Robotics

LEGO MindStorms EV3 & Robot C

Introduction and Moving

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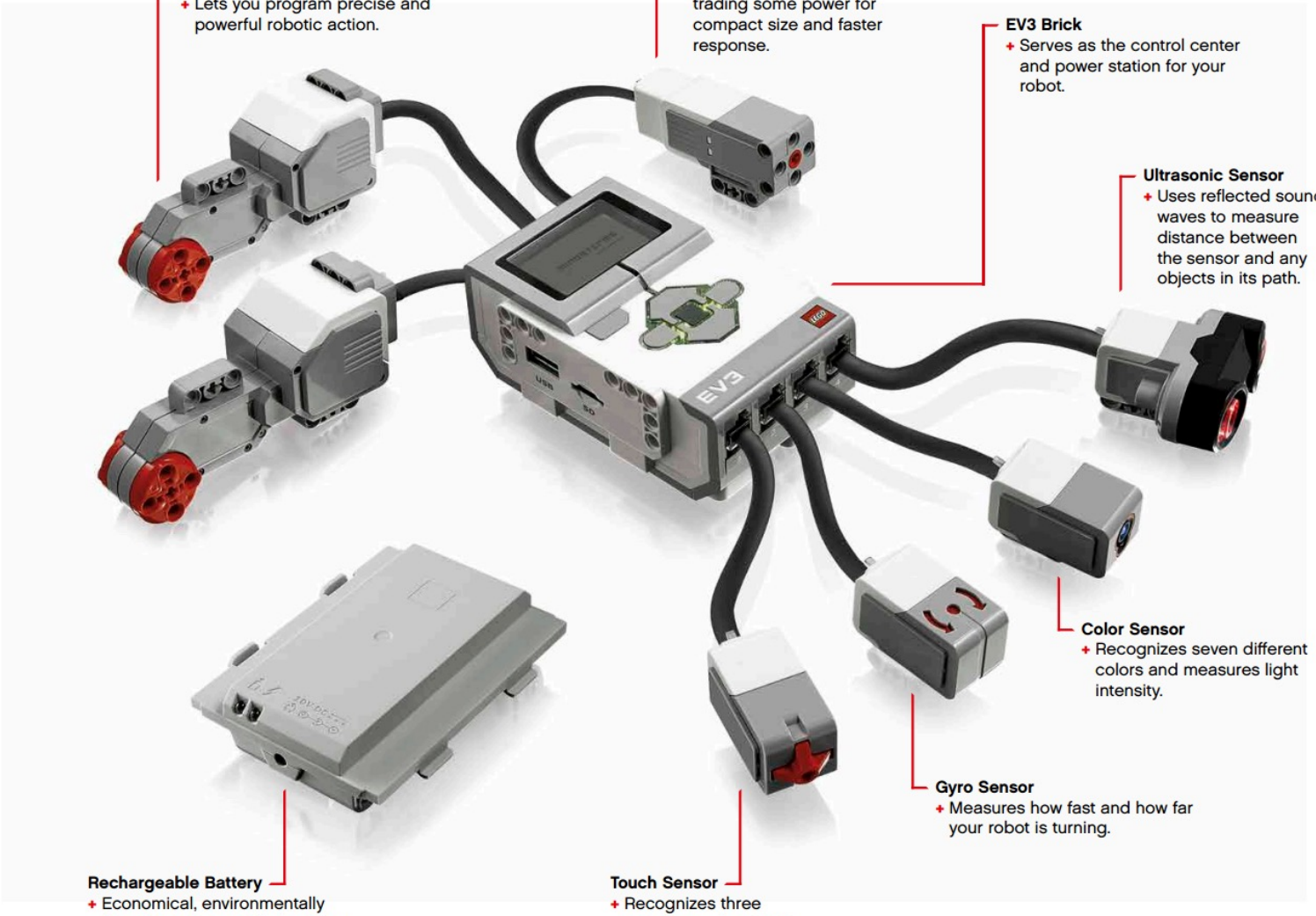
CONTENTS

Specifications

- **Programmable robotics kit by LEGO**
  - EV3 Brick
  - Operating System - LINUX
  - 300 MHz ARM9 Controller / Flash Memory -16 MB / RAM - 64 MB
  - Brick Screen Resolution - 178x128 / Black & White
  - USB 2.0 Communication to Host PC - Up to 480 Mbit/sec
  - USB 1.1 Host Communication - Up to 12 Mbit/sec
  - Micro SD Card - Supports SDHC, Version 2.0, Max 32 GB
  - Speaker / Rechargeable battery
- **Sensors and motors**
  - Touch sensor, Color sensor, Gyro Sensor, Ultrasonic sensor
  - Large / Medium Motor

Components


Large Motor
+ Lets you program precise and powerful robotic action.
Medium Motor
+ Maintains precision, while trading some power for compact size and faster response.
EV3 Brick
+ Serves as the control center and power station for your robot.
Ultrasonic Sensor
+ Uses reflected sound waves to measure distance between the sensor and any objects in its path.
Color Sensor
+ Recognizes seven different colors and measures light intensity.
Gyro Sensor
+ Measures how fast and how far your robot is turning.
Touch Sensor
+ Recognizes three conditions—touched, bumped, and released.
Rechargeable Battery
+ Economical, environmentally friendly, and convenient power source for your robot.

EV3 Brick

Wireless Connection Status Icons

(from the left):

Bluetooth enabled but not connected or visible to other Bluetooth devices

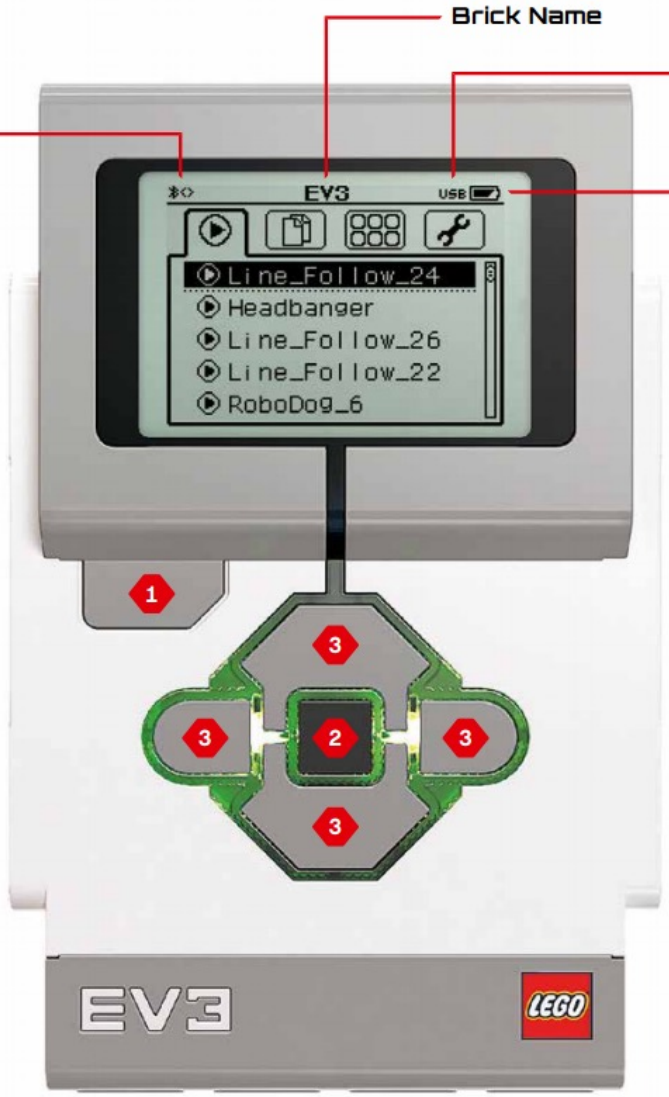
Bluetooth enabled and visible to other Bluetooth devices

Bluetooth enabled and your EV3 Brick is connected to another Bluetooth device

Bluetooth enabled and visible and your EV3 Brick is connected to another Bluetooth device

Wi-Fi enabled but not connected to a network

Wi-Fi enabled and connected to a network



USB

USB connection established to another device

Battery level

Brick Buttons

1. Back
This button is used to reverse actions, to abort a running program, and to shut down the EV3 Brick.

2. Center
Pressing the Center button says "OK" to various questions—to shut down, to select desired settings, or to select blocks in the Brick Program App. You would, for example, press this button to select a checkbox.

3. Left, Right, Up, Down
These four buttons are used to navigate through the contents of the EV3 Brick.

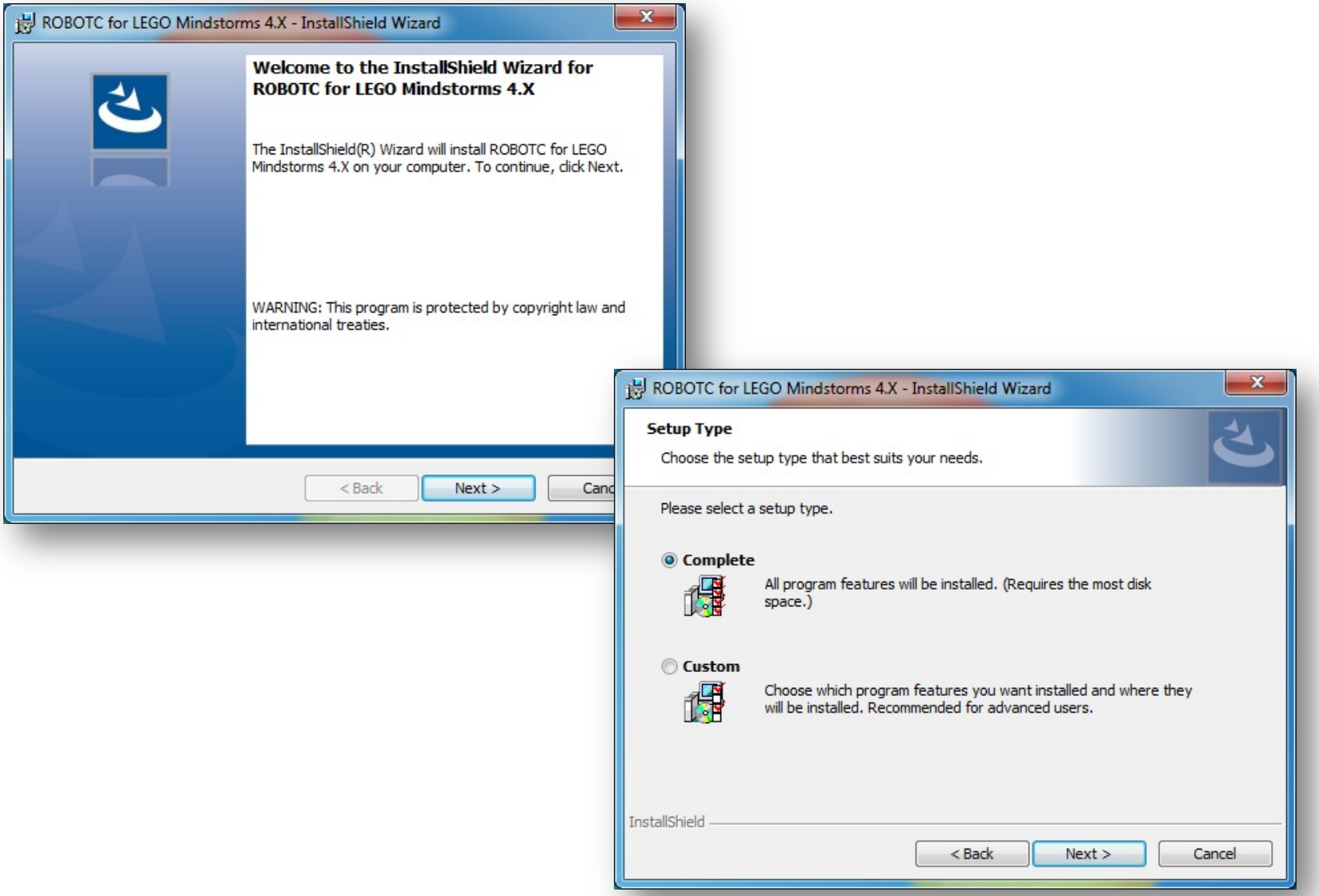
RobotC

- **Programming environment for robotics kit**
  - Developed by the Carnegie Mellon Robotics Academy
  - Integrated development environment for students to program and control LEGO VEX, EV3, NXT and RCX series
  - Based on C programming language
  - Not a free software – requires class licenses
    - In-class license will be provided and should be unregistered after the final lecture
  - URL
    - Include useful resources of RobotC
    - http://www.robotc.net

RobotC

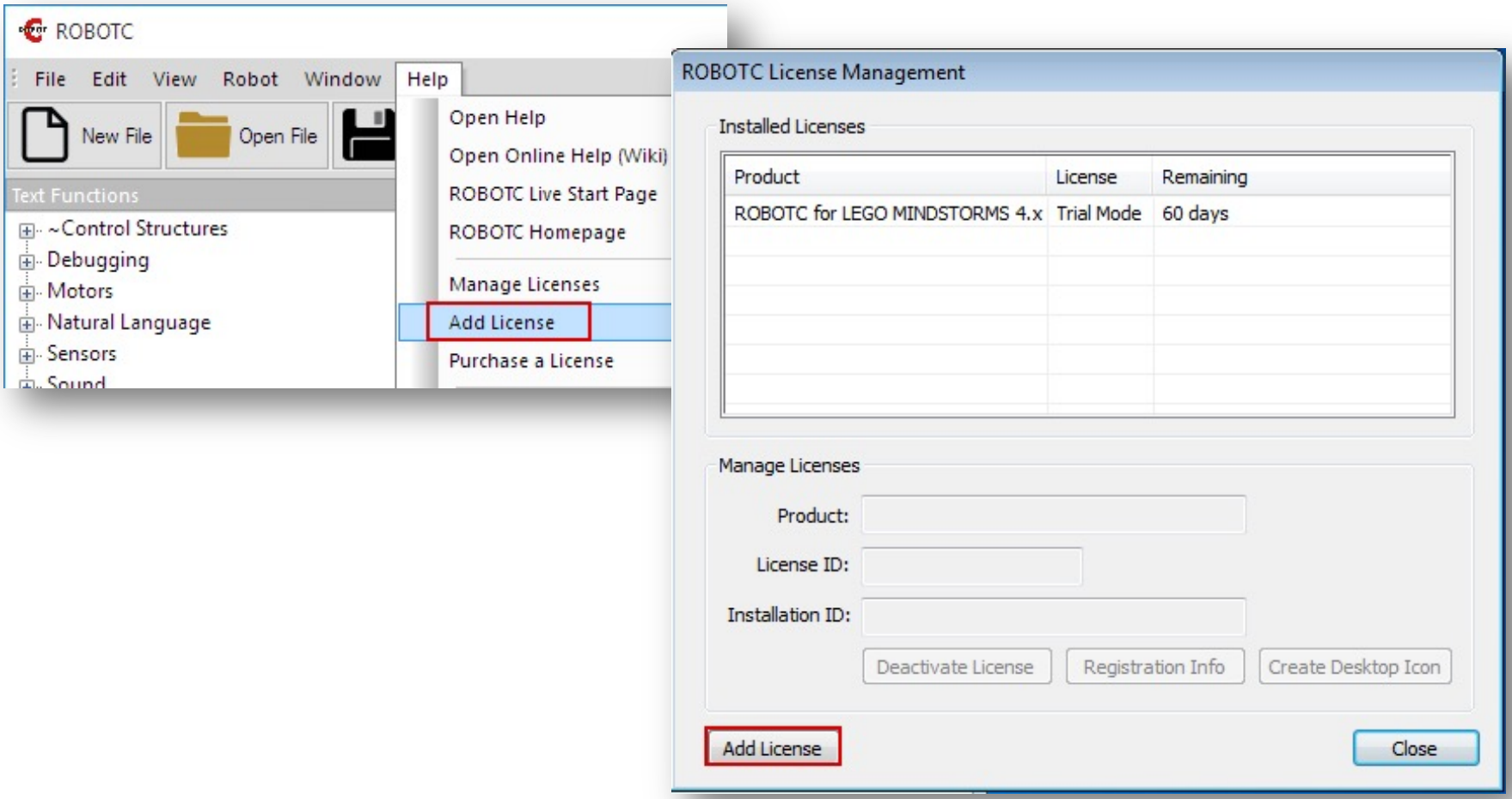
- **Note**
  - RobotC only supports Windows platform
  - For Mac users:
    - Bootcamp
    - Virtualization software (VMware or Parallels)
- **Installation**
  - Download RobotC package and install
  - URL
    - http://robotc.net/download/lego/
    - Click on the 'Download ROBOTC for LEGO Mindstorms 4.X'

Installing RobotC



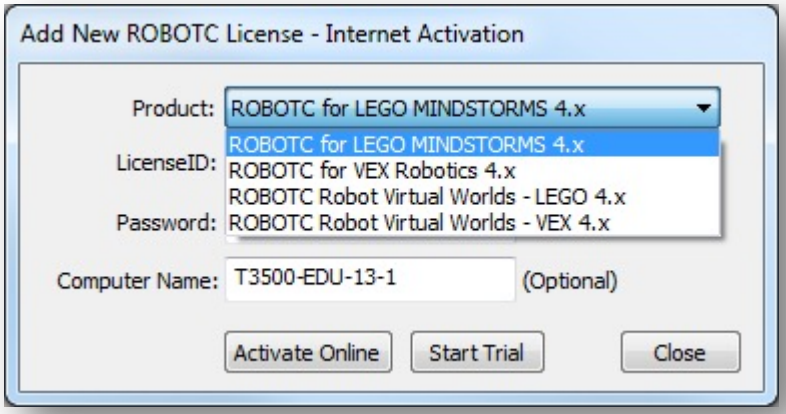
License

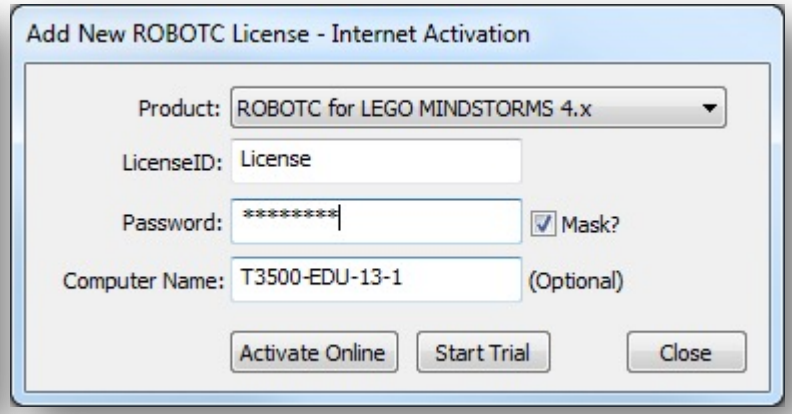
- Open ROBOTC and navigate to the Help menu. From there, select the 'Add License' menu option.



License

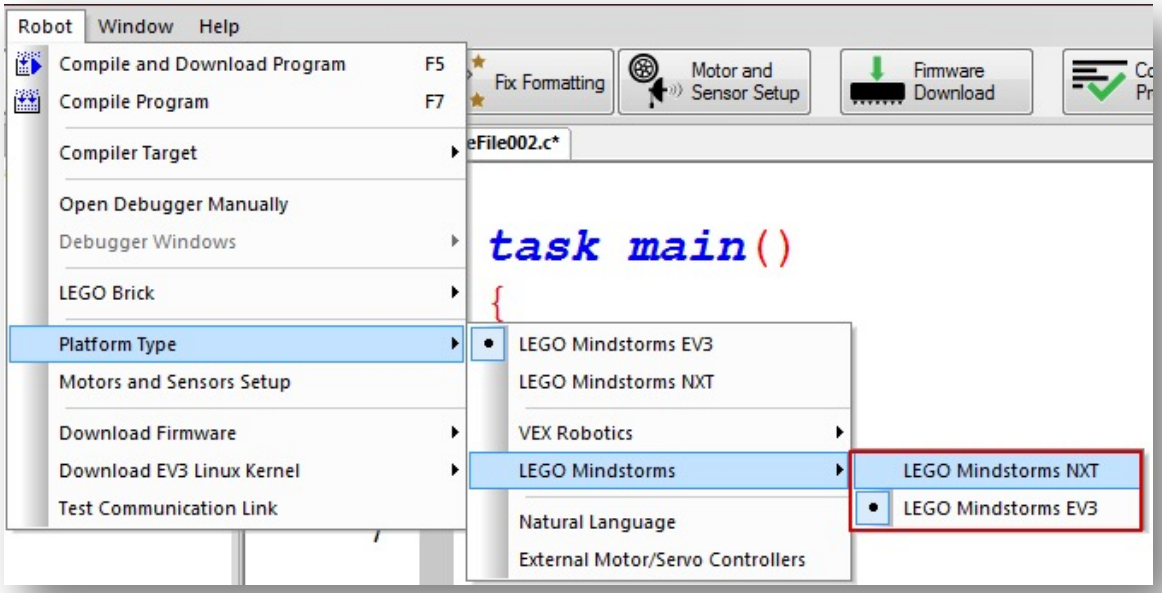
- **Clicking the Add License button will bring up a 'Add New ROBOTC License' window. From here you must first select which type of license you have and then enter your License ID and Password**
  - To see the password characters as you type, uncheck the 'Mask?' checkbox.



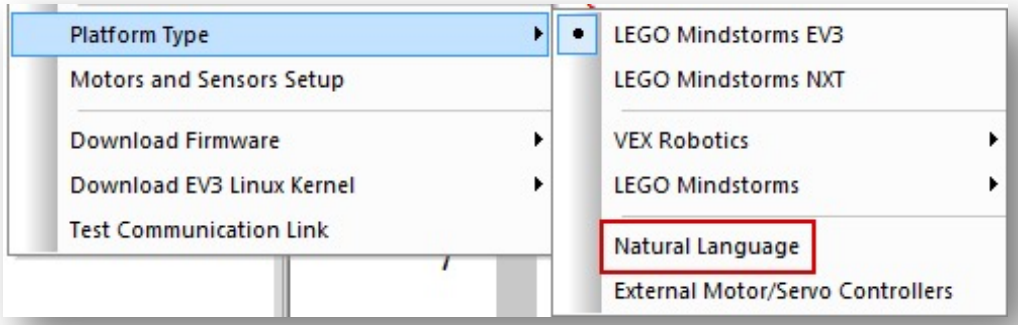


Getting started

Changing Platform Type

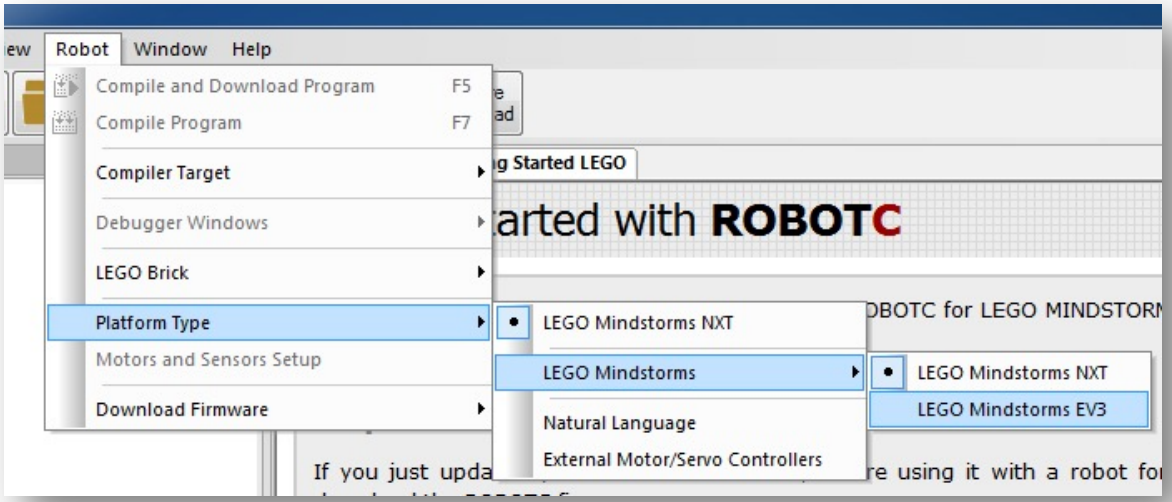


Choosing Natural Language Mode

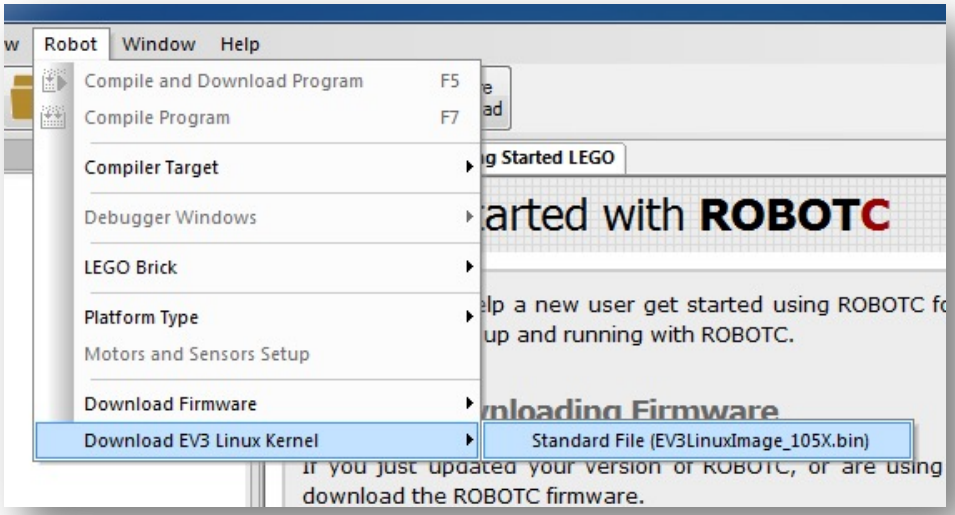


Download firmware

- Switch Platform Type to EV3

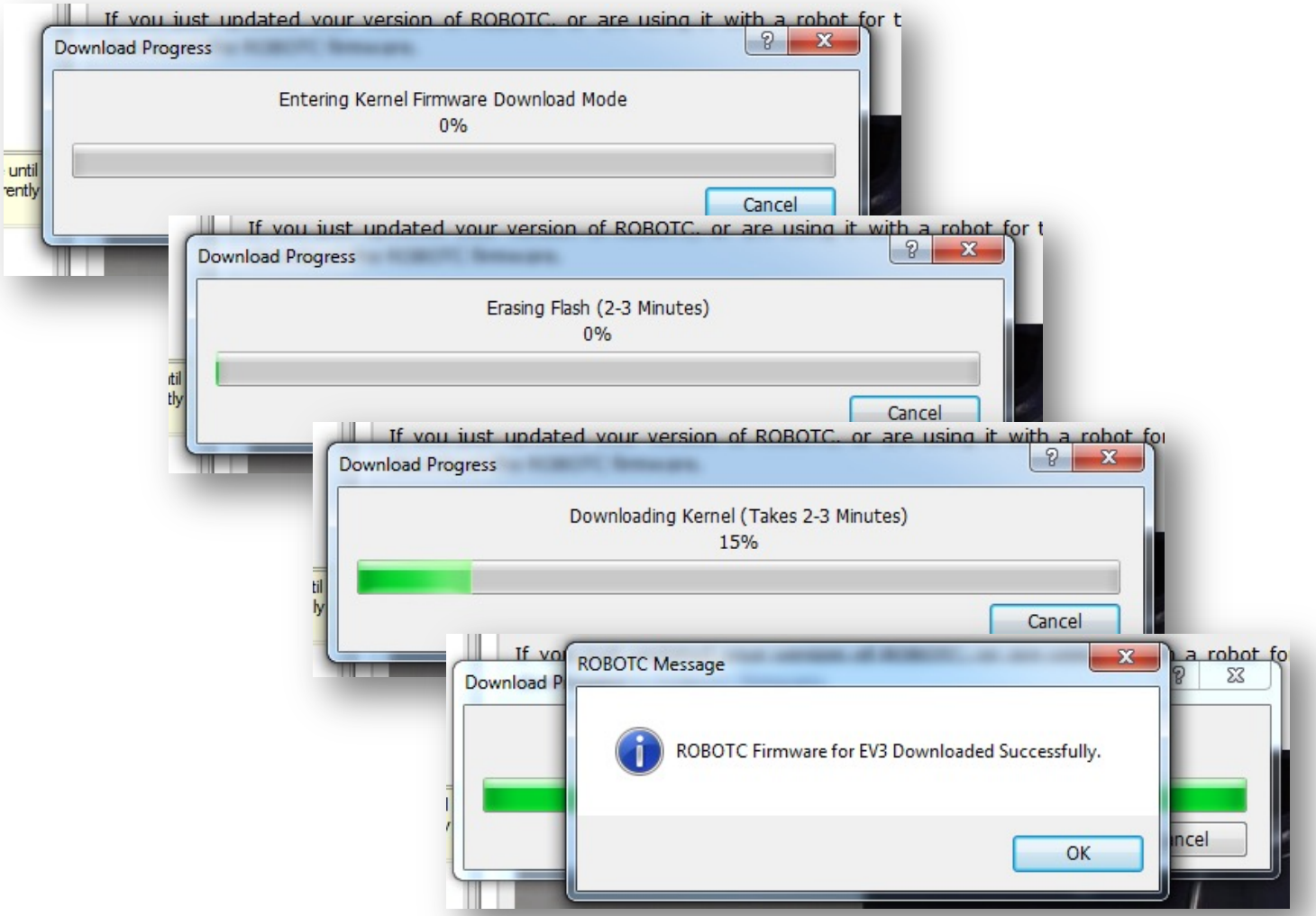


- Updating EV3 Kernel (Operating System)



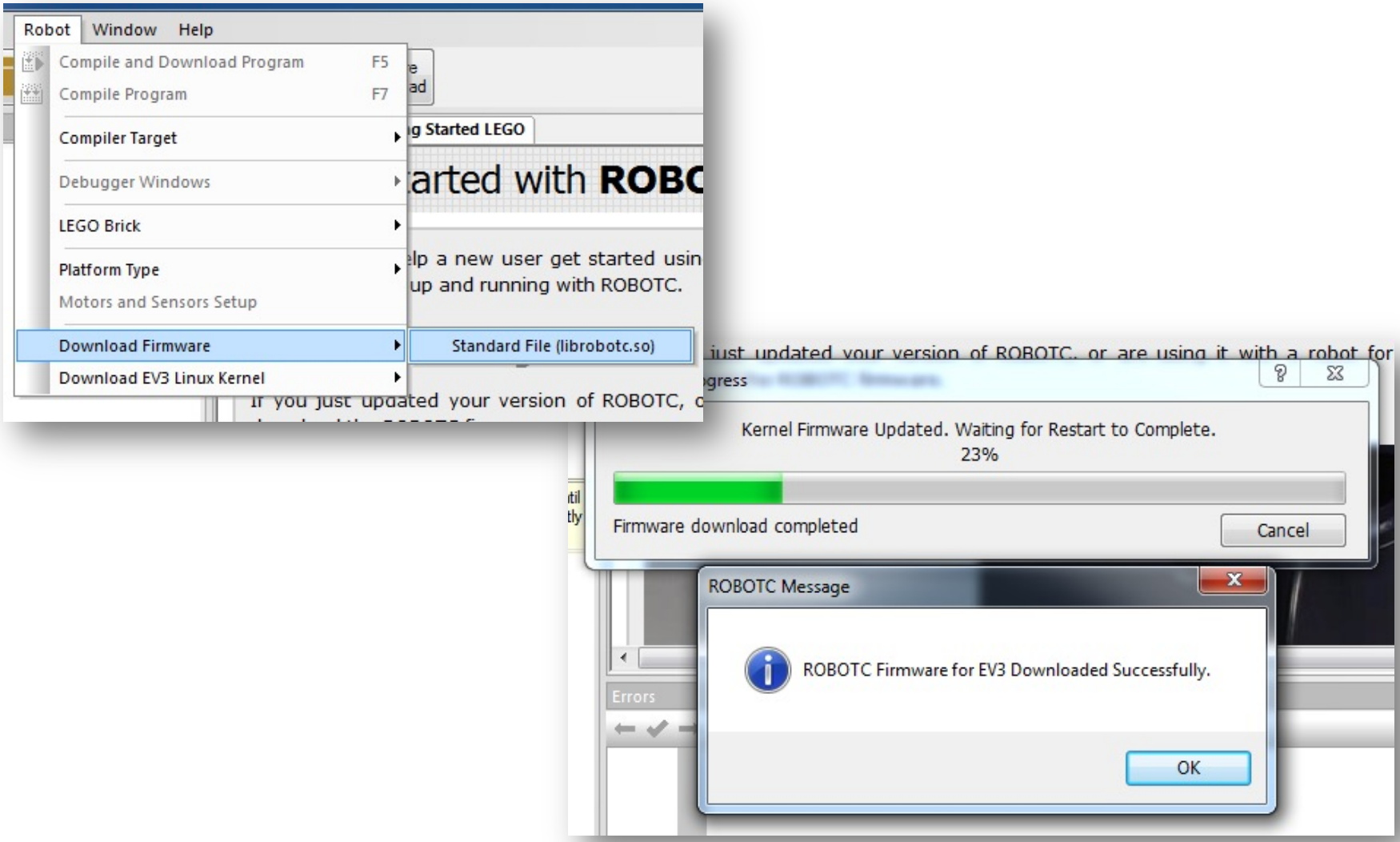
Download firmware [cont.]

- Updating EV3 Kernel (Operating System) [cont.]



Download firmware [cont.]

- Install ROBOTC Firmware



Preparation

Preparation of communication

- Attach charged battery with EV3 brick
- Turn on your EV3 brick (Press and hold a center button)
- Connect EV3 brick with PC via USB cable

Program 1 - test connection

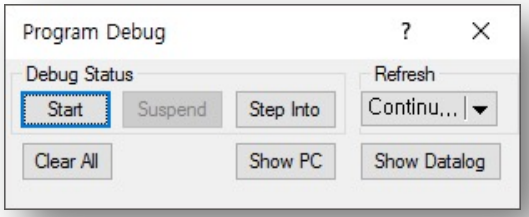
- **Now, you are ready to program**
  - Try to enter the following code:

```
task main() {
        PlaySound( soundBeepBeep );
        wait1Msec( 500 );
        PlaySound( soundBeepBeep );
        wait1Msec( 500 );
}
```

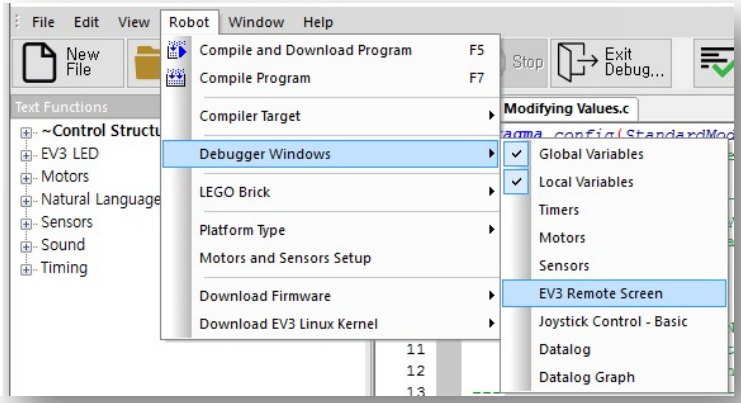
  - 'F5' to compile and download it to EV3 intelligent brick – Try!
    - 'F7' to compile only to check errors

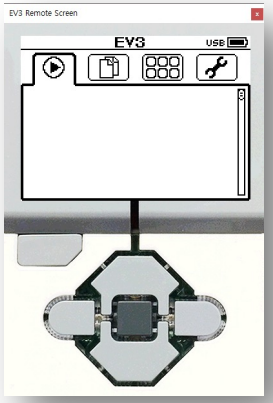
Program 1 - test connection [cont.]

- Click ‘Start’ button to hear sounds



- Try to see EV3 brick screen in your PC
  - Menu: Robot – Debug Windows – EV3 Remote Screen

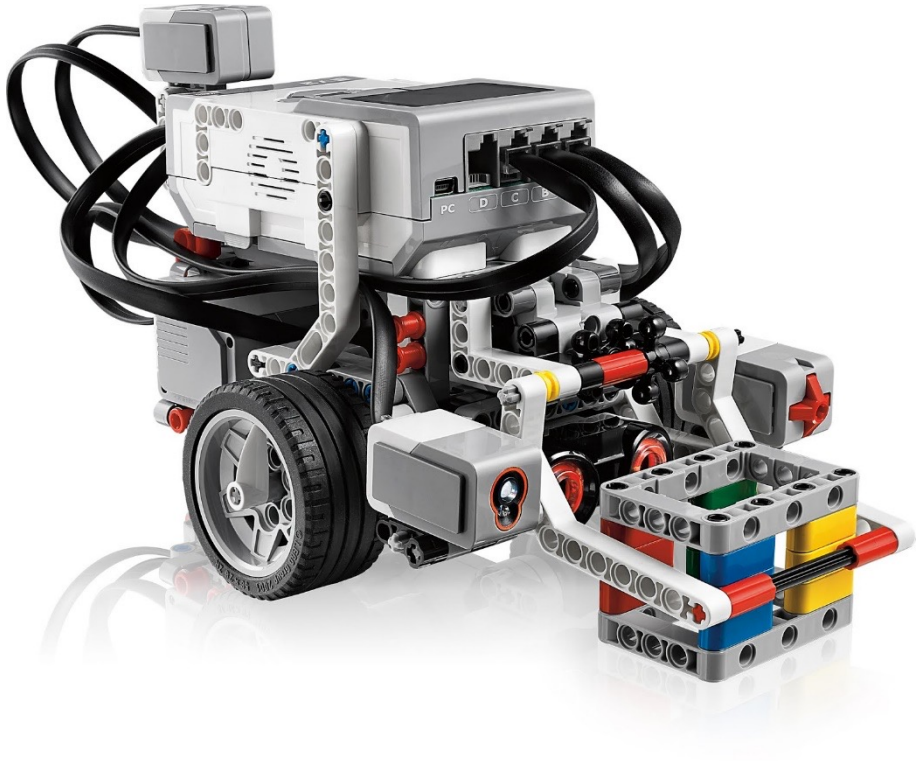




- Is everything ok? Then you are ready to build your first robot

Build first robot

- Build “Educator Vehicle”



Program 2 - test robot

- **Array motor[]**
  - Set motor speed varies from 0 (stop) to 100 (full speed)
    - Note: actual speed can be different according to battery status
  - Array indices motorA, motorB and motorC are related to three outputs of EV3 brick
    - Note: be careful to check the mapping between output port and actual motor

Program 2 - test robot [cont.]

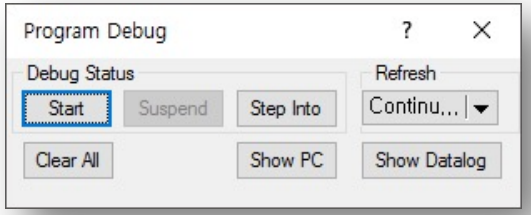
- Type the following code

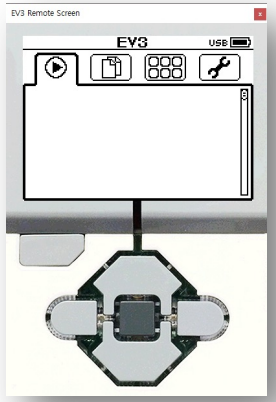
```
#define LEFT_MOTOR motorC
#define RIGHT_MOTOR motorB
task main() {
  motor[LEFT_MOTOR] = +50; motor[RIGHT_MOTOR] = +50;
  wait1Msec(2000);
  motor[LEFT_MOTOR] = +50; motor[RIGHT_MOTOR] = 0;
  wait1Msec(2000);
  motor[LEFT_MOTOR] = 0; motor[RIGHT_MOTOR] = +50;
  wait1Msec(2000);
  motor[LEFT_MOTOR] = -50; motor[RIGHT_MOTOR] = -50;
  wait1Msec(2000);
}
```

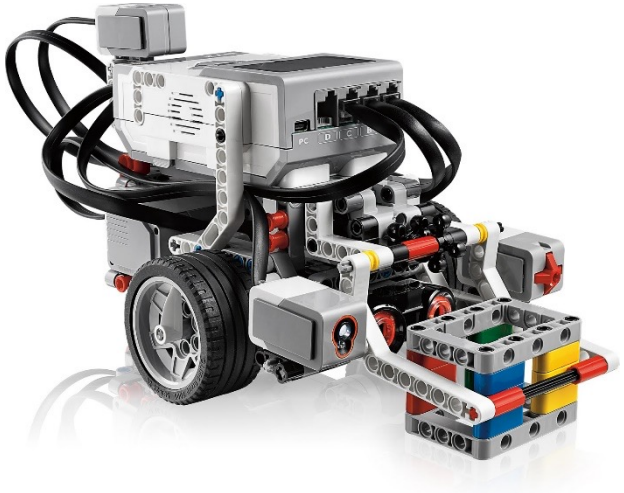
- ○ Connect EV3 brick with PC via USB cable
- ○ Compile and download (F5)

Program 2 - test robot [cont.]

- Run in RobotC environments
- Run in EV3 Remote Screen
- Detach USB cable and run using EV3 brick directly







Program 2 - test robot [cont.]

- **How can you rotate your robot “exactly” 90 degrees?**
  - It is hard now, but use of servo motor having built-in encoder can accurately rotate each wheel
  - So, now? You have to use suitable waiting time experimentally

Lab 9

- **Move the robot vehicle to follow the square of 15cm side.**
  - (1) Let the robot move in the clockwise direction.
  - (2) After the robot returns to the original position, rotate it 180 degree at the same location.
  - (3) Now, let the robot move in the counterclockwise direction.