iqr Tutorial 06-Robot-Lego Mindstorms

iqr tutorials will provide you with a practical introduction to using the neural simulation software and give you an insight into the principles of connectionist modeling. They are intended to be complementary to the detailed operation manual.
The home page of iqr is at iqr.sourceforge.net. Up to date information, documentation and tips and tricks ca be found in the iqr wiki (sourceforge.net/p/iqr/wiki/Home/).
The repository of iqr packages is here: sourceforge.net/projects/iqr/files/. iqr is open source software. You can browser the entire source code of iqr here: http://sourceforge.net/p/iqr/code/HEAD/tree/. Please contribute to iqr by reporting bug (sourceforge.net/p/iqr/bugs/) and requesting features (sourceforge.net/p/iqr/feature-requests/).

Aims

- Familiarize yourself with the basic hardware of the Lego Mindstorms robot
- Understand what type of sensors there are, how to connect them, and what their characteristics are
- How to compile and upload the on-board java program to the brick
- How to connect the robot to iqr

Building and setting up the robot

Prerequisites

- Bluetooh dongle: The communication between iqr and the robot is provided via a Bluetooth connection. Your computer therefore needs built-in Bluetooth, or a sparate Bluetooth dongle.
- To do this tutorial you will need the iqr module “BTleJOSMindstorm” which can be downloaded as part of the experimental iqr modules package from http://sf.net/projects/iqr-extension.
- To connect with the robot you need to install this version 1.1.3: http://mindstorms.lego.com/en-us/support/files/default.aspx#Driver
- And you need to install the leJOS package from here: https://sourceforge.net/projects/lejos/files/

Robot assembly

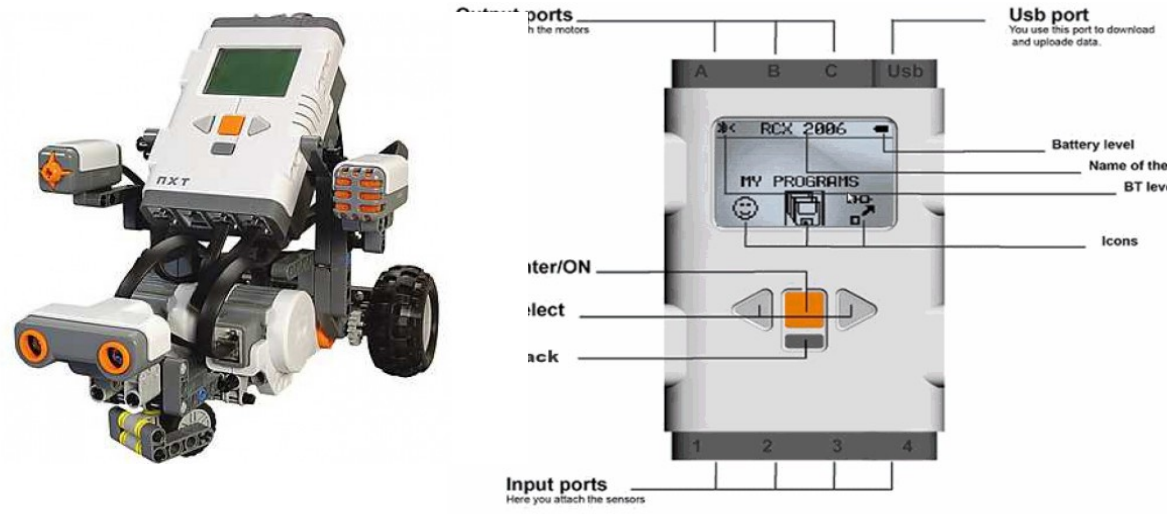
Start by assembling the default Lego Mindstorms robot shown below. This robot should be build using two motors and one of each of the following sensor types touch, light, sound, ultrasound.

Not all sensors are returning values with the same properties and there for we need to connect them to the NXT in a specific way:

1: Touch sensor, 2: Sound sensor, 3: Light sensor, 4: Ultrasound sensor

The motors need to be connected as follows:

A: Right motor, B: Left motor



Installing leJOS

When we use the Lego Mindstorms with iqr, the main simulation is running on the PC, and the robot is mostly remote controlled. To be able to do this, we need to "hack" the robot's main control unit, the brick, and install the alternative operating system "leJOS".

The documentation of leJOS can be found here: http://lejos.sourceforge.net/nxt/nxj/tutorial. The description below follows the instructions from http://www.bartneck.de/2008/03/04/java-lego-nxt-eclipse-tutorial/#installUSB

Follow these steps

- Install drivers and leJOS
- Bring NXT to the firmware upload mode: Use a paper clip to press and hold the hidden button (NXT will play a soft pulsing sound that signals its readiness)
- Use leJOS flash tool to upload the firmware

Note if you encounter problems with connecting to the NXT, check that you do **not** have arduino drivers installed.

Compiling and upload the on-board program

To interface with iqr, a program that reads commands from, and send sensor readings to the serial port need to be compiled and installed on the brick. The file of the default program is called "rcMindstorms.-java" and can be downloaded from the iqr website.

To compile the program you need to make sure that the path to the tools that are part of the leJOS package is added to you system environment (for instructions on how to do this check http://www.computerhope.com/issues/ch000549.htm). One the path is configured open a shell in the folder that contains the java source file (here's a neat trick how to do that efficiently: http://lifehacker.com/5989434/quickly-open-a-command-prompt-from-the-windows-explorer-address-bar).

Once on the command use the following commands to compile, link, and upload the program:

- `nxjc rcMindstorms.java`
- `nxjlink -o rcMindstorms.nxj  rcMindstorms`
- `nxjupload -r rcMindstorms.nxj`

Connecting to the robot

iqr is communication with the robot over a Bluetooth connection. This connection needs to be established before we start the simulation in iqr. Below are the steps to make this connection on the Linux and Windows operating systems.

On Linux

- On the NXT turn on visibility in the Bluetooth menu
- To find devices by running “hcitool scan” from a terminal, and note down the device ID e.g. ”00:16:53:0D:58:15”
- Manually create the device node running “sudo mknod -m 666 /dev/rfcomm0 c 216 0” from a terminal
- The actual connection to the device is established with “/usr/bin/rfcomm connect /dev/rfcomm0 <DEVICE ID> 1” -> replace <DEVICE ID> with the ID you determined with the hcitool command
- Note: Most likely, the device “/dev/rfcomm0” will belong to group dialout, so make sure you are a member of the group

On Windows

- First you will need to pair NXT and Windows
  - On the NXT turn on visibility in the Bluetooth menu
  - On windows browse and add the Bluetooth device:
    - The device might show up as “Other”
    - PIN is “1234”
  - Wait for Windows to install the drivers
- Connecting:
  - Determine the serial port that was assigned to the device by going to “Control Panel\All Control Panel Items\Devices and Printers” then NTX->Properties->Hardware
  - Use the serial port name (e.g. COM8) as device name in the iqr module
  - No further steps are required; every time you start the simulation in iqr, the PC should connect to the brick

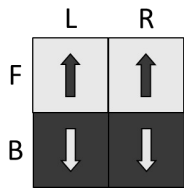
Interfacing the robot with iqr

Important: Follow these steps before running the iqr simulation:

1. Connect the robot to the PC via Bluetooth
2. Run the appropriate program on the NTX brick, e.g. `rcMindstorms.ntx`

Within iqr the communication with the robot is happening with a group of neurons that is representing the readings for the sensors, and a group that send commands to the motors. The sensor group has four neurons that represent the values of the touch, sound, light, and ultrasound sensors.
The values for each sensor should be 0...1.

The motors are controlled by a group of 2x2 neurons, with the polarity shown here.



Exercises