Introduction to
Robots and the Mind
- part 1 -

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Robots | the Mind

| Robots &	the Mind
(Bert Wachsmuth) *(Math & CS)*	*(Michael Vigorito)* *(Psychology)*
• Algorithms and Program design • Programming in Java • Building Robots • Sensor feedback • Behavior-based robots • Robots that learn	• Science and Catholic thought • Neuroscience • Evolution & natural selection • Sensation and perception • Adaptive behavior and learning

What is a Robot (1/2)

♦ *"An intelligent robot is a machine able to extract information from its environment and use knowledge about its world to move safely in a meaningful and purposeful manner"*

♦ *"A robot is a machine that gathers information about its environment (senses) and uses that information (thinks) to follow instructions to do work (acts)."*

What is a Robot (2/2)

♦ A robot is a system which **exists** in the physical world and autonomously **senses** its environment and **acts** in it.

♦ The word "robot" was used in a play called "Rossum's Universal Robots" in 1921 by Czech playright Karel Capek. It stood for *forced labor* or *serf*.
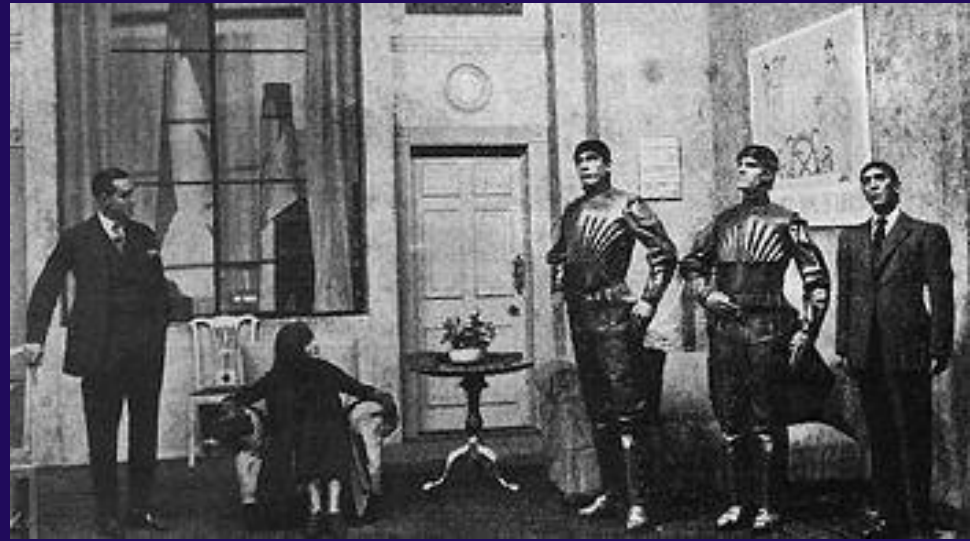
Robots in the Physical World

Components of a Robot

A robot … **exists** … **senses** … and **acts**

It has:

♦ Sensors

♦ Effectors/Actuators

♦ On-board computer

♦ (Locomotion System)
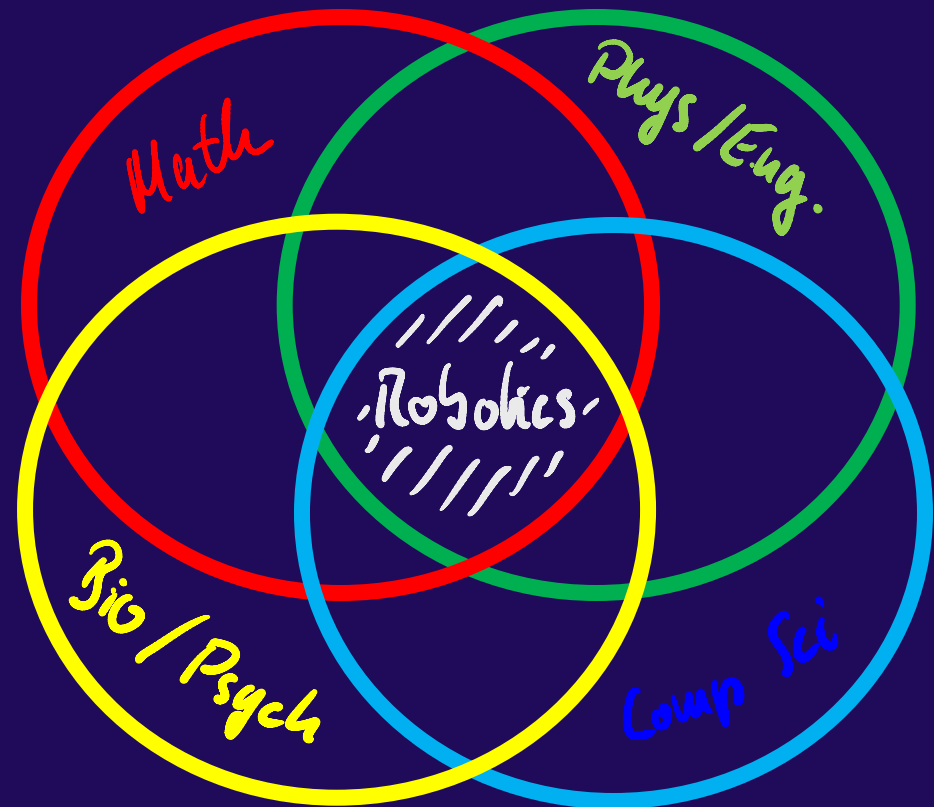
Robot with different Locomotion System

What is Robotics

♦ Robotics is the science and technology of robots, their design, manufacture, and application.

♦ Robotics is at the intersection of multiple disciplines

♦ A person working in the field is a roboticist.

Math

Phys /Eng.

Robotics

Bio / Psych

Comp Sci

Robotics Concepts

Robotics revolves around two basic ideas:

♦ **Model**: an abstract representation of the world and the robot in it, often in mathematical terms

♦ **Algorithm**: a sequence of well-defined steps to solve a particular problem or accomplish a particular goal

Model/Algorithm Example
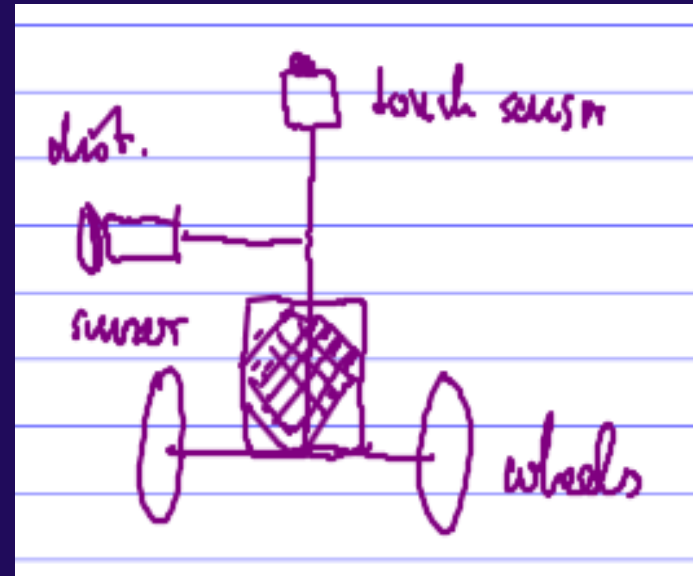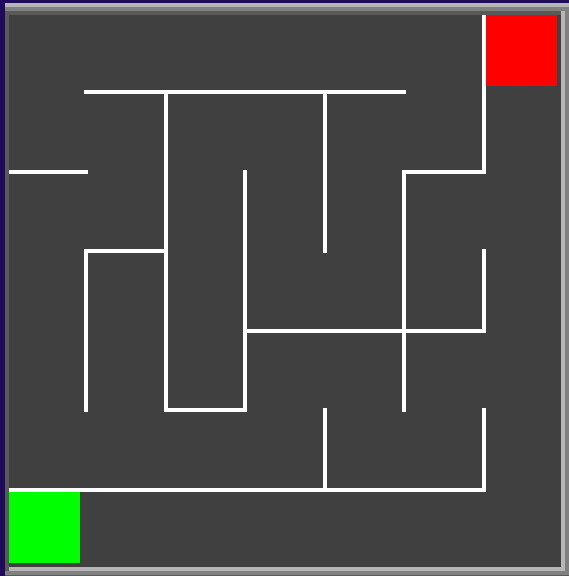
Problem: find intersection of two lines

♦ Model:

– each line is represented by:

– linear equations $y = m_1 x + b_1$ and $y = m_2 x + b_2$

♦ Algorithm:

– Solve $m_1 x + b_1 = m_2 x + b_2$

• Collect numbers on one side

• Collect x's on other side

• Factor and divide

Maze Model/Algorithm

- Touch left wall and extend right arm forward
  - if front clear and wall on the left, go forward
  - if left wall is missing, turn left 90^0
  - if front is blocked, turn right 90^0
- Repeat until you reach finish

Maze Algorithm
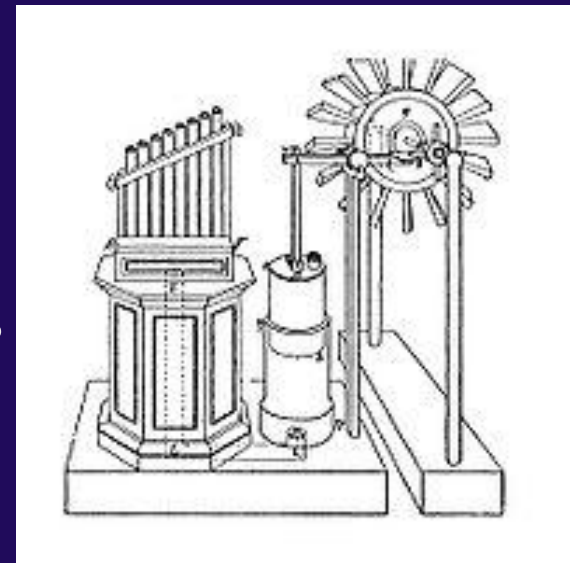
http://www.youtube.com/watch?v=MXlVLwS01wo

History of Robots

First century A.D. and earlier

Descriptions of more than 100 machines and automata, including a fire engine, a wind organ, a coin-operated machine, and a steam-powered engine, in Pneumatica and Automata by *Heron of Alexandria*

History of Robots

1206

Al-Jazari created early humanoid automata, including a programmable "automaton band"

1495

Leonardo da Vinci created designs for a humanoid robot, including a mechanical knight (wave, sit, pretend-walk, pretend-speak)

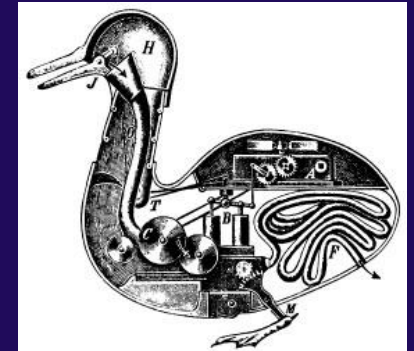Source: http://en.wikipedia.org/wiki/Robotics

History of Robots
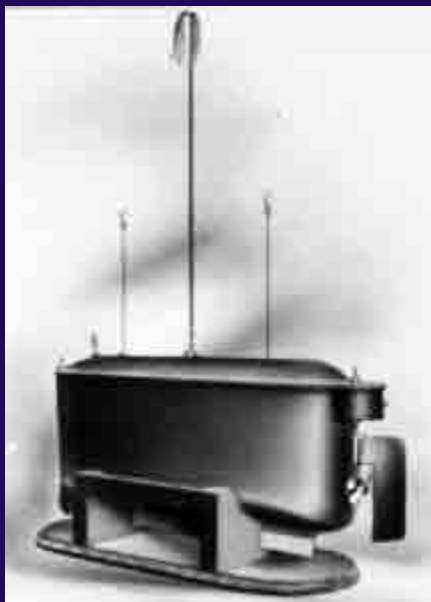
1738

Jacques de Vaucanson:
Mechanical duck that was able
to eat, flap its wings, and excrete.
Designed automatic loom (see *J.M. Jacquard*)

1898

Nikola Tesla demonstrates first
radio-controlled boat

History of Robots

1921

First fictional automatons called "robots" appear in the play R.U.R. Rossum's Universal Robots by *Čapek*

1930s

Humanoid robot "Electro" and "Sparko" the dog created by *Westinghouse* exhibited at the 1939 and 1940 World's Fairs
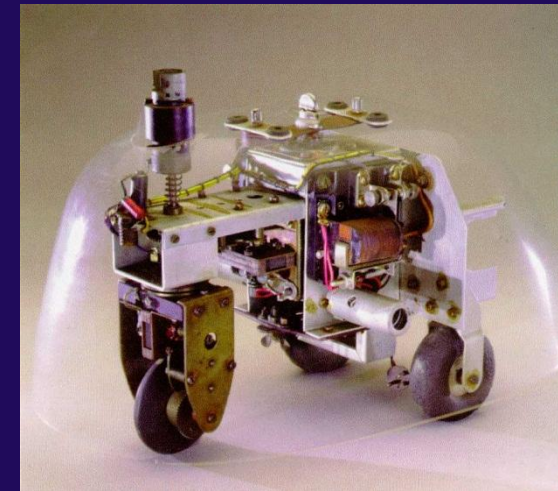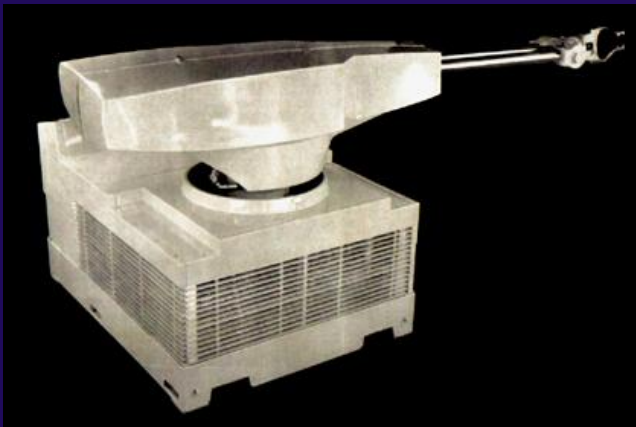
History of Robots

1948

William Grey Walter: "turtles" (Elsie and Elmer) exhibiting biological behaviors

1956

First commercial robot Unimate from the *Unimation* company founded by *George Devol* and *Joseph Engelberger* , worked at GM plant in NJ


Source: http://en.wikipedia.org/wiki/Robotics

History of Robots
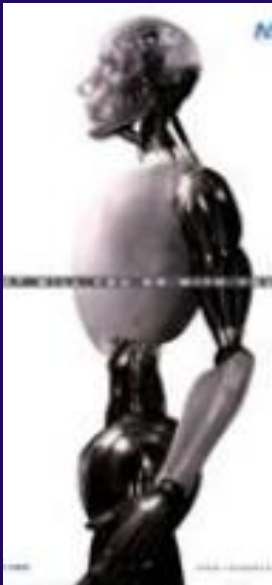
1970's and beyond (more and more capable):

– palletizing robot

– programmable universal manipulation arm

– swimming and flying robots

– robotic cars

– robots in space and on other planets

– household robots

– rescue robots

– medical and surgical robots

– robots for war and destruction

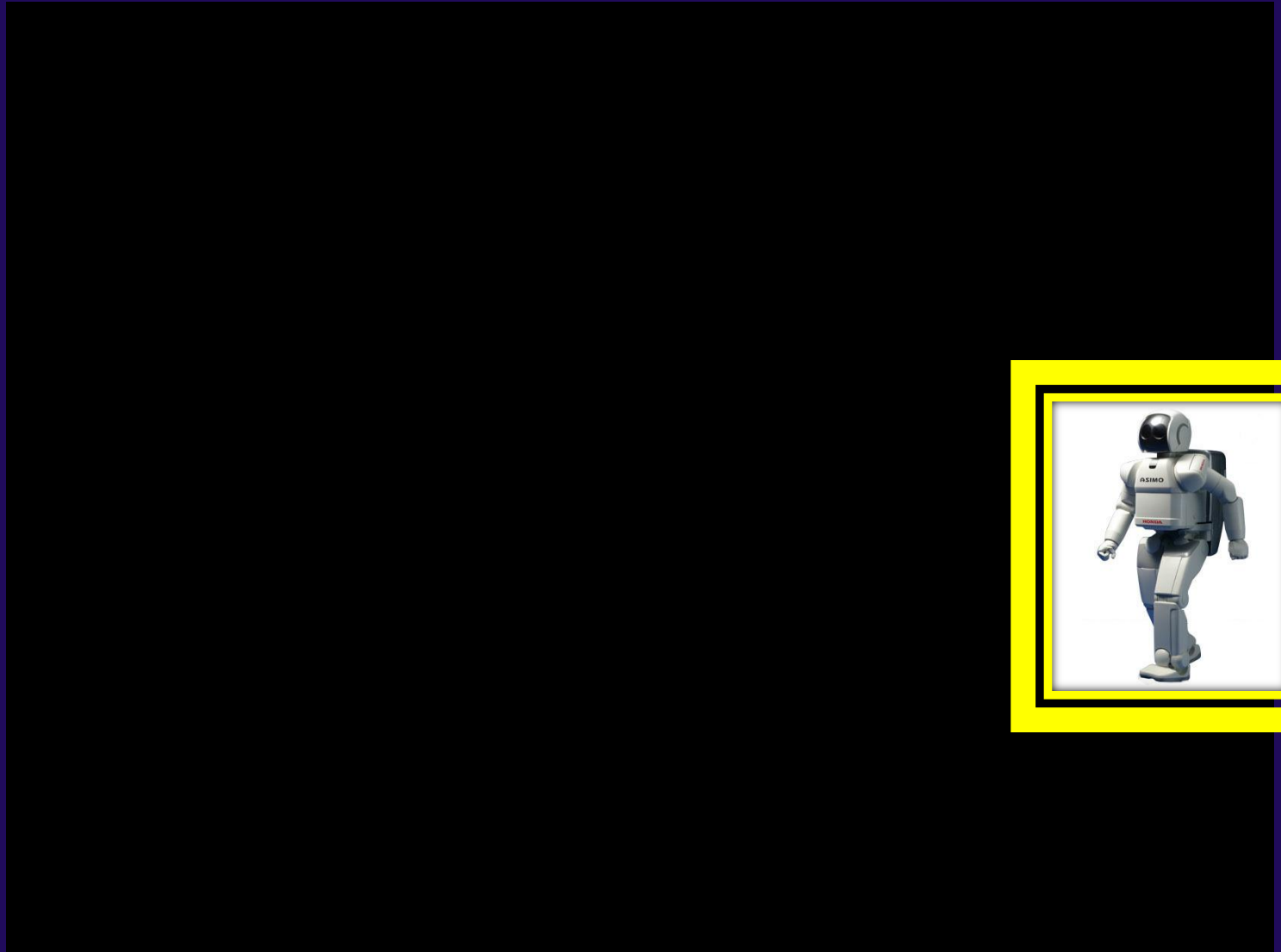Source: http://en.wikipedia.org/wiki/Robotics
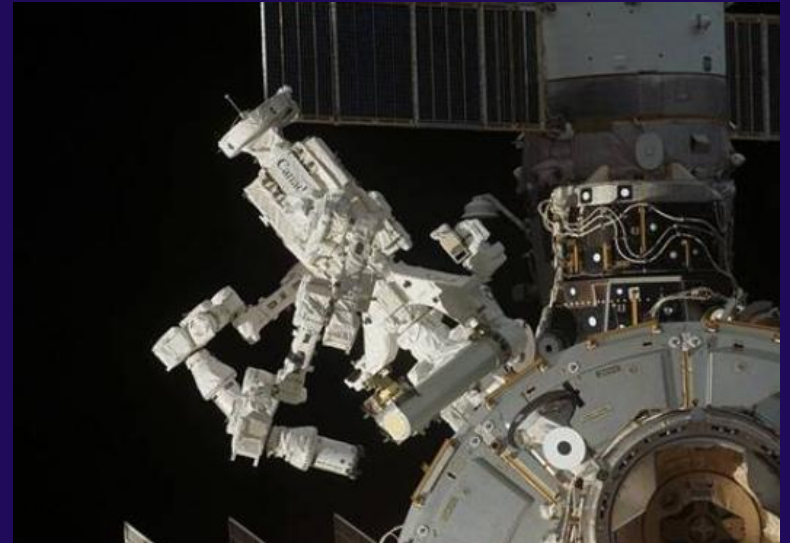
Real Robots

Fake Robots (all but one)

Fake Robots (all but one)

Honda's Asimo

Trends in Robotics

Classical Robotics (mid-70's)
- exact models
- no sensing necessary

Reactive Paradigm (mid-80's)
- no models
- relies heavily on good sensing

Hybrids (since 90's)
- model-based at higher levels
- reactive at lower levels

Probabilistic Robotics (since mid-90's)
- seamless integration of models and sensing
- inaccurate models, inaccurate sensors

Logo Mindstorm NXT

♦ NXT Intelligent Brick
– 32bit ARM7 microcontroller
– 256 KB Flash , 64 KB RAM
– 4 input ports (for sensors)
– 3 output ports (for motor)
– LCD display with 100 x 64 pixels
– Speaker for 8bit resolution mono sound

♦ 3 servo motors & integrated rotation sensors

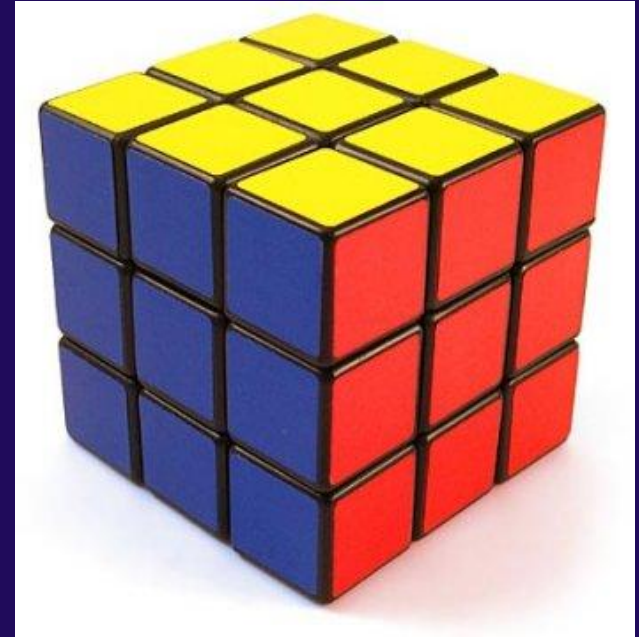♦ Sensors: touch, light, sound, ultrasound

♦ Contains about 500 parts

NXT "smart" components

NXT Rubik's Cube Solver

http://www.youtube.com/watch?v=w3f-WyDqOUw
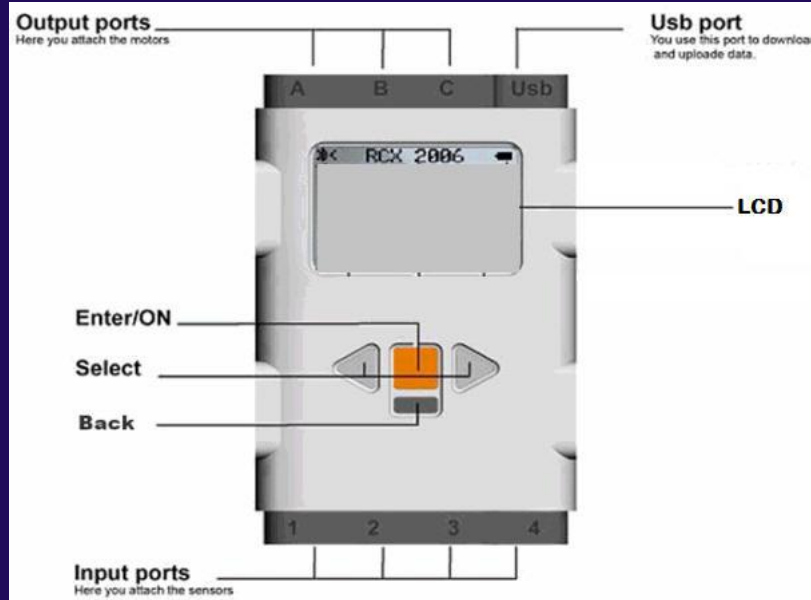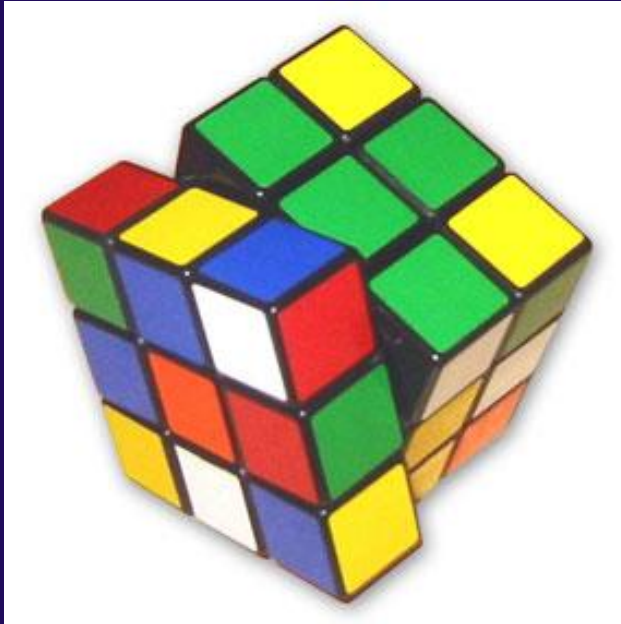
Segway Robot

- ◆ A Segway is a transporter that balances on two wheels
- ◆ Construct a NXT robot that simulates a Segway transporter
  - Uses a PID (proportional–integral–derivative) controller, which is a generic control loop feedback mechanism

Robot Programming

♦ Robots have on-board computer to monitor the sensors and regulate the actuators

♦ NXT can be programmed in:
- NXT-G
- Assembly Language
- C or C#
- *Java*
- MS Robotics Studio

A "Program"

♦ Sequence of instructions to tell robot what to do:

– Written by humans in a *programming language*
– Translated by a *compiler* to machine language
– *Uploaded* to robot's processor
– *Executed* by robot step by step

Programming Necessities

- **Editor** to write the program
- **Compiler** to translate the program
- **Uploader** to transfer the program
- **Robot** to execute the program

eclipse GANYMEDE

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