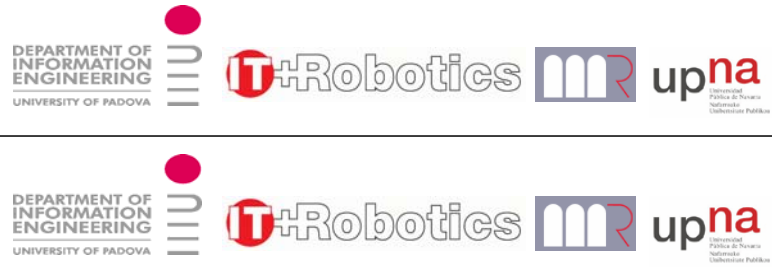


# Why Lego Mindstorms?

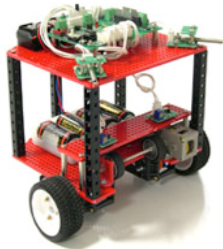
DEI  
The University of Padova

Questo materiale è stato sviluppato nell'ambito del progetto "Teacher Education on Robotics-Enhanced Constructivist Pedagogical methods" (TERECOP), finanziato dal programma della Commissione Europea Socrates/Comenius/Action 2.1, Agreement N° 128959-CP-1-2006-GR-COMENIUS-C21 2006-2518/001-001 S02.



## Several educational robot kits

Electronics/mechanics kits



<=== Simpler

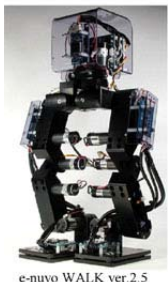
More complex ===>

Humanoid robot kits

**Bioid Beginner Kit**



Robovie-i



Robovie-M

---

# Advantages of Lego Mindstorms

- students have a previous experience with Lego bricks
  - it has robust software and hardware
  - is a good tradeoff between complexity and possibility
  - simulation environments are available more and more  
(one can avoid to buy a kit for every student)
  - several third parts software and hardware to enlarge experimenting possibilities
  - The kit cost allow the students to buy one to continue experimenting at home
- 

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# Advantages of Lego Mindstorms (from teacher perspective)

- it is a widely used platform (several resources on the web)
  - Educational activities developed by other schools are on the web
  - The Mindstorm NXT-G graphical interface is built on LabView and allows a step by step migration to programming in LabView. [One start programming the robot in NXT-G, then control it through LabView, then he/she programs in LabView other instruments.]
-

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# Advantages of Lego Mindstorms (from teacher perspective)

- It comes straight from Papert experience
    - Logo -> Dacta --> Mindstorms
    - Availability of such kits, diffusion & broad wide community, reasonable prices, open source soft alternatives for programming it, increasing amount of experiences & ready-to-use examples
- 



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# LEGO® Mindstorms Educational Kit

IT+Robotics Srl  
A spin-off of the University of Padova

# The Mindstorm NXT Kit educational

- In the two boxes you have:

- Hundreds Hardware pieces



- 5 Different sensors



.....



- 3 motors

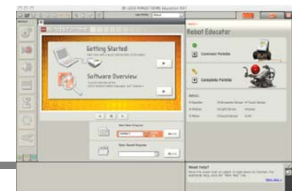


- Programmable brick to control motors and sensors



- To be bought apart:

- Mindstorm NXT-G visual programming environment



What you can find into LEGO© Mindstorms Educational Kit?



Mindstorms gray box

Educational blue box

- LEGO® MINDSTORMS
- Gray box contains:

- The NXT
- Sensors
- Servo Motors
- Basic LEGO Mindstorms pieces
- USB cable
- RJ12 cable



LEGO® MINDSTORMS Educational  
Blue box contains:

much more LEGO Mindstorms pieces to express your imagination



The NXT is the brain of a MINDSTORMS® robot. It's an intelligent, computer-controlled LEGO® brick that lets a MINDSTORMS robot come alive and perform different operations.



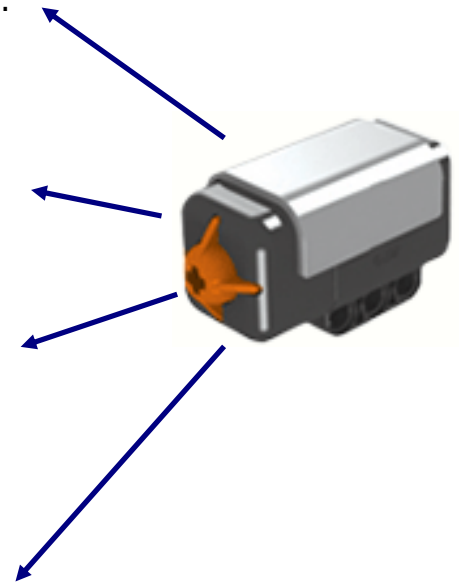
## NXT: the brain

- ✓ 32-bit ARM7 microcontroller
- ✓ 256 Kbytes FLASH, 64 Kbytes RAM
- ✓ 8-bit AVR microcontroller
- ✓ 4 Kbytes FLASH, 512 Byte RAM
- ✓ Bluetooth wireless communication
- ✓ USB full speed port (12 Mbit/s)
- ✓ 4 input ports, 6-wire cable digital platform
- ✓ 3 output ports, 6-wire cable digital platform
- ✓ 100 x 64 pixel LCD graphical display
- ✓ Loudspeaker - 8 kHz sound quality.
- ✓ Power source: 6 AA batteries




## Touch sensor

- The Touch Sensor gives your robot a sense of touch.
- The Touch Sensor detects when it is being pressed by something and when it is released again.
- You can use the touch Sensor to make your robot pick up things: a robotic arm equipped with a Touch Sensor lets the robot know whether or not there is something in its arm to grab.
- You can use a Touch Sensor to make your robot act on a command.



## Sound sensor

- 
- The Sound Sensor makes your robot hear!
  - The Sound Sensor can detect both decibels [dB] and adjusted decibel [dBA]. A decibel is a measurement of sound pressure.
  - The sensitivity of the sensor is adapted to the sensitivity of the human ear. In other words, these are the sounds that your ears are able to hear.
  - Also, the sensor can detect some sounds that are too high or too low for the human ear to hear.

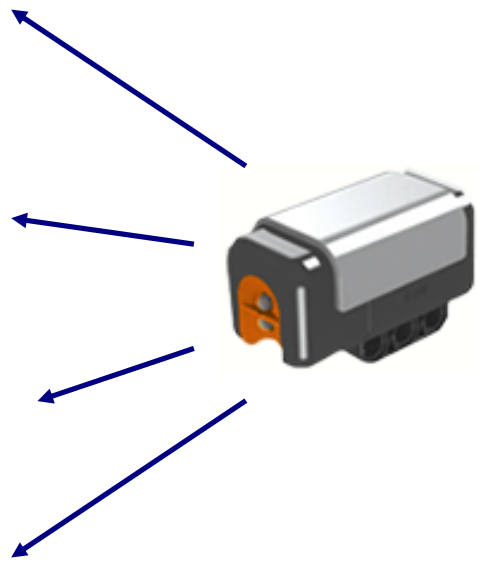
# Light sensor

The Light Sensor is one of the two sensors that give your robot vision

The Light Sensor enables your robot to distinguish between light and dark. It can read the light intensity in a room and measure the light intensity of colored surfaces.

You can make a burglar alarm robot: when an intruder turns on the light in your room the robot can react to defend your property.

You can make a line-following robot or a robot that can sort things by color.



# Ultrasonic sensor

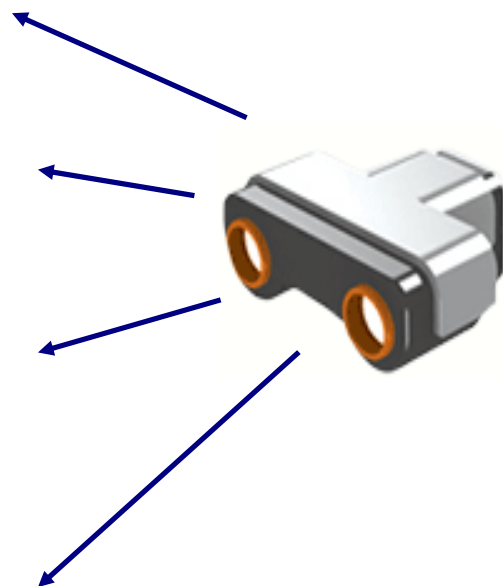
The Ultrasonic Sensor enables your robot to see and detect objects.

You can use it to make your robot avoid obstacles, sense and measure distance, and detect movement.

The Ultrasonic Sensor measures distance in centimeters and in inches.

It is able to measure distances from 0 to 255 centimeters with a precision of +/- 3 cm.

The Ultrasonic Sensor uses the same scientific principle as bats: it measures distance by calculating the time it takes for a sound wave to hit an object and return – just like an echo.





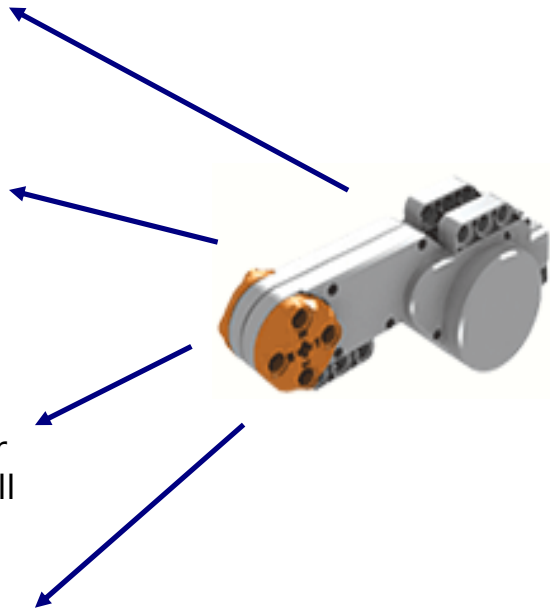
# Servo Motors

The three Servo Motors give your robot the ability to move.

If you use the Move block in the LEGO MINDSTORMS NXT software to program your motors, the two motors will automatically synchronize, so that your robot will move in a straight line.

**Built-in Rotation Sensor**  
Each motor has a built-in Rotation Sensor. This lets you control your robot's movements precisely. The Rotation Sensor measures motor rotations in degrees or full rotations [accuracy of +/- one degree].

The built-in Rotation Sensor in each motor also lets you set different speeds for your motors



# Mindstorms NXT Software

The LEGO® MINDSTORMS® NXT software enables you to program your NXT robotic invention and upload your programs to the NXT via USB or Bluetooth connectivity.

The intuitive Mac and PC compatible drag and drop software, powered by National Instruments LabVIEW, comes with building instructions and programming guides to easily begin constructing and programming with MINDSTORMS NXT.



# Important Accessories

**Battery pack for  
rechargeable battery**

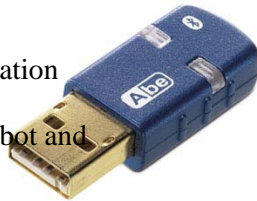


**Standard 9v transformer**  
plugs into an AC outlet to  
recharge your battery



**Bluetooth pen**

Enable wireless communication  
between your LEGO®  
MINDSTORMS® NXT robot and  
your PC or Mac



**USB 2.0 cable** to connect  
your PC to your robot and  
program it

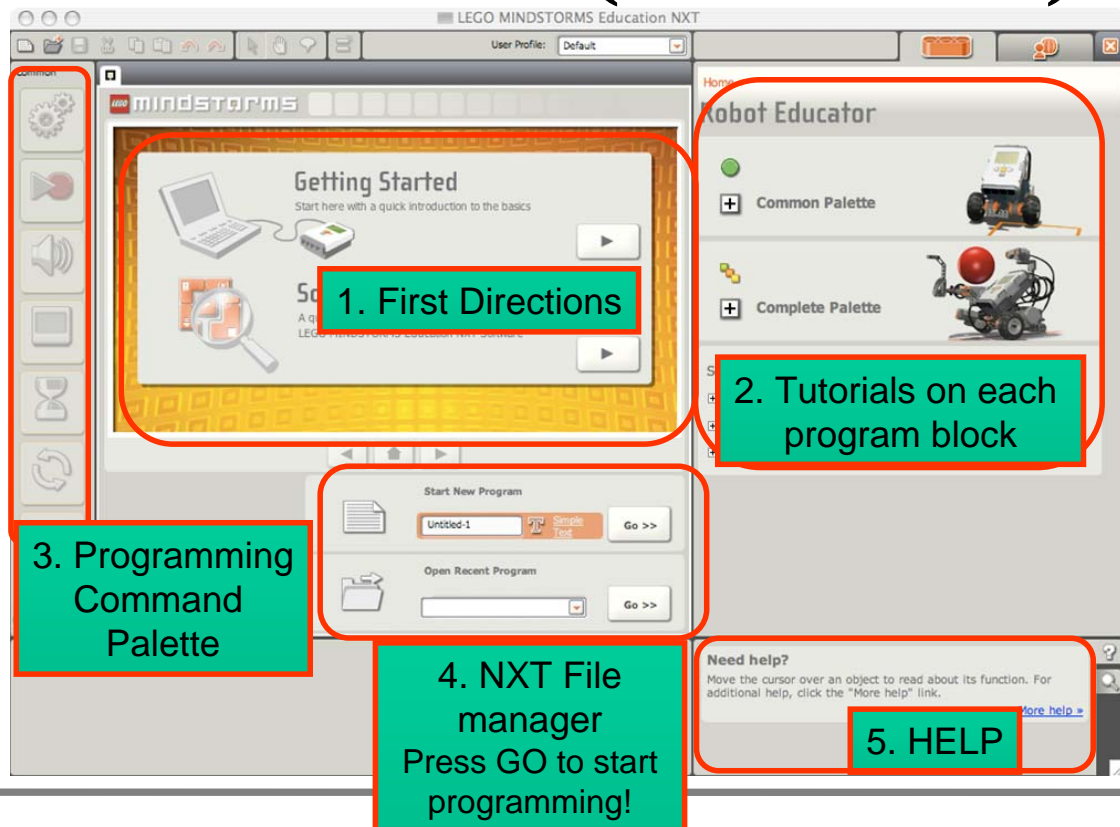
**RJ12 cable** to  
connect the sensor  
to the NXT



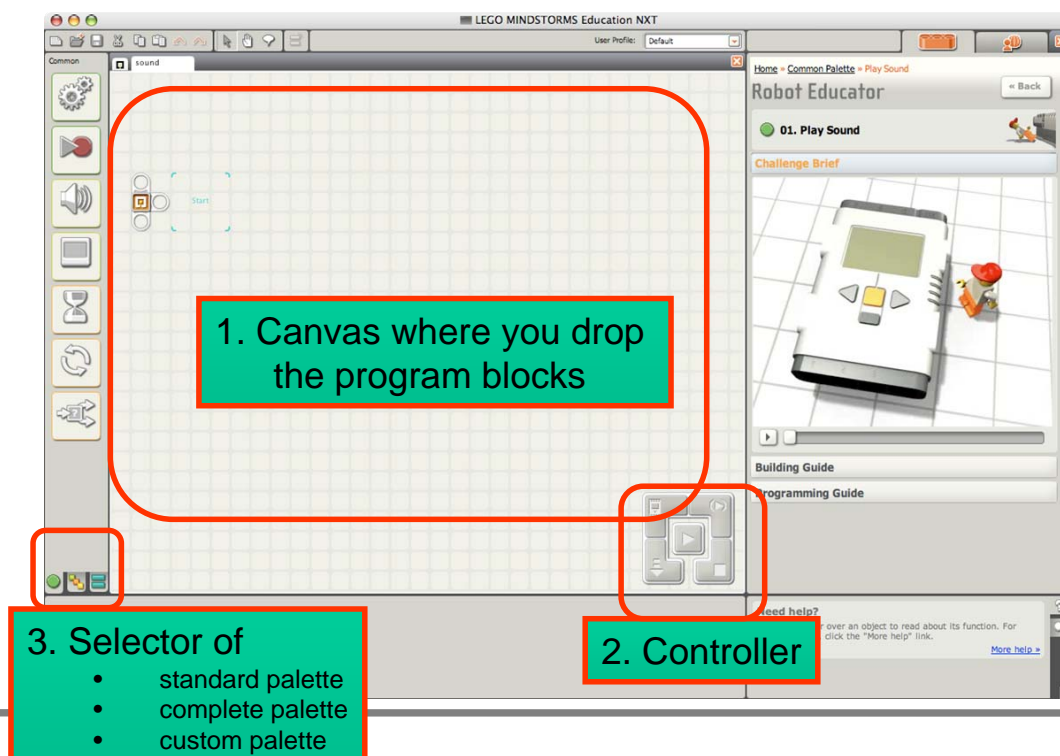
# Understanding NXT-G Software

DEI  
The University of Padua

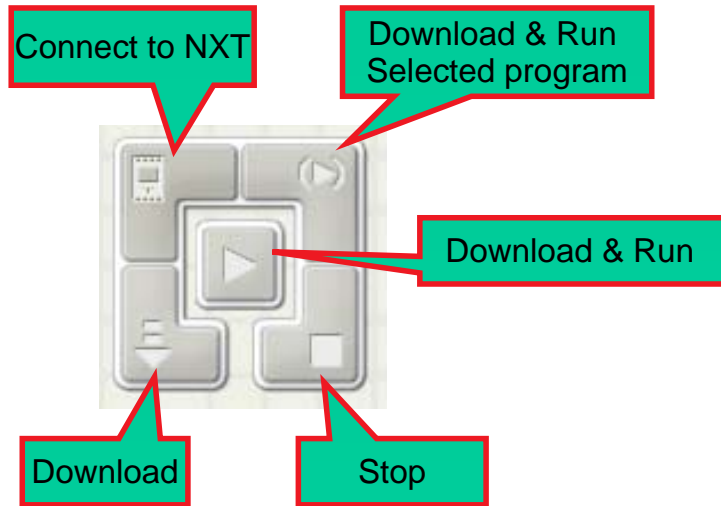
# NXT Software (first screen)



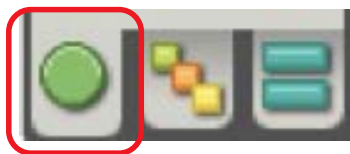
# NXT Software (programming canvas)



# NXT Software (the controller)



# NXT Software (program blocks)



» **Common palette**  
Contains the most commonly used programming blocks.



» **Complete palette**  
Contains all the various programming blocks.



» **Custom palette**  
Contains downloaded blocks and the blocks you make yourself.



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# NXT Software (program blocks)



For a detailed description of the single program blocks  
refer to the “*Appendix A - Program Blocks*”

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## Other languages & platforms to program NXT robots

UPNA  
Public University of Navarra

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When using other alternatives to program NXT we should check:

Type fo interface

Type of language

Needs new firmware or no

Etc....

At the end the reader will find a link to the “teamhassenplug” web page with a complete list of the features that we should check.....

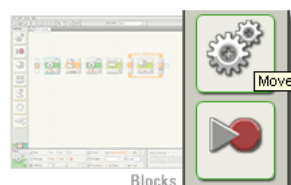
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## LEGO® MINDSTORMS® NXT

<http://www.ni.com/academic/mindstorms/works.htm>

The LEGO MINDSTORMS NXT software enables you to program your NXT robots and download your programs to the NXT via USB or Bluetooth connectivity. The drag and drop software, powered by National Instruments LabVIEW, comes with building instructions and programming guides to easily begin constructing and programming with MINDSTORMS NXT robots.



## LabVIEW Toolkit for LEGO® MINDSTORMS® NXT

<http://zone.ni.com/devzone/cda/tut/p/id/4435>

Program your LEGO MINDSTORMS NXT using NI LabVIEW

- Program and control LEGO MINDSTORMS NXT with the full power of LabVIEW
- Get real-time updates from the NXT during program operation with LabVIEW front panels
- Create native Blocks for the MINDSTORMS NXT



## Next Byte Codes & Not eXactly C (NBC & NXC)

<http://bricxcc.sourceforge.net/nbc/>

Next Byte Codes (NBC) is a simple language with an assembly language syntax that can be used to program LEGO's NXT programmable brick (from the new LEGO Mindstorms NXT set).

Not eXactly C (NXC) is a high level language, similar to C, built on top of the NBC compiler. It can also be used to program the NXT brick. NXC is basically NQC for the NXT.

leJOS NXJ: <http://lejos.sourceforge.net/>

What is leJOS?

leJOS (pronounced like the Spanish word "lejos" for "far") is a tiny Java Virtual Machine. In 2006 it was ported to the LEGO NXT brick.


leJOS NXJ offers the following:

- \* Object oriented language (Java)
- \* Preemptive threads (tasks), Recursion, Synchronization, Exceptions
- \* Arrays, including multi-dimensional
- \* Java types including float, long, and String
- \* Most of the java.lang, java.util and java.io classes
- \* A Well-documented Robotics API

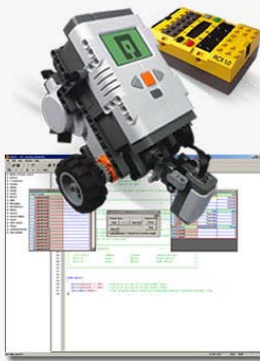
RobotC for LEGO® MINDSTORMS® NXT :

<http://www.robotc.net/index.htm>

RobotC is designed for engineering, programming and robotics education.



The C-Language of Engineering Education



**ROBOTC for**  
ROBOTC is design and robotics education support for teaching LEGO robot language for teaching intelligent systems

Educators can choose classroom set-ups. NXT-based MINDS for Education NXT classroom site license

Packages are available and the CMU Robotics

LEGO, the LEGO logo, MINDSTORMS and the brick configuration are trademarks of the LEGO Group and are used under license. All LEGO trademarks & product images used here by permission. Robotmatter and the Robotics Academy are not associated with Pitco, Inc., the LEGO Group, or LEGO Education.



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pbLua for LEGO® MINDSTORMS® NXT :

<http://www.hempeldesigngroup.com/lego/pbLua/index.html>

an exciting new text-based language for the Mindstorms NXT; it has these characteristics:

1. It's written in portable C, with minimal runtime requirements

2. It can be compiled on the fly on the target machine, which is the NXT in our application

3. It's a small, easy to read, and easy to write language

4. It has extensive documentation available online, and a very friendly newsgroup



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NXT Programming Software Comparison:

<http://www.teamhassenplug.org/NXT/NXTSoftware.html>

Other possibilities:

URBI (Universal Robotic Body Interface) for NXT:

<http://www.gostai.com/lego.html>

LEJOS OSEK is an open source firmware for LEGO MINDSTORMS NXT

<http://lejos-osek.sourceforge.net/>

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