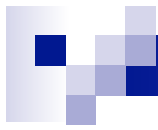


Lego Robots and Software Design

CITS1001 extension notes

Rachel Cardell-Oliver



Lecture Overview

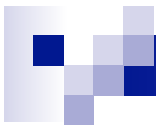
1. **Designing NXT Robots**
2. NXT Hardware
3. Sensors and Actuator API
4. The Behaviour Interface



Software Design

is a problem-solving process whose objective is to find and describe a way

- To implement the system's *functional requirements*...
- While respecting the constraints imposed by the *quality, platform and process requirements*, including the budget
- And while adhering to general principles of *good quality*



Lecture Overview

1. Designing NXT Robots
2. **NXT Hardware**
3. Lejos Java API
4. The Behaviour Interface



Lego NXT: by Ro Mathew

- From the Czech word:

robota

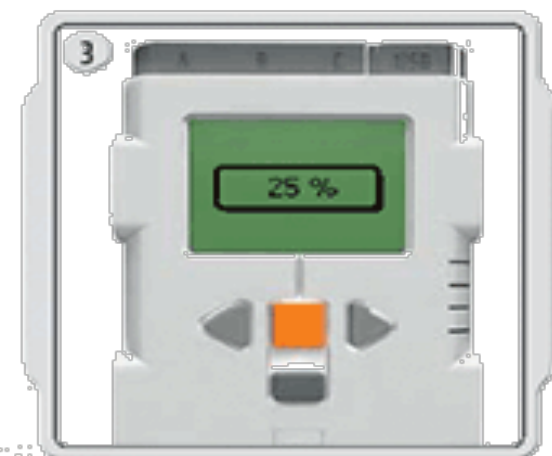
- Slavery, Drugery, Servitude –
Forced Labour



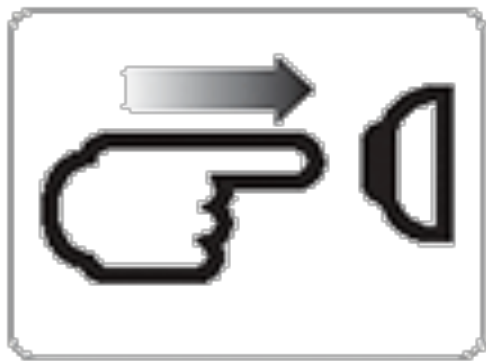
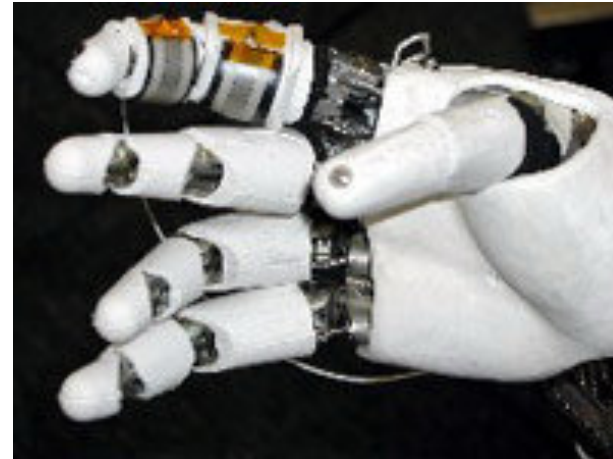
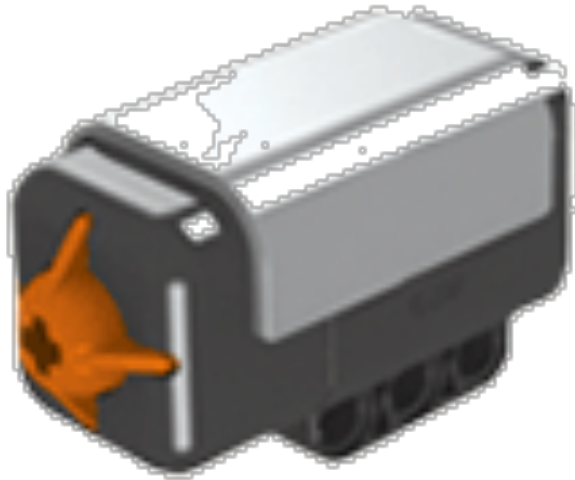
Robot **Sensors**:

- **Provide information for the robot to examine its environment.**

Robot Sound:



Robot Touch:



PRESSED

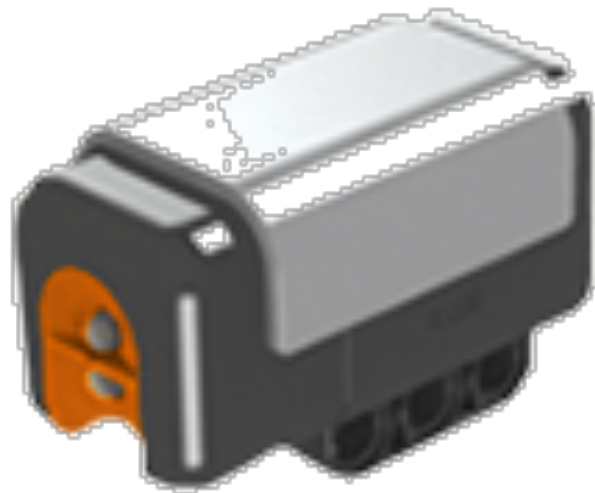


RELEASED



BUMPED

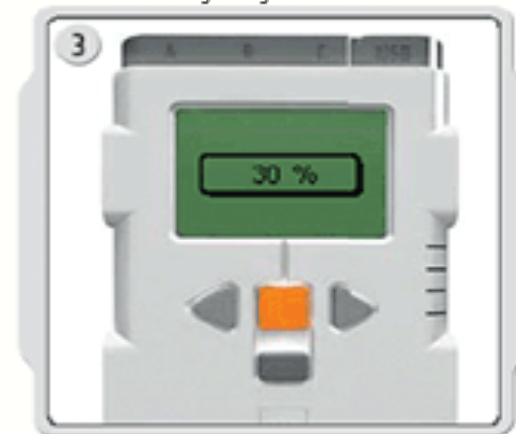
Robot Vision - Colour:



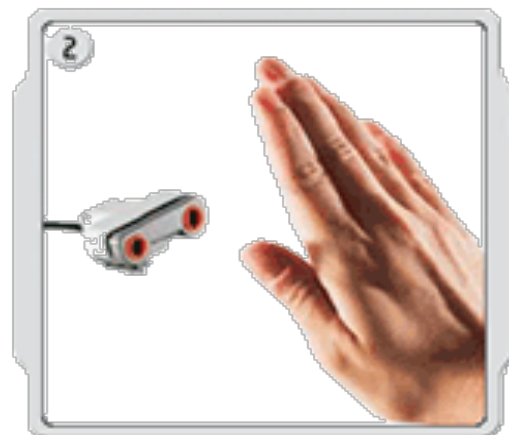
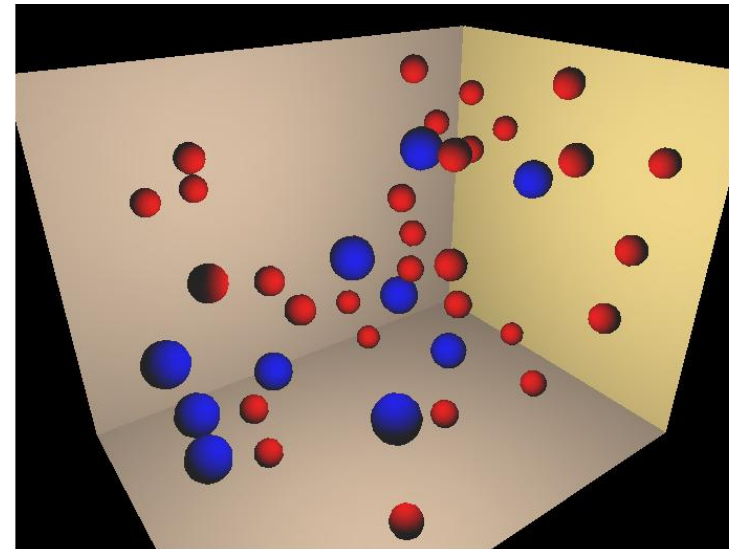
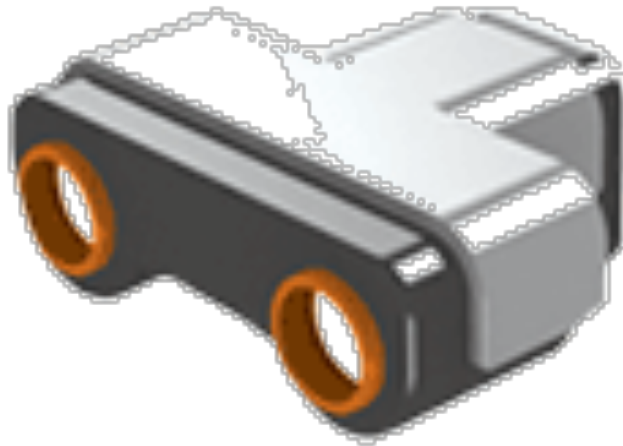
This is what your eyes see

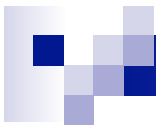


This is what your robot will see, using the light sensor.



Robot Vision – Distance:





Robot **P**eripherals:

- **Allows the robot to change its environment.**

Robot Peripherals:



screen



speakers



Robot **Controller**:

- **Acts as the brain for the robot: Coordinates Devices**

ROBOT CONTROLLER



Connect to our computer

Store programs and data

Connect to our sensors and motors

Retrieve information and provide power

Run programs and display information



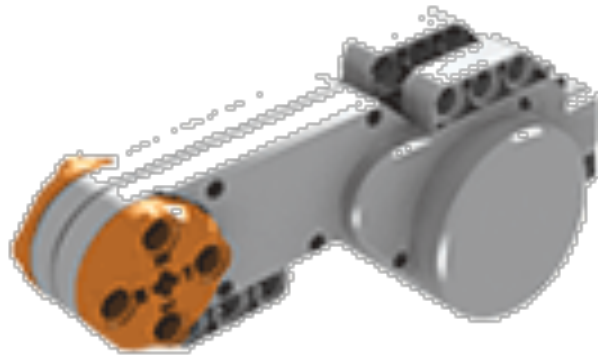


Robot **Motion System:**

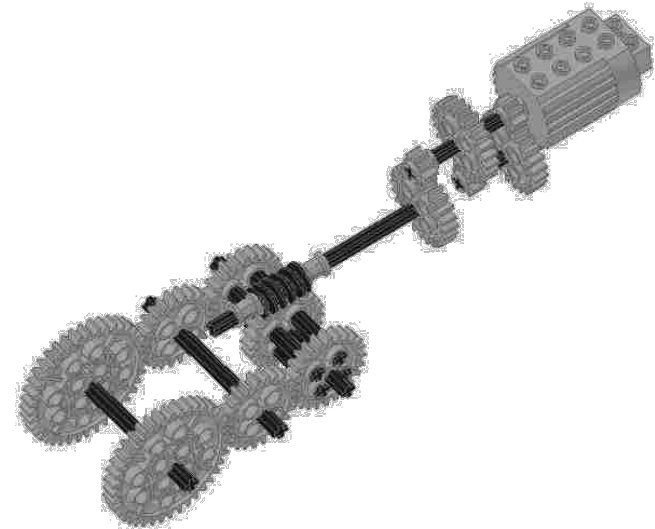
- **Acts as the muscles for the robot allows physical movement**

Robot Motion:

The more sensors, the better the robot is able to interact with the environment.



■ Motors



■ Gears
and
Axles



Robot **System**:

- **Incorporates sensors, peripherals, motion and power systems**

Robot System:



For Building Instructions see CITS1001 extensions page

Components

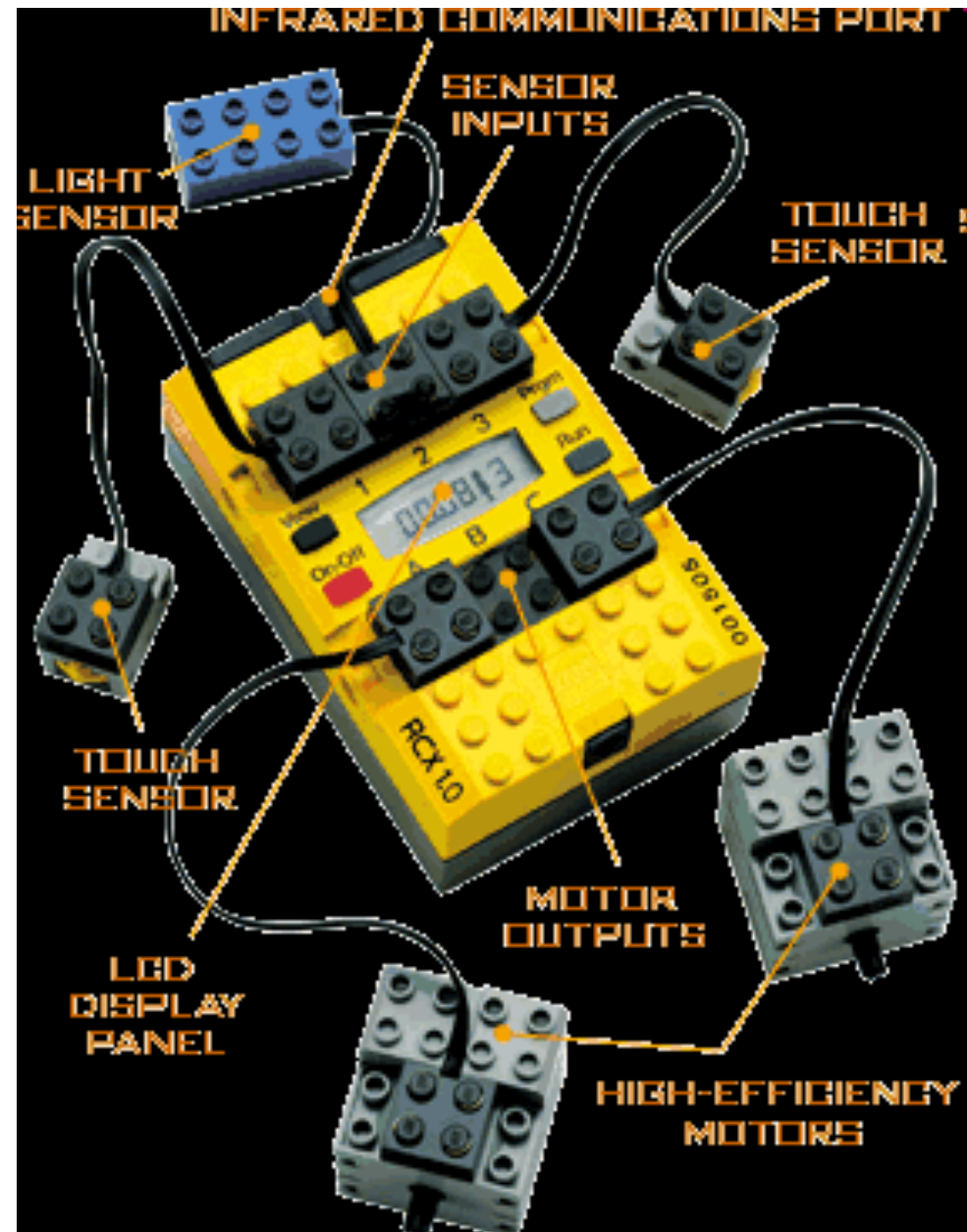
- [Basic NXT Driving Base](#)
- [Motor Module](#)
- [Sound Sensor Module](#)
- [Touch Sensor Module](#)
- [Ultrasonic Sensor Module](#)

Models

- [Scorpion](#)
- [TriBot](#)
- [Alpha Rex humanoid](#)



LEGO RCX





Lecture Overview

1. Designing NXT Robots
2. NXT Hardware
3. **Lejos Java API**
4. The Behaviour Interface

Cockroach Robot

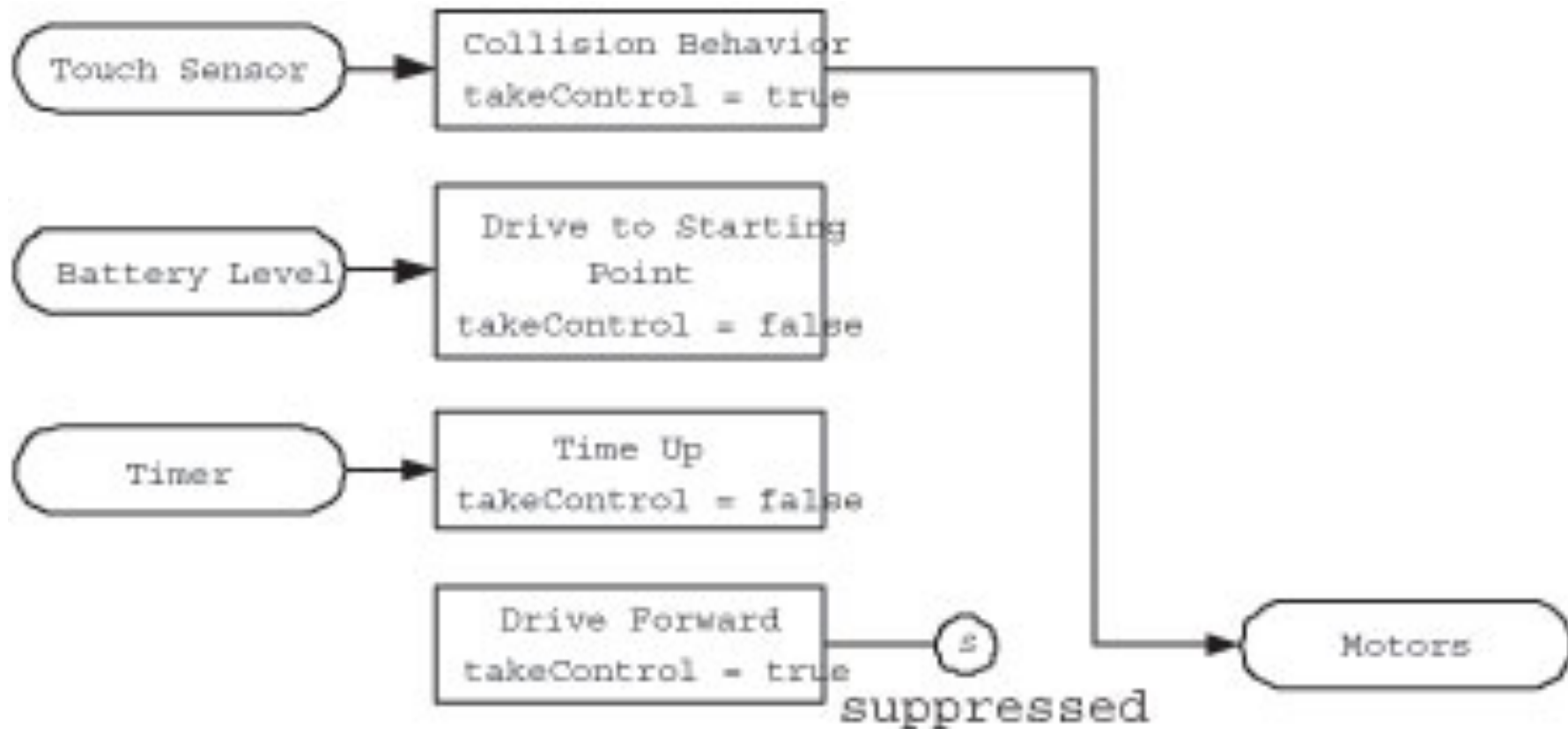
```
import lejos.nxt.*;
class Cockroach {
    public static void main(String [] args) {
        LightSensor ls = new LightSensor(SensorPort.S2) ;
        Motor.B.forward();
        Motor.C.forward() ;
        LCD.drawString("Too much light",3,4);
        LCD.refresh();
        while (ls.readValue() > 55) {
            //keep moving forward until dark is found }
            LCD.drawString("That's better",3,4);
            LCD.refresh();
            Motor.B.stop();
            Motor.C.stop();
        }
    }
}
```



Lecture Overview

1. Designing NXT Robots
2. NXT Hardware
3. Lejos Java API
4. **Lejos Behaviour Interface**
(from the book Max Lego NXT, Chapter 18)

Subsumption





```
package lejos.subsumption;
```

```
public interface Behavior {
```

```
public boolean takeControl();
```

- Trigger condition for invoking this behaviour

```
public void action();
```

- Start a behaviour (eg. move forward)
- Actions must return quickly (so that Arbitrator can continue checking takeControl)

```
public void suppress();
```

- Terminate this behaviour (eg. Stop a motor)
 - Also update any data if needed
- ```
}
```



# Arbitrator

```
public Arbitrator(Behaviour [] behaviours);
```

- Create an arbitrator with an array of behaviours:  
highest array index has highest priority

```
public void start()
```

- Starts the arbitration system:
  - call takeControl() for each behaviour starting with the highest priority behaviour, until true
  - Execute the suppress() method of the current (lower priority) behaviour then
  - Execute the action() method of the chosen behaviour



# Learn More ...

- Lejos project home page
- <http://lejos.sourceforge.net/>
  - Lejos NXT API
  - Sample Programs
    - See BumperCar example for behaviours
  - Lego RCX tutorial (for previous generation hardware, but many parts still relevant)