hardware!

unified coding blocks for all accessories;

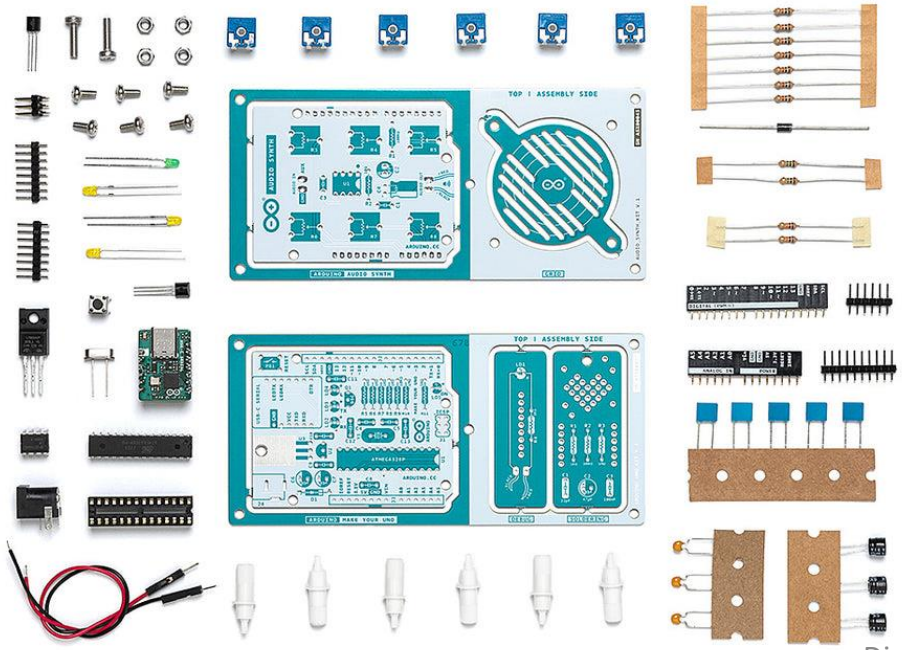
hardware simulators and device twins for micro:bit accessories.

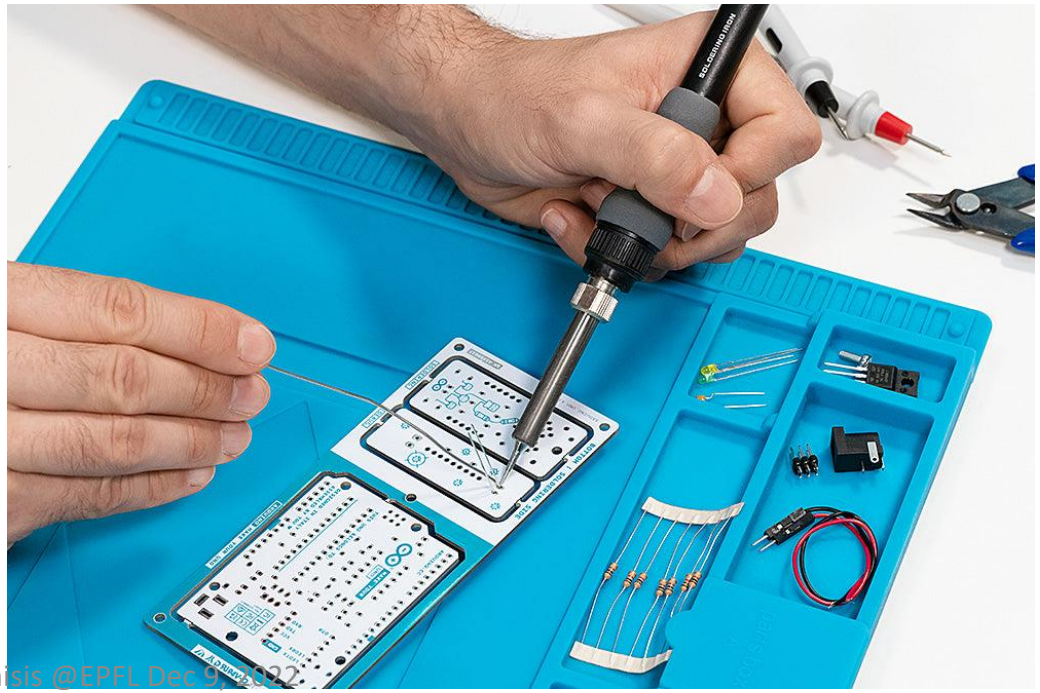


Arduino Make your own kit!

“With the Arduino Make Your UNO kit you'll learn how to solder components. Hone your soldering skills on the dedicated practice area and then start assembling your UNO from scratch. Follow the complete 3D guide and **become a maker** in less than one hour!”

“Handmade by you - The Arduino Make Your UNO kit puts you at the center. Assembling the Arduino UNO piece by piece makes it unique to you, there’s even space on the board to sign your name to give it that personal touch”

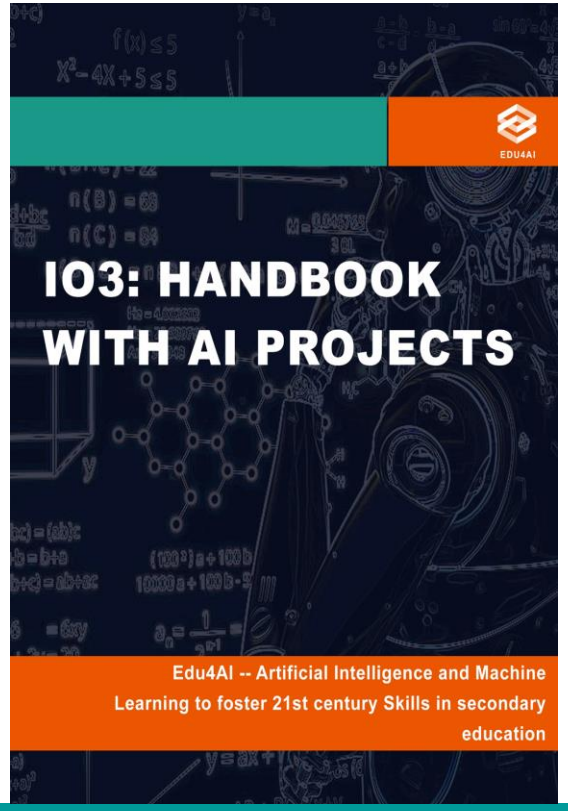




Edu4AI – Artificial Intelligence and Machine Learning to foster 21st century skills in secondary education

Erasmus+ 2020-2022

https://edu4ai.eu



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Grant number: 2020-1-DE03-KA201-077366

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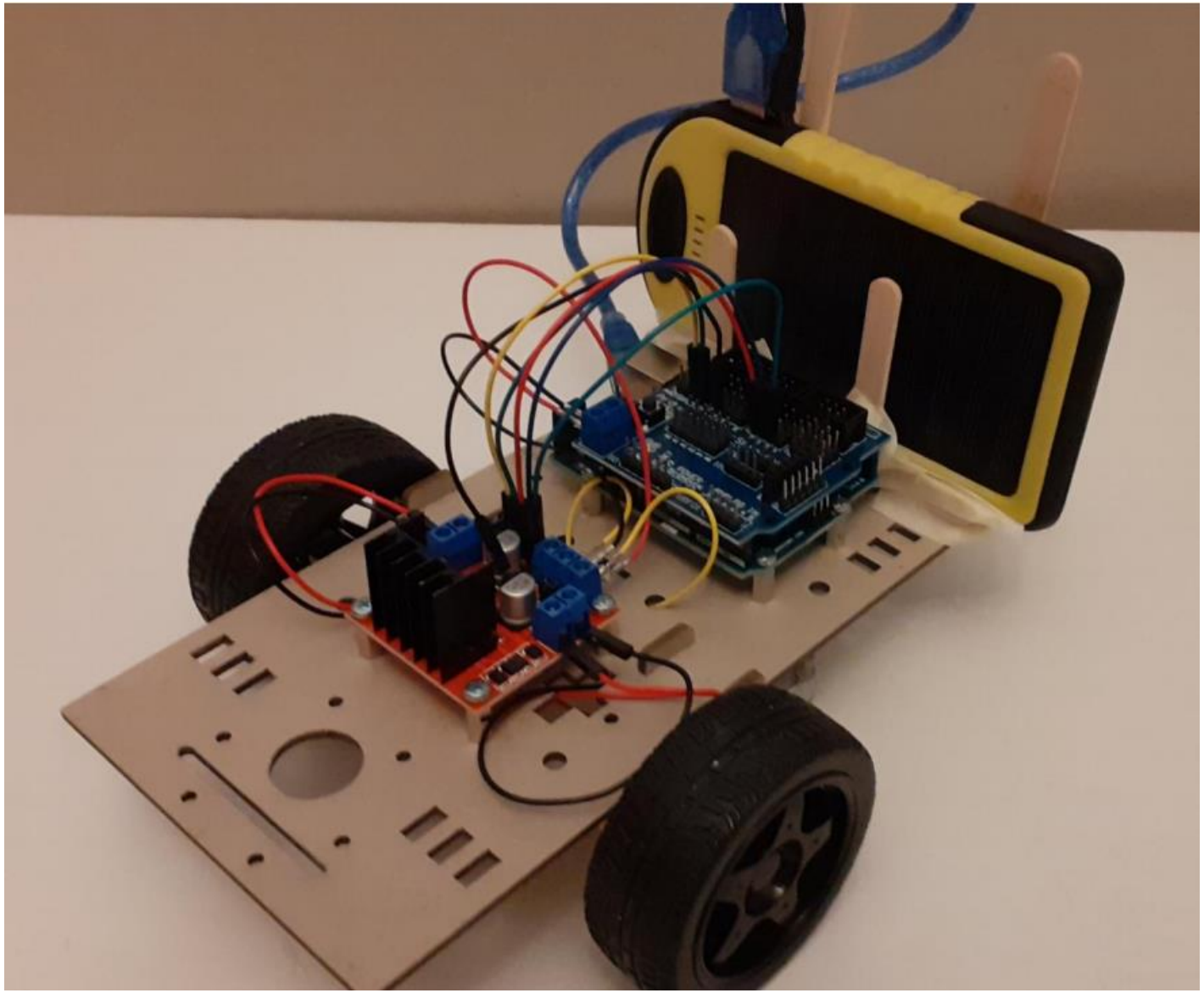
EDU4AI projects

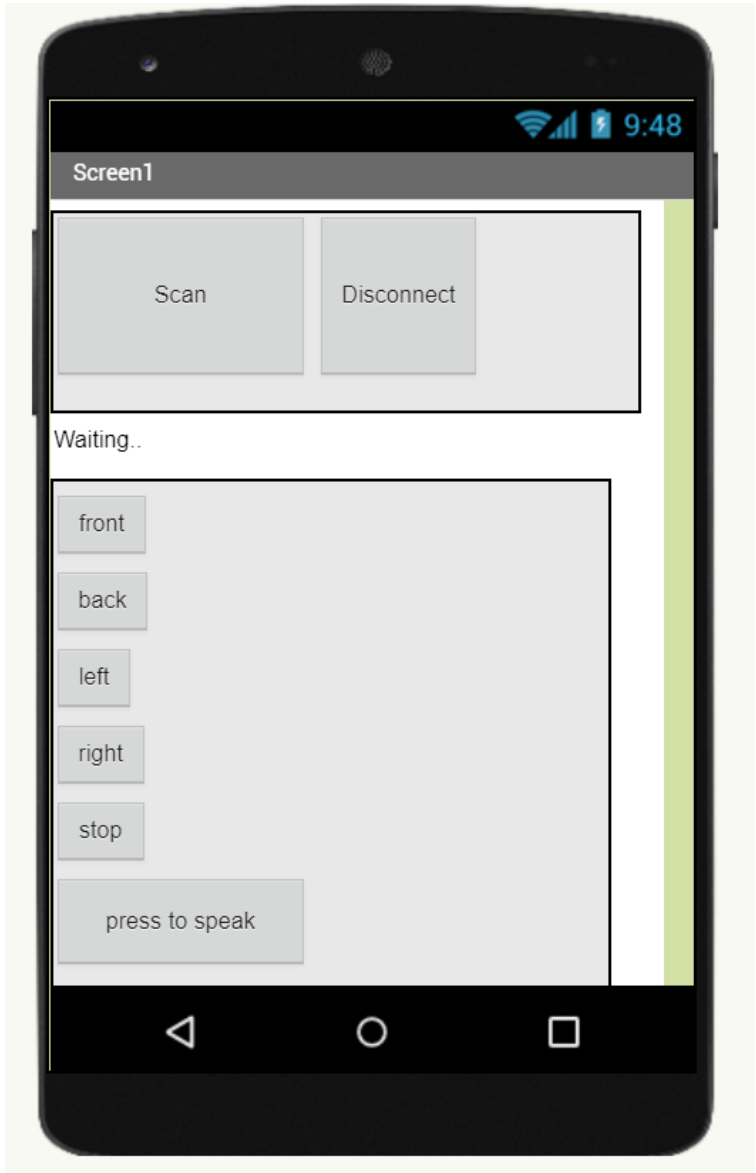
Semi-autonomous vehicle controlled by the driver's voice commands

Autonomous driving vehicle recognising traffic signs

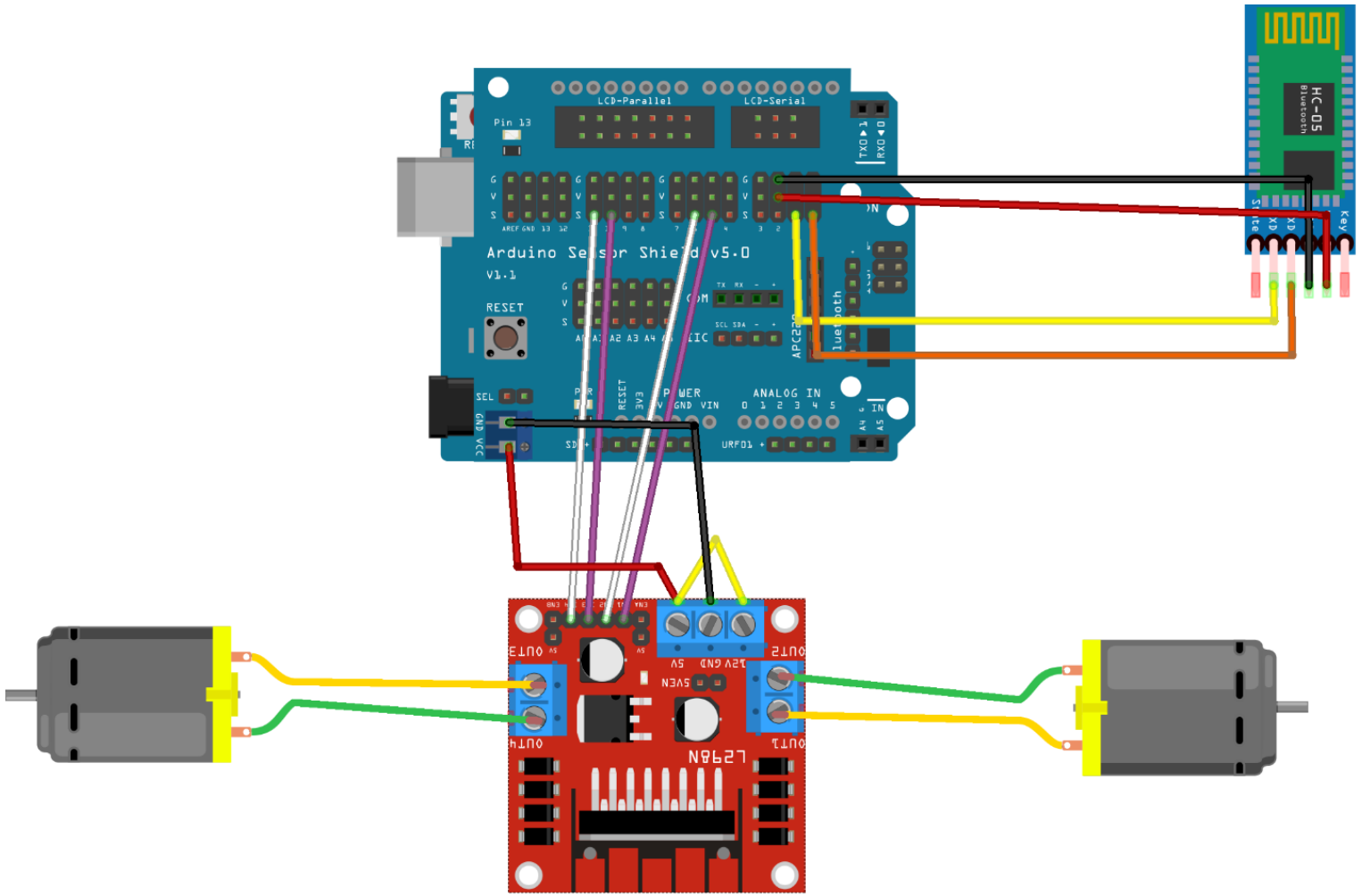


EDU4AI projects

Robot controlled by the driver's voice commands



App Inventor + Arduino



Speech to text: robot recognising voice commands

App Inventor + Arduino

If the sentence heard by the Speech Recognizer contains the word:	Then, send the character:	And the automobile will:
“forward”	“f”	move forward
“backwards”	“b”	move backward
“left”	“l”	turn on the left
“right”	“r”	turn on the right
“stop”	“s”	stop

demo

Robot recognising traffic signs

Personal Image Classifier

Training Page

To get started, click the plus icon to add a classification and then use the "Capture" bu Custom drag images into the c b x to add images to the selected classification. You can also upload previously generated data and models using the buttons below. When one, hit "Train"

Train

CAPTURING FOR: Deadlock!

No webcam found. To use this interface, use a device with a webcam.

Capture

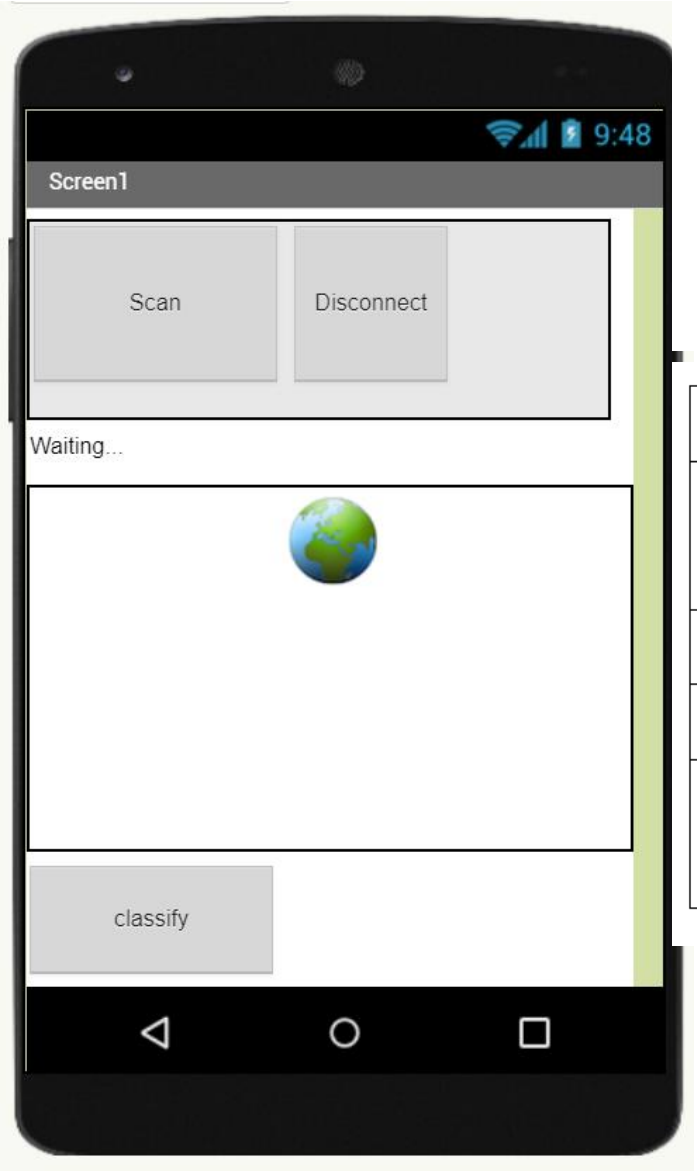
Stop!
37 examples

Left!
38 examples

Right!
29 examples

Upload

Robot recognising traffic signs



Sign identified	Car Response
"Deadlock"	Reverses for 2 seconds and then turns right
"Left"	Turns left
"Right"	Turns right
"Stop"	Stops for 2 seconds and then moves forward.

Our current projects…

- ASSESSMAKE21 Innovative digital solutions to assess 21st century skills in makerspaces http://www.assessmake21.eu/
- STEAM2GO Mobile makerspaces for promoting maker education in schools democratizing STEAM education and innovation development for all the learners https://steam2go.eu/

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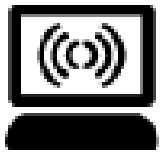

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