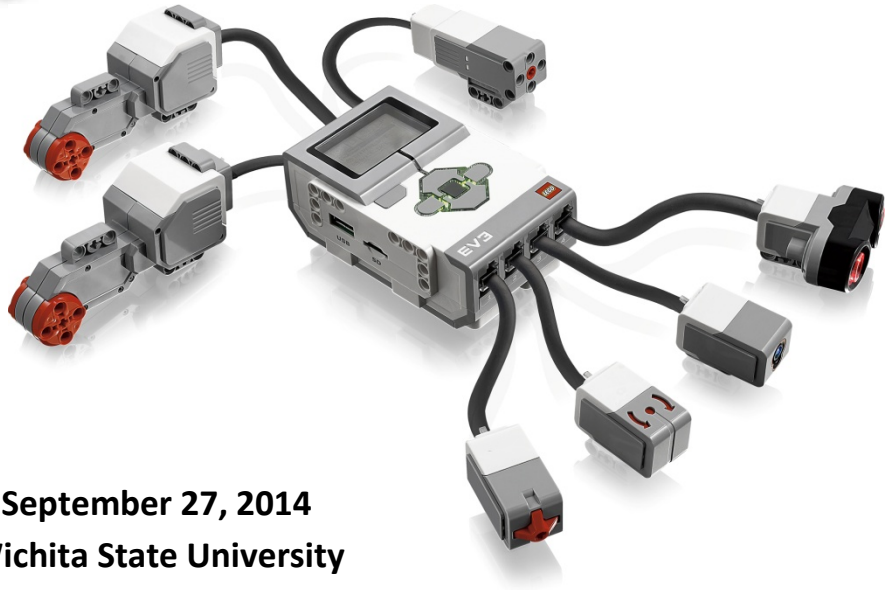
Robotics Workshop

for Parents and Teachers



September 27, 2014
Wichita State University
College of Engineering

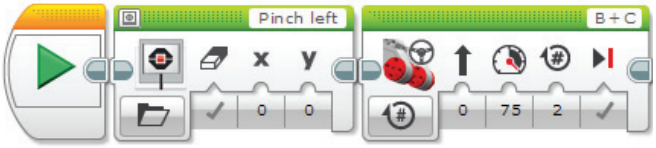
Steve Smith
Christa McAuliffe Academy
ssmith3@usd259.net

Karen Reynolds
Wichita State University
karen.reynolds@wichita.edu

Resources available at **http: //smithlearning.com/robotics**
Shocker Mindstorms Challenge information at **http://www.wichita.edu/shockermindstorms**

Notes

Robotics Design Process



1. Learn

What is the PROBLEM we need to solve?

What are the OBSTACLES or RESTRICTIONS we will face?

2. Plan

BRAINSTORM how to solve the problem and overcome obstacles.

Draw a sketch of your ROBOT.

Write your program out in PSEUDO-CODE.

3. Build

Build your ROBOT design.

Collect your SENSOR DATA.

Write the PROGRAM for your problem one step at a time.

4. Test

WATCH and TAKE NOTES of your robot's performance.

5. Reflect

Keep a RECORD of your progress.

Decide what CHANGES need to be made on robot or program.

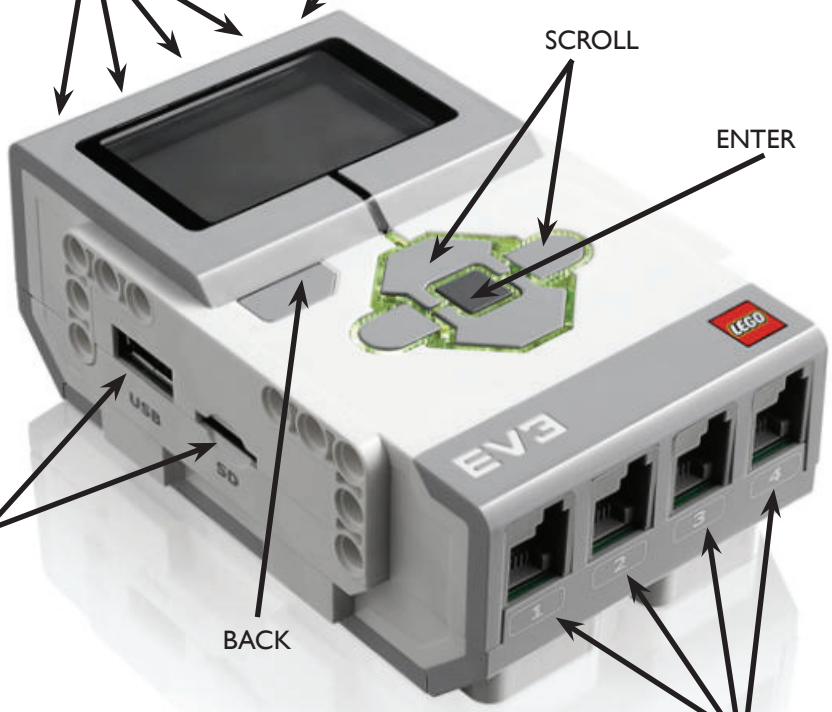
EV3 Key Parts

Output Ports (for motors)
defaults are _____ and _____
for large motors

USB Port
connect to computer

SCROLL

ENTER



EXPANSION PORTS

BACK

Touch Sensor

Color Sensor

Ultrasonic Sensor

ALL MOTORS AND SENSORS
use "Auto ID"
(so defaults are less important)

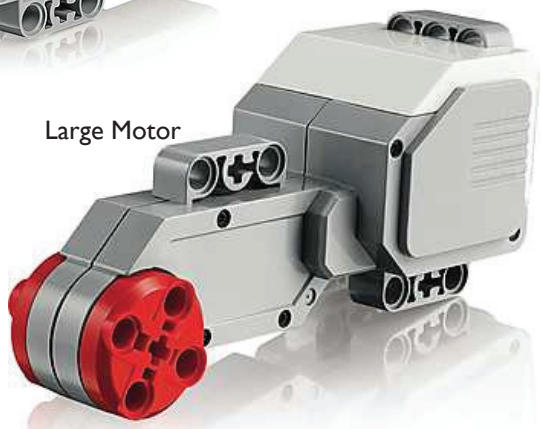
Input Ports (for sensors)
defaults are

_____, _____, _____, _____

Medium Motor

Gyro Sensor

Large Motor



Infrared Beacon

Infrared Sensor

EV3 Brick Navigation Map

1. RUN RECENT

Most recently run programs that will be displayed on this screen. The program at the top of the list which is selected by default is the latest program run

Run Recent screen

2. FILE NAVIGATION

Access and manage all the files on your EV3 Brick, including files stored on a SD Card. Files are organized in project folders. In the File Navigator, files can be moved or deleted.

Open folder in File Navigation

3. BRICK APPS

- Port View
- Motor Control
- IR Control
- Brick Program
- Brick Datalog

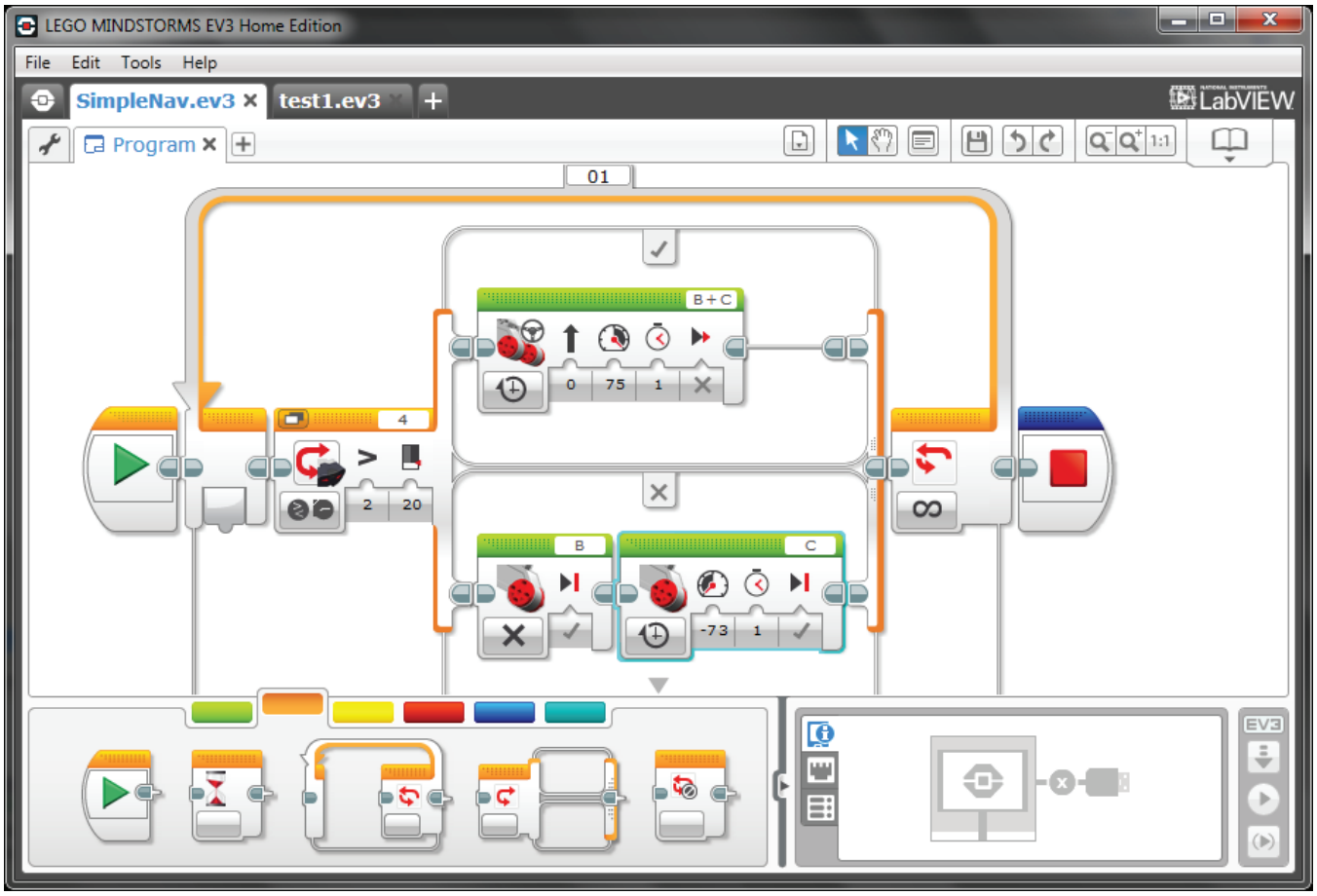
Brick Apps screen

4. SETTINGS

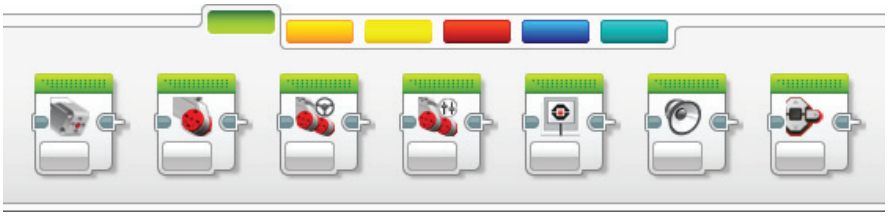
- Volume
- Sleep
- Bluetooth
- WiFi
- Brick Info

Settings screen

Building Blocks: EV3 Programming

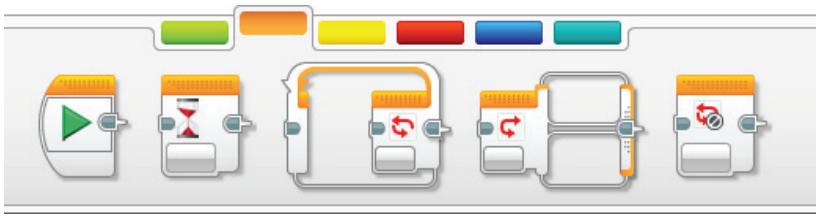


1. ACTION BLOCKS (green)



Medium Motor - Large Motor - Move Steering - Move Tank - Display - Sound - Brick Status Light

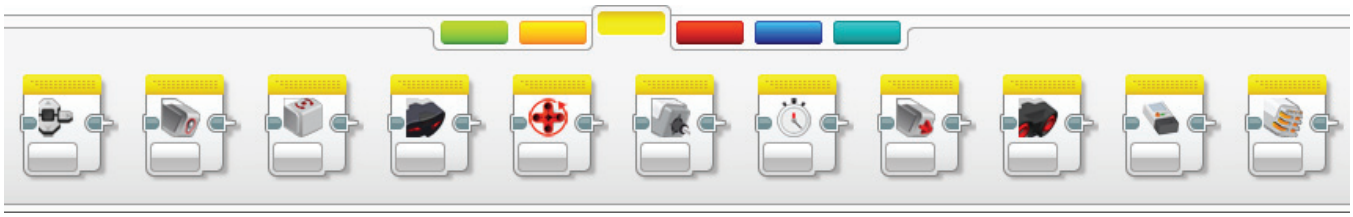
2. FLOW CONTROL BLOCKS (orange)



Start - Wait - Loop - Switch - Loop Interrupt

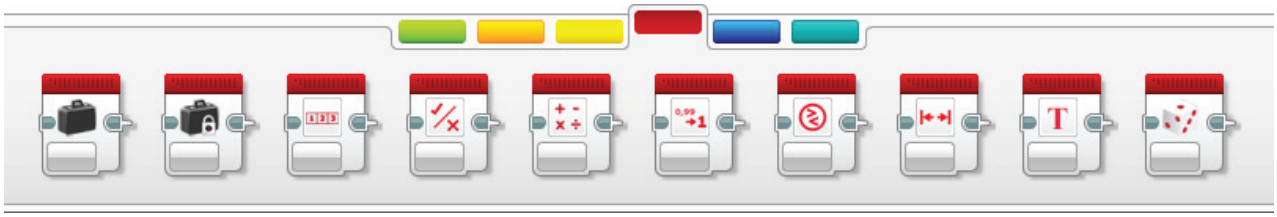
Building Blocks: EV3 Programming

3. SENSOR BLOCKS (yellow)



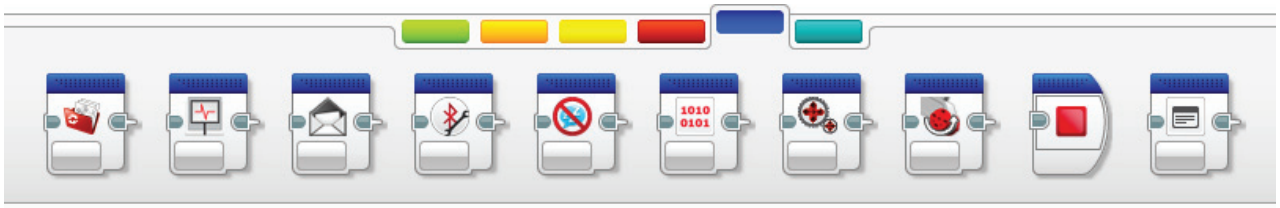
Brick Buttons - Color Sensor - Gyro Sensor - Infrared Sensor - Motor Rotation - Temperature - Timer - Touch Sensor - Ultrasonic Sensor - Energy Meter - NXT Sound Sensor

4. DATA BLOCKS (red)



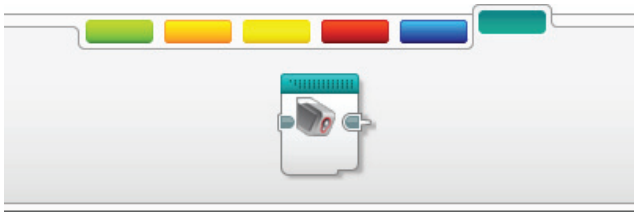
Variable - Constant - Array - Logic - Math - Round - Compare - Range - Text - Random

5. ADVANCED BLOCKS (blue)



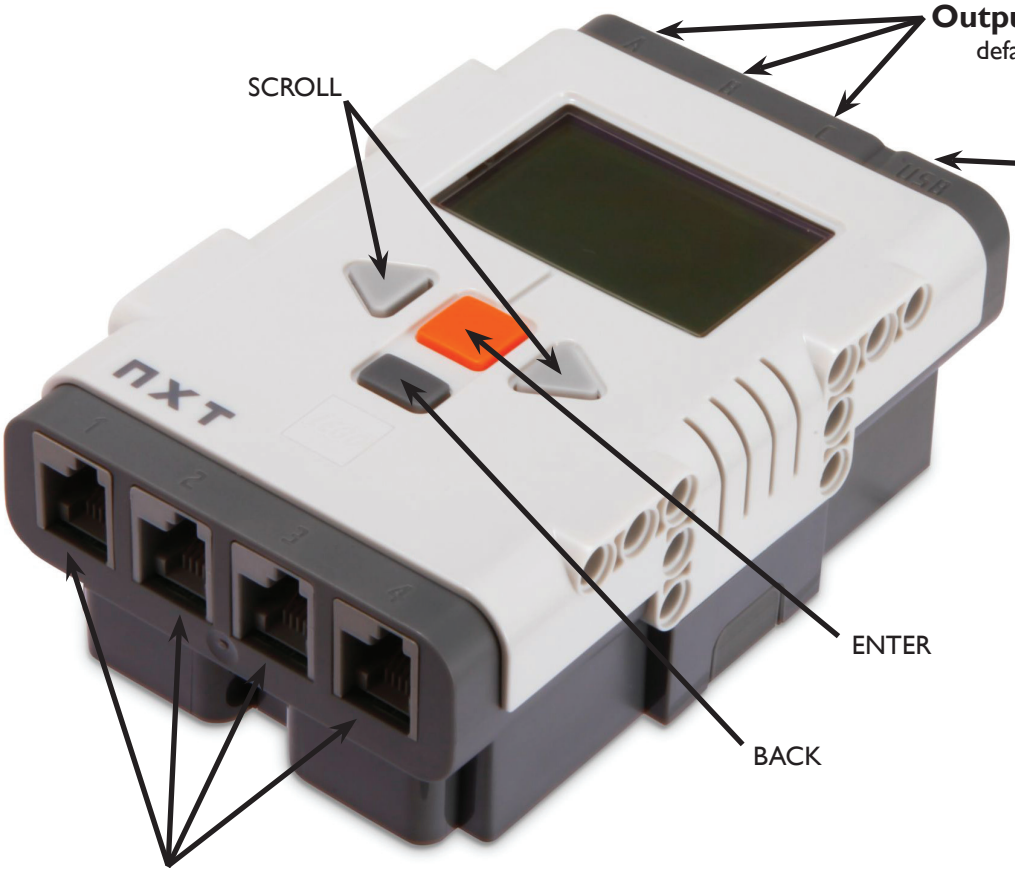
File Access - Data Logging - Messaging - BlueTooth - Keep Awake - Raw Sensor Value - Unregulated Motor - Invert Motor - Stop Program - Comment

6. MY BLOCKS (turquoise)



Custom created series of actions that need to be repeated

NXT Key Parts



Output Ports (for motors)
defaults are _____ and _____

USB Port
connect to computer

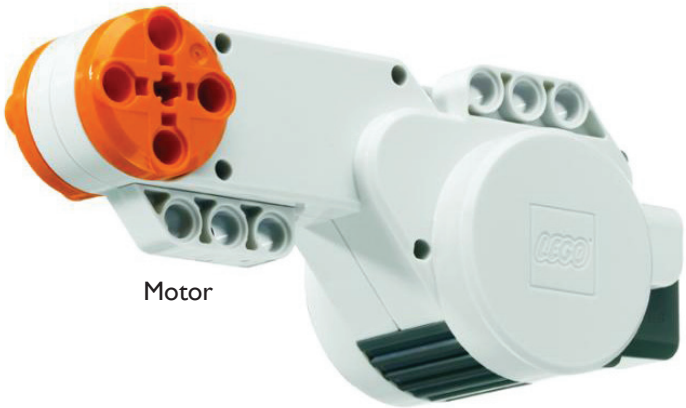
Input Ports (for sensors)
defaults are
"**T**he **S**ensor **L**ine **U**p"
_____, _____, _____, _____


Touch Sensor


Sound Sensor


Light Sensor


Ultrasonic Sensor


Motor


Color Sensor

NXT Brick Navigation Map

My Files

- Software Files
- NXT Files
- Sound Files
  - SAME FOR ALL ABOVE
    - Run
    - Send
    - Delete

NXT Program

- Setup Instructions
- Programming UI

View

- Sound dB
- Sound dBA
- Reflected Light
- Ambient Light
- Light Sensor*
- Temperature ˚C*
- Temperature ˚F*
- Rotation*
- Motor Rotations
- Motor Degrees
- Touch
- Ultrasonic Inch
- Ultrasonic cm
  - SAME FOR ALL ABOVE
    - Port 1
    - Port 2
    - Port 3
    - Port 4

Bluetooth

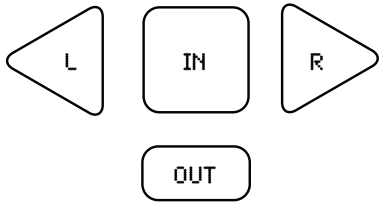
- My Contacts
  - Select
- Connections
  - 0 1 2 3
- Visibility
  - Visible
    Invisible
- On/Off
  - On
  - Off
- Search

Settings

- Volume
  - Volume UI
- Sleep
  - Sleep UI
- NXT Version
  - Version Info
- Delete Files
  - Software Files
  - NXT Files
  - Sound Files
  - Try Me Files

Try Me

- Try Me Programs

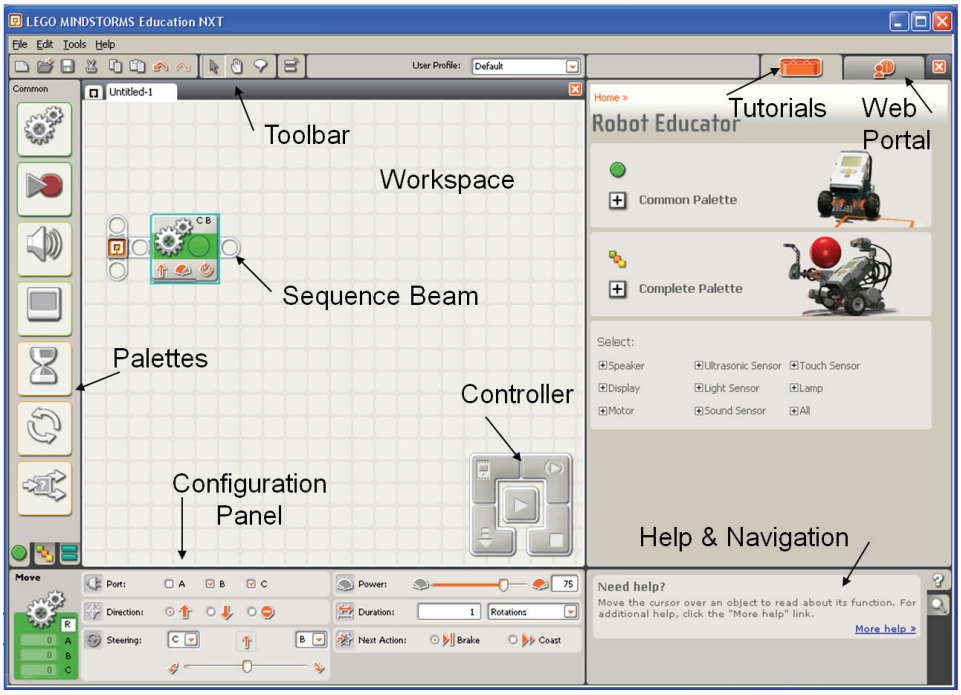


NXT Navigation Map

**indicates a legacy sensor*

LEGO education

Basic Building Blocks: NXT-G Programming



Move Block

Use this block to set your robot to go forwards or backwards in a straight line or to turn by following a curve. Define how far your robot will go by using the Duration property.

Block Variables

1. The letters at the top right corner of the block show which of your NXT's ports will be controlled.
2. The icon at the bottom left shows which direction your robot will go.
3. The icon at bottom center shows the power level. Your robot's speed may also be affected by other conditions, like the surface it is moving over or whether it is moving up or down a slope.
4. The icon at bottom right shows whether you have set the Duration property to unlimited, degrees, rotations, or seconds.

Sound Block

You can use this block to play a sound file or a single tone. To compose a melody of tones, arrange several sound blocks in a row with each set to play different tones.

If you select "Wait for completion" in the configuration panel, the sound file or tone will finish playing before the program moves on to the next block. With this item unchecked, the sound file or tone will continue to play while the next block of your program proceeds.

Choosing "Repeat" will cause a sound file to play again and again.

Block Variables

1. The icon at bottom left shows whether the block will play a sound file or a tone.
2. The icon at bottom center shows whether the block will start or stop playing a sound.
3. The icon at bottom right shows the block's volume. An icon with four orange bars is set to the loudest volume.
4. You can drag data wires from other blocks to this block's data hub that will affect the Lamp block's properties.

Wait Block

This block lets your robot sense its environment for a certain condition before it continues. Use the slider or type in a value to set a trigger point so that the program continues when sensor values are below or above it.

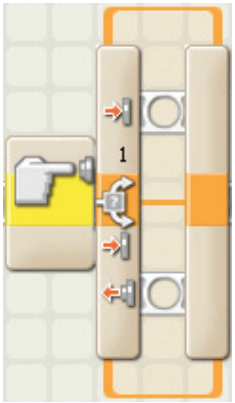
1. The number or letter at the top right corner of the Wait block shows the port the block is monitoring. The configuration panel, which is described below, will let you change ports if necessary.
2. If you have chosen to wait for a light, sound, or ultrasonic sensor, this icon indicates at what level the trigger point is set; the more colored bars displayed, the higher the trigger point. If you have chosen to wait for a touch sensor, the icon will display the touch sensor condition (bumped, pressed, or released) that will trigger the block and allow the program to move on.

Loop Block

Use this block to repeat sequences of code. Set the condition that will end the loop: elapsed time, the number of repetitions, a logic signal or a sensor. You can also set a loop to go on forever.

Block Variables

1. When a Loop block's action property is set to "Forever," an infinity symbol (∞) is displayed at the bottom of the trailing portion of the block.
2. If the "Show Counter" checkbox is selected in the configuration panel, a plug will appear that will allow you to use the number of completed loops as an input elsewhere in your program (if you connect a data wire from the plug to another block's data hub). You can also use current count to control the loop itself. (See the Count setting in the Configuring the Loop Block section below).
3. If you choose for a sensor to control the loop, the trailing portion of the Loop block will expand in size revealing an icon for the chosen sensor. For example, if you choose a Light Sensor to control the loop, a Light Sensor icon will be displayed in the expanded portion of the block. Also, any relevant information about the chosen control property will displayed at the bottom of the block.



Switch Block

Use this block to choose between two sequences of code. For example, when configured with a touch sensor, the switch block might run one series of blocks when the sensor is pressed and another when the touch sensor is not.

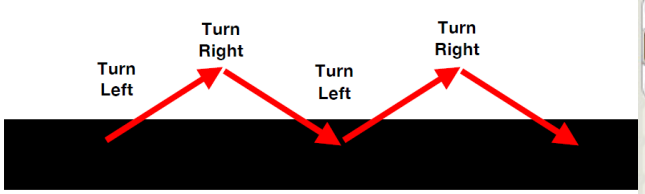
Block Variables

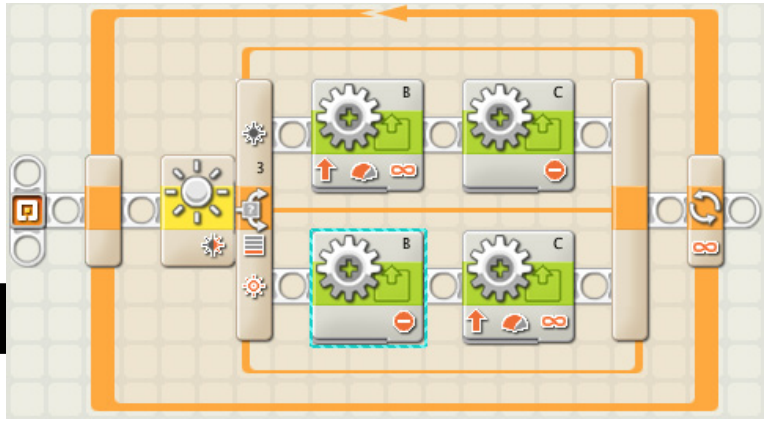
1. The icon at the beginning of the switch block indicates the sensor or other condition that will cause the block to choose between the two rows of programming blocks. In this case the current status of a touch sensor will cause the program to switch.
   - The upper blocks will run if the touch sensor is pressed.
   - The lower block will run if the touch sensor is not being pressed.

Following a LINE

ONE Sensor (2-state line follower)

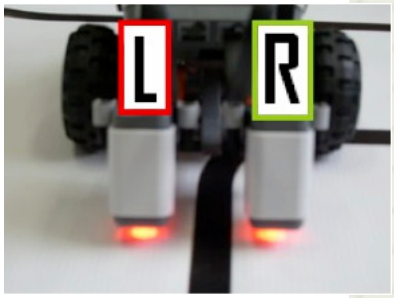
SENSOR	RESULT
white	go right
black	go left

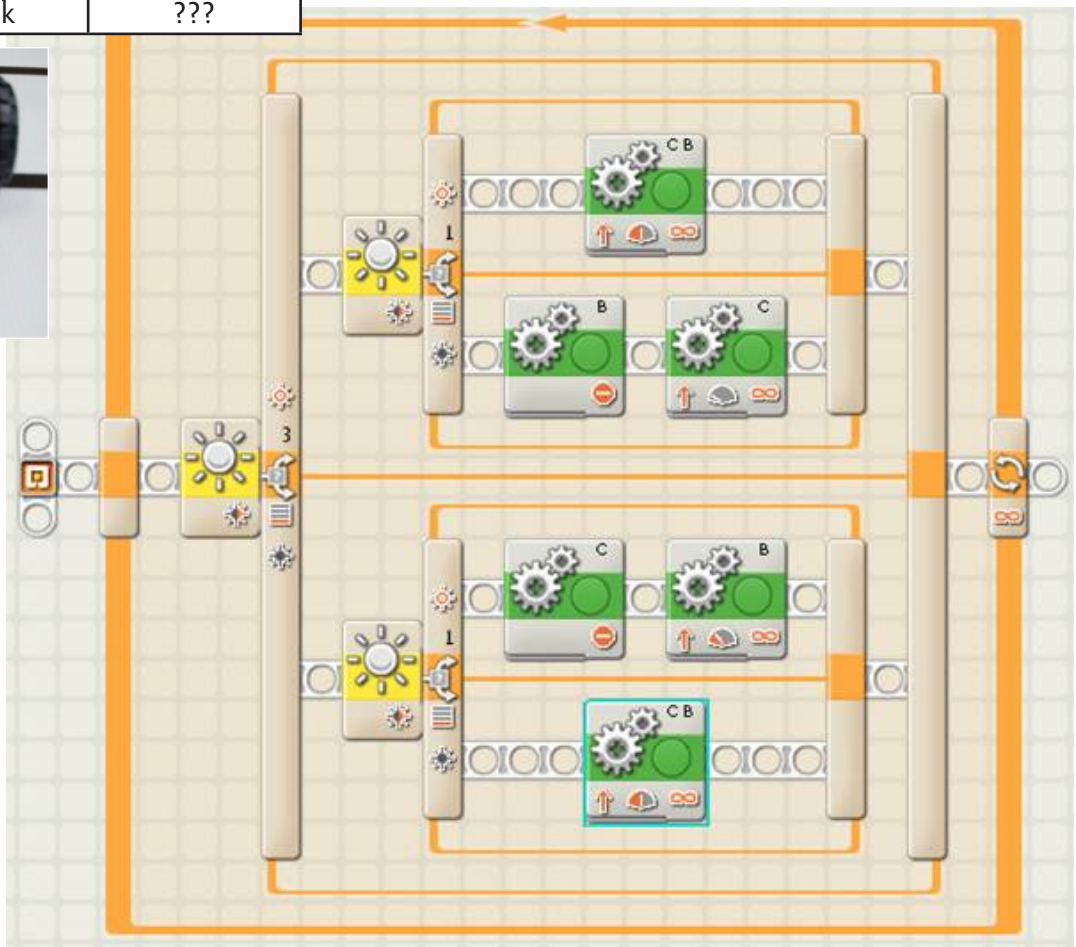




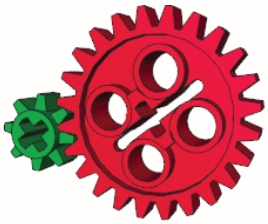
TWO Sensor (4-state line follower)

LEFT SENSOR	RIGHT SENSOR	RESULT
white	white	go straight
white	black	turn right
black	white	turn left
black	black	???



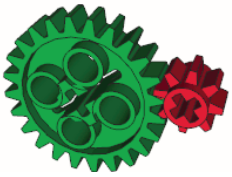


LEGO Mindstorms GEARS



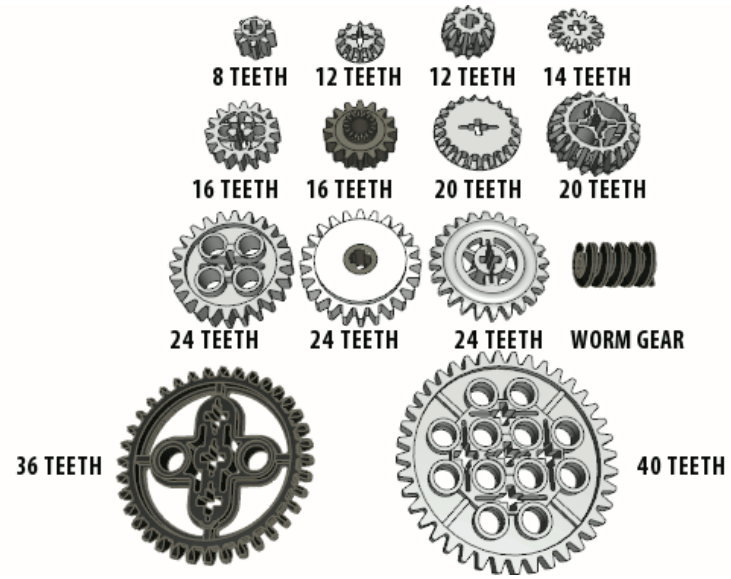
GEARING DOWN

If we drive a large gear with a small gear, we increase the **torque** but decrease the **speed.** (That is called gearing down.)



GEARING UP

If we drive a small gear with a large gear, we increase the **speed** but decrease the **torque.** (That is called gearing up.)



Driver Gear	Follower Gear	Gear Ratio (teeth)	Output Ratio (rotations)	Speed (distance ÷ time)

GEAR WEBSITES:

HowStuff Works (Gear Ratios)
http://science.howstuffworks.com/transport/engines-equipment/gear-ratio1.htm

Gears Tutorial
http://sariel.pl/2009/09/gears-tutorial/

Gear Ratio Calculator
http://sariel.pl/tools/ratios/

ROBOT DESIGN

Robot's Name:

Picture:

PERFORMANCE:

Wheel Circumference

Distance per rotation:

Straight Line Test

Distance from center after 10 feet:

Distance from center after 20 feet:

Turning Test

	degrees	*accuracy out of 5 tries*
90° turn		**5 4 3 2 1**
180° turn		**5 4 3 2 1**
360° turn		**5 4 3 2 1**

Modifications or
Special Features:

Course Information Sheet

Challenge: _____

Sensor Values:

Color/Object	Practice Course	Real Course

Color/Object	Practice Course	Real Course

Things We Notice about the Course:

-
-
-
-
-
-
-

Ideas:

Group:

Date:

Goal:

Results:

Next Time:

Course Planning Sheet

Mission: _____ Phase: _____ Team: _____

Objective:

Sketch:

Steps in Task:

Navigation Landmarks:

Parts Needed / Data Collected:

Things to try:

Limitations / Restrictions:

Planning Sheet

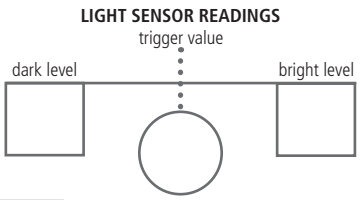
Program Name: _____

task:

sketch of robot:

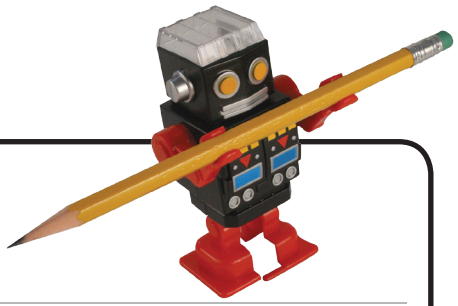
steps in task:

sensor readings:



notes / reflection:

TODAY'S REFLECTIONS



Something I learned today:

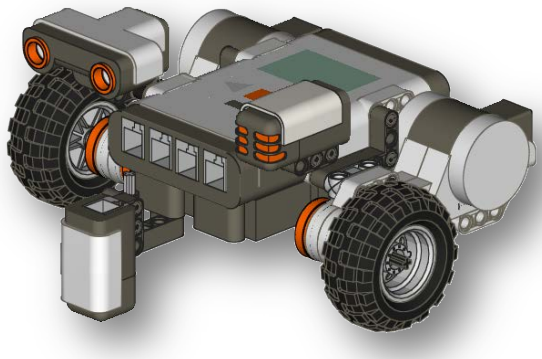
My favorite "Discovery" (can be an "ah-ha", or something that went right or wrong):

Tomorrow I would like to try:

Robotics
RESOURCES

GOOD BOOKS:

Building Robots with LEGO Mindstorms NXT
(Dave Astolfo - Syngress Press)



Classroom Activities for the Busy Teacher: NXT
(Damien Kee - Cafe Press)

LEGO Mindstorms NXT-G Programming Guide
(James Floyd Kelly - Apress)

LEGO Mindstorms NXT: The Mayan Adventure
(James Floyd Kelly - Apress)

Winning Design! LEGO Mindstorms NXT Design Patterns for Fun and Competition
(James J. Trobaugh - Apress)

LEGO Mindstorms NXT One-Kit Wonders
(James Floyd Kelly - No Starch Press)

GOOD WEBSITES:

The NXT Step
http://www.thenxtstep.com/

Domabotics
http://www.damienkee.com/

DrGraeme
http://drgraeme.net/

HowStuffWorks (Gear Ratios)
http://science.howstuffworks.com/transport/engines-equipment/gear-ratio1.htm

McAuliffe Robotics
http://smithlearning.com/robotics/

COMPARING THE NXT & EV3:

http://robotsquare.com/2013/07/16/ev3-nxt-compatibility/

http://botbench.com/blog/2013/01/08/comparing-the-nxt-and-ev3-bricks/

http://www.legoeducation.us/eng/misc/comparingEV3andNXT.cfm