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ROBOFEST

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EV3 Software

EV3 Robot

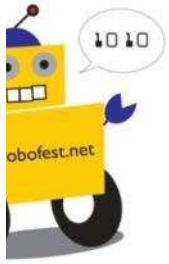
Workshop

Instructor: Prof Keith Bozin

Assistants: Chris Parker

Lawrence Technological University





Course Overview

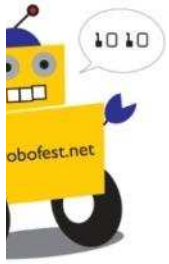
- 2014 RoboFest competition Avoid Meltdown
- Omnibot introduction
- Using the Omnibot to solve the Avoid Meltdown challenge



2014 RoboFest competition

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- Video overview
 - <http://www.youtube.com/watch?v=dFG2KL26I7U&feature=youtu.be>
- Key tasks
 - Edge follow and search for the building
 - Measure the width of the building
 - Deliver the tennis balls and egg
 - Return home
 - Compute the building volume



2014 RoboFest competition

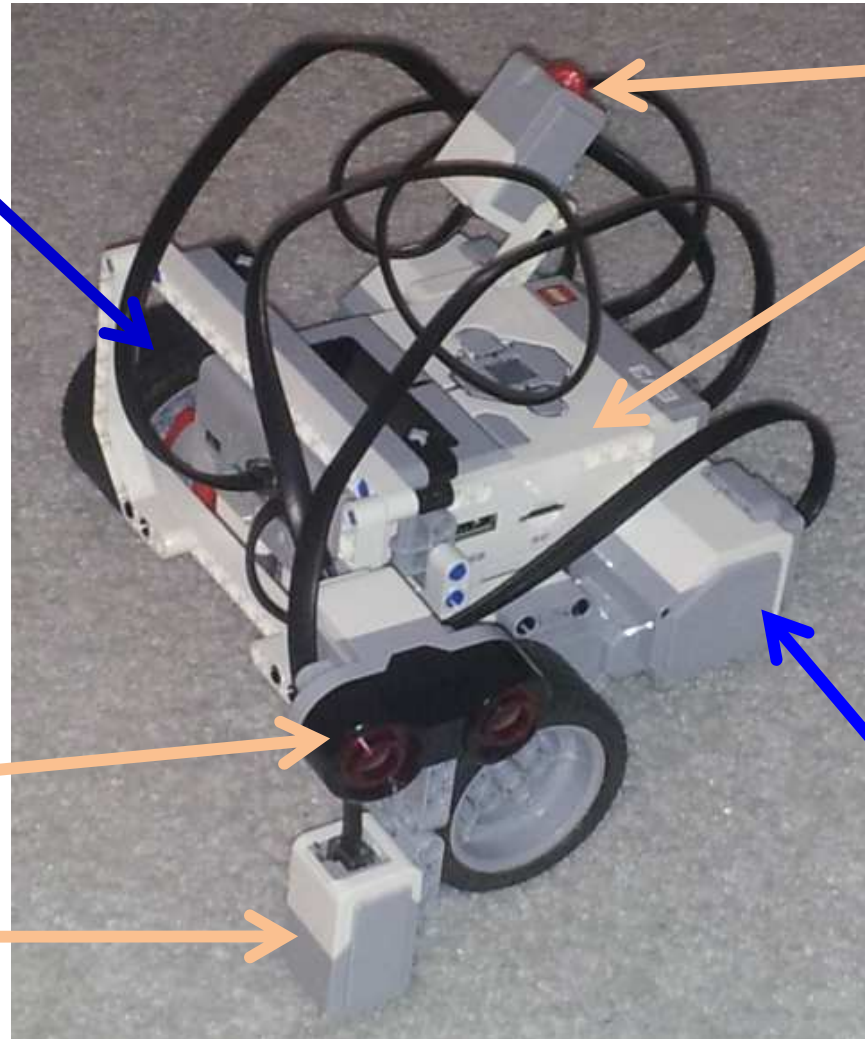
- Please note that the delivery of the tennis balls and egg are beyond the scope of this workshop
- Here are some basic ideas for delivery
 - Utilize motor deliver the balls
 - Drive a claw or arm to hold and drop the balls in the building
 - Open a door that releases a ball into the building
 - Shoot or throw the ball into the building



Lego EV3 robot used – Omnibot

Right Motor: C

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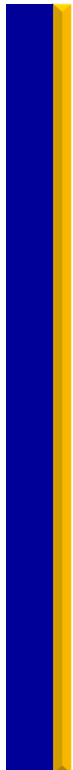
Touch Sensor

EV3 Brick

Left Motor: B

Sonar Sensor

Color Sensor





Remember the connections!

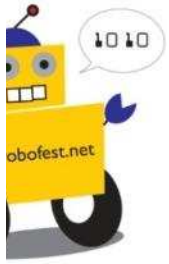
- Left Motor connects to **B**
- Right Motor connects to **C**
 - If your motors are upside down forward will be backwards in your program
- Color sensor connects to port no. **1**
- Touch sensor connects to port no. **2**
- Sonar sensor connects to port no. **4**

Please note that the retail version of EV3 uses an infrared sensor, not a sonar sensor.



EV3 Versions Used

- Examples use EV3 Educational Version 1.0.1
- EV3 Firmware version: V1.03E
- All example programs in file:
Robofest_Workshop_EV3.ev3



Other EV3 Versions

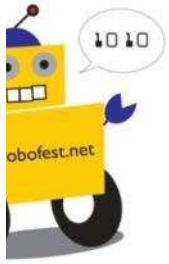
- LEGO offers a home edition of the EV3 software
- It is free to download and use, but has some limitations
 - No experiments
 - Limited sensor support
- Download at

<http://www.lego.com/en-us/mindstorms/downloads/software/ddsoftwaredownload/download-software/>



Solving The Key Tasks

- Solution algorithm
 - Edge follow and search for the building
 - Measure the width of the building
 - Return home
 - Compute the building volume



Task 0

Move forward and stop when edge of the table is reached

Watch the YouTube videos at:
<http://youtu.be/T70UHOUTs48>

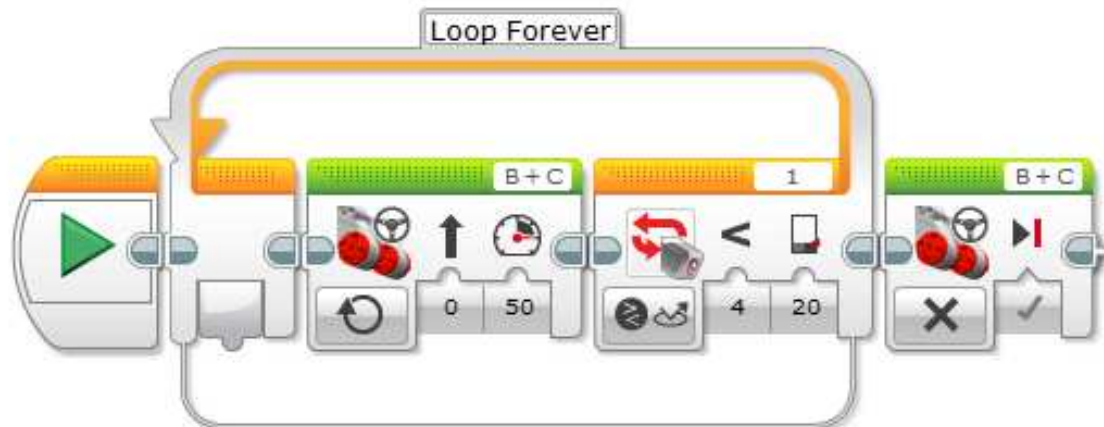


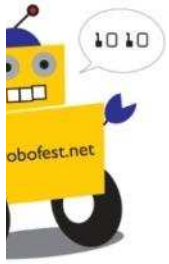
Task 0: Example Solutions

- Using wait block



- Using loop block





Task 1

Edge follow and search for the building

Watch the YouTube videos at:

<http://youtu.be/ksok9bfyYB4>



Solving The Key Tasks

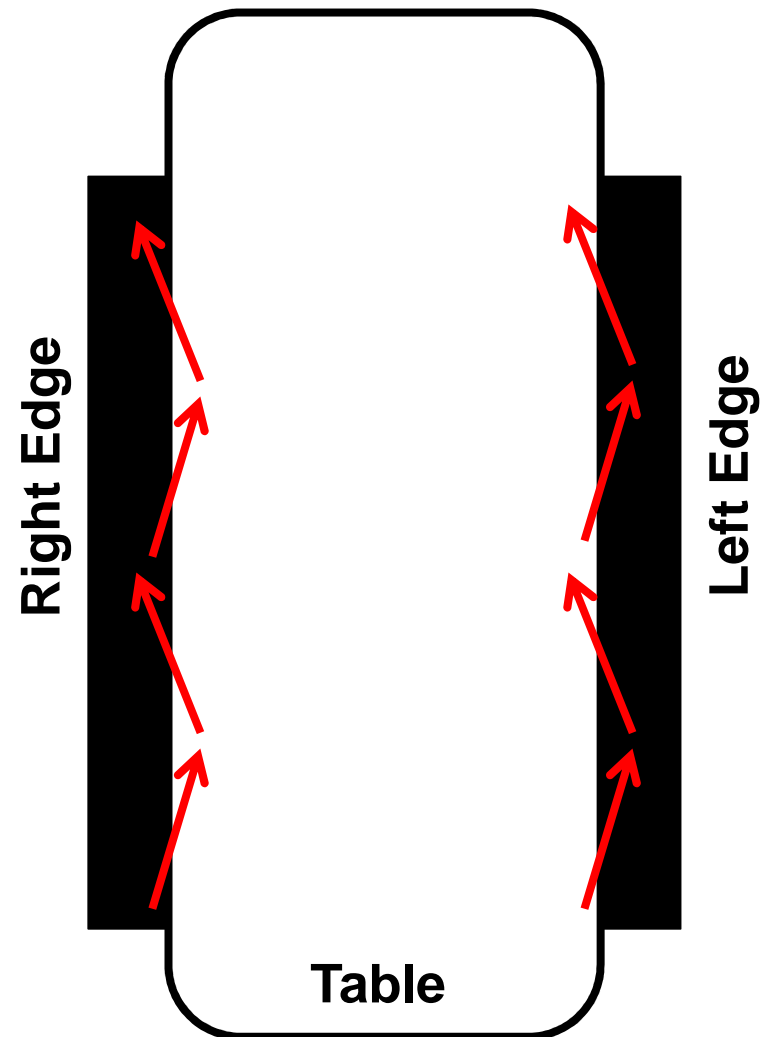
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- Solution algorithm
 - **Edge follow and search for the building**
 - Measure the width of the building
 - Return home
 - Compute the building volume



Follow The Edge Of The Table

- Use the zig-zag method to follow the edge of the table
- Edge following is also referred to as line following
- We need to determine when the robot is on or off the table
- Robot must stop when the building is found



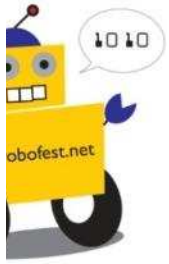


Follow The Edge Of The Table

- Get color sensor values to determine when the robot is **on** or **off** the table. We will use the color sensor in Reflective Light Intensity mode.
 - Off table = _____
 - On table = _____
 - On foil = _____

Color
Sensor
Reading

A	B 2	C 0	D
1 78	2 8764	3 0	4

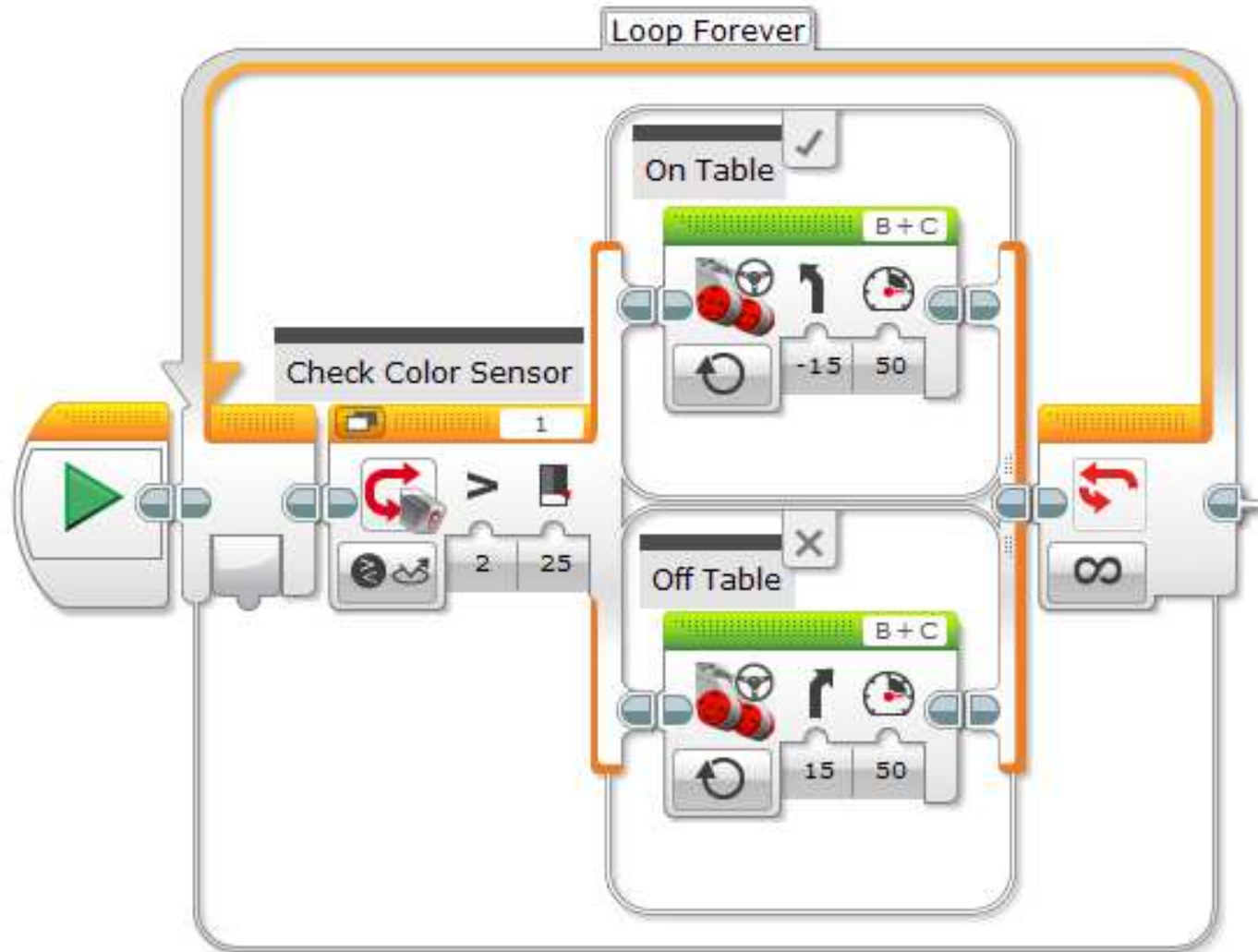


Follow The Edge Of The Table

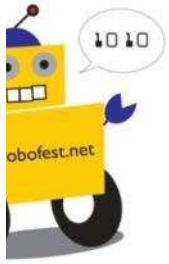
- Light sensor settings example
 - Off table = 10
 - On table = 40
 - Median threshold = $(10+40)/2 = 25$
- Two cases
 - Light sensor reading > 25 . On table.
 - Light sensor reading < 25 . Off table.



Simple Line Following Algorithm

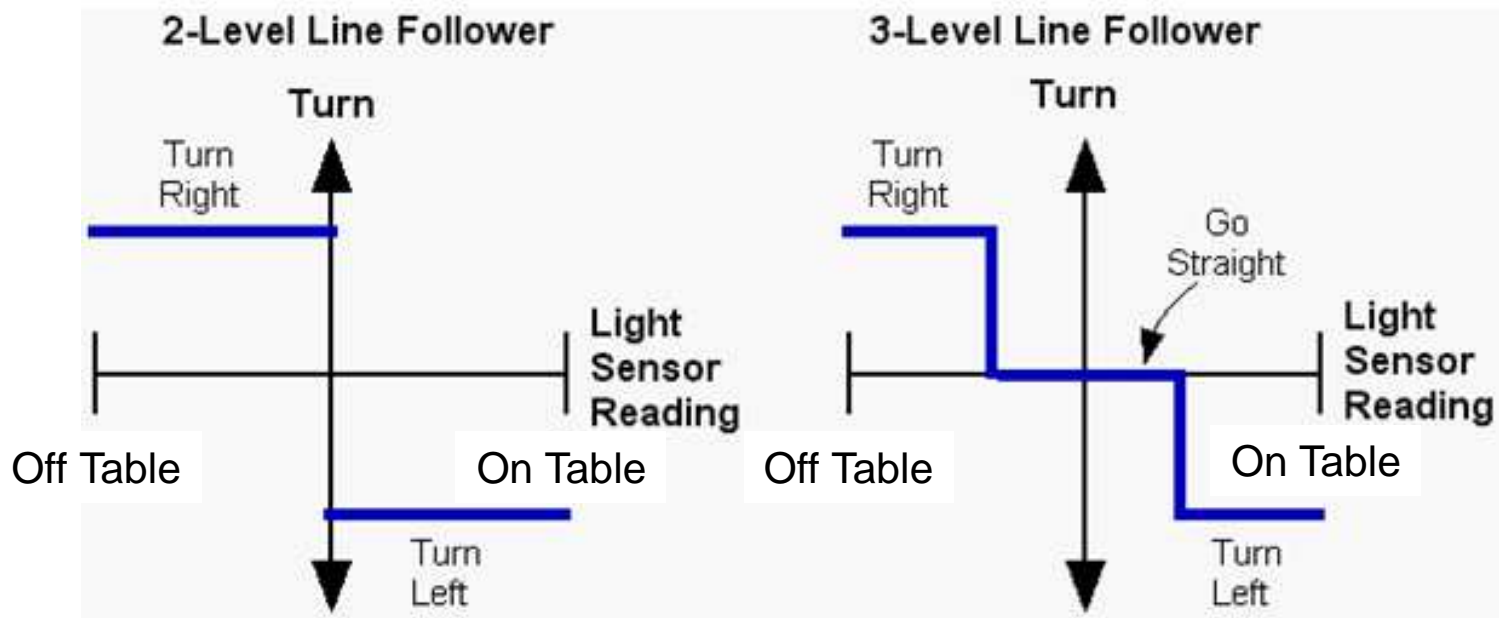


Program: LineFollowZZ.ev3



How to improve our line following algorithm

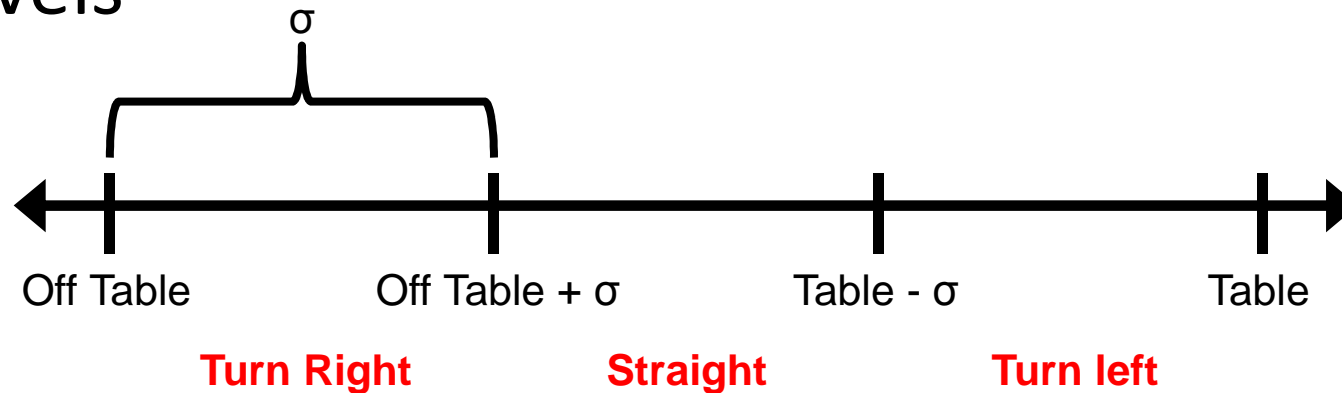
- Zig-zag method can cause a bumpy response
- We can improve the performance by using a more sophisticated algorithm





3-Level Line Follower

- Divide light sensor reading range into three levels



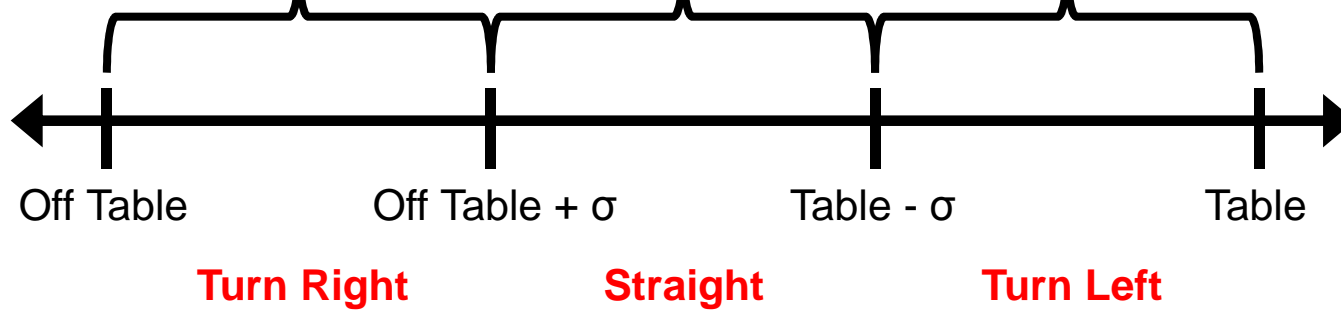
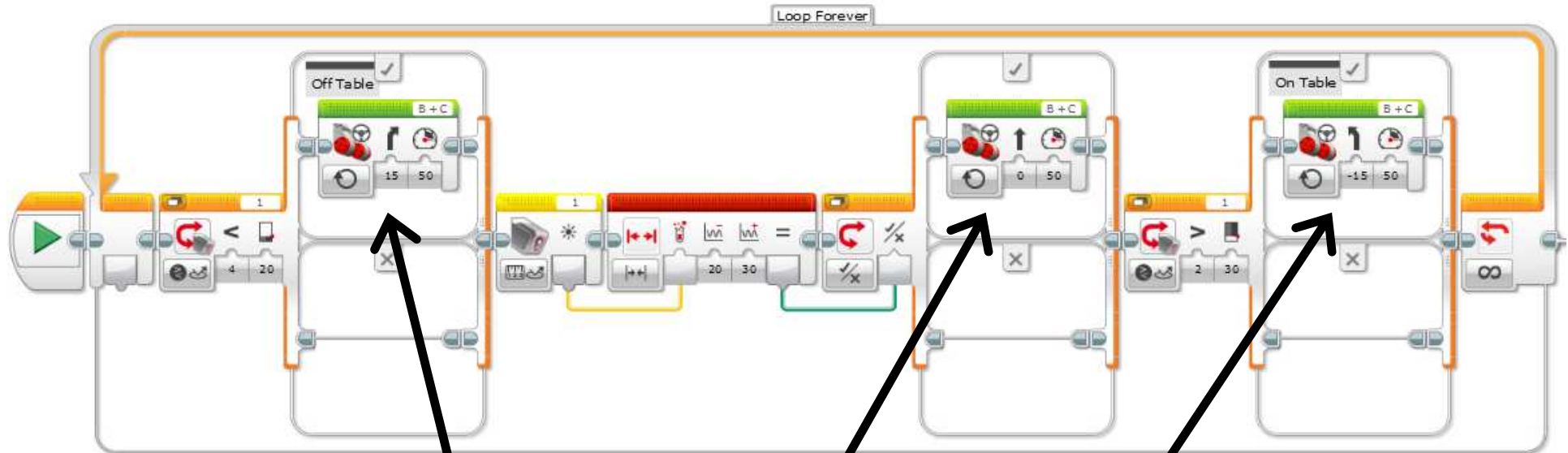
- For your robot

Off Table = 10 Table = 40 σ = 10

Off Table + σ = 20 Table - σ = 30



Three State Line Following

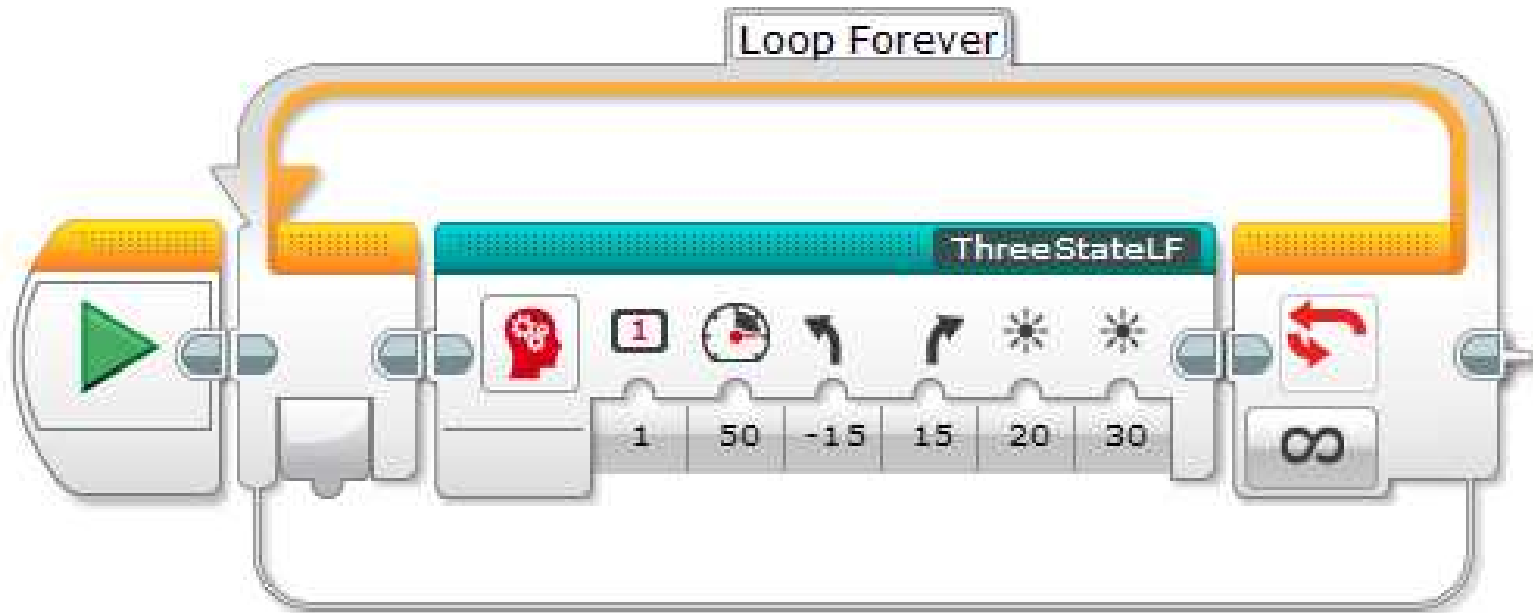


Program: LineFollowThreeState.ev3

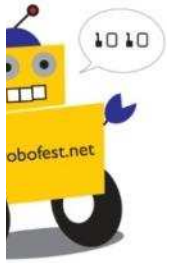


Three State Line Following My Block

- Simplify program by using the three state line following my block included in the Robofest Workshop project files

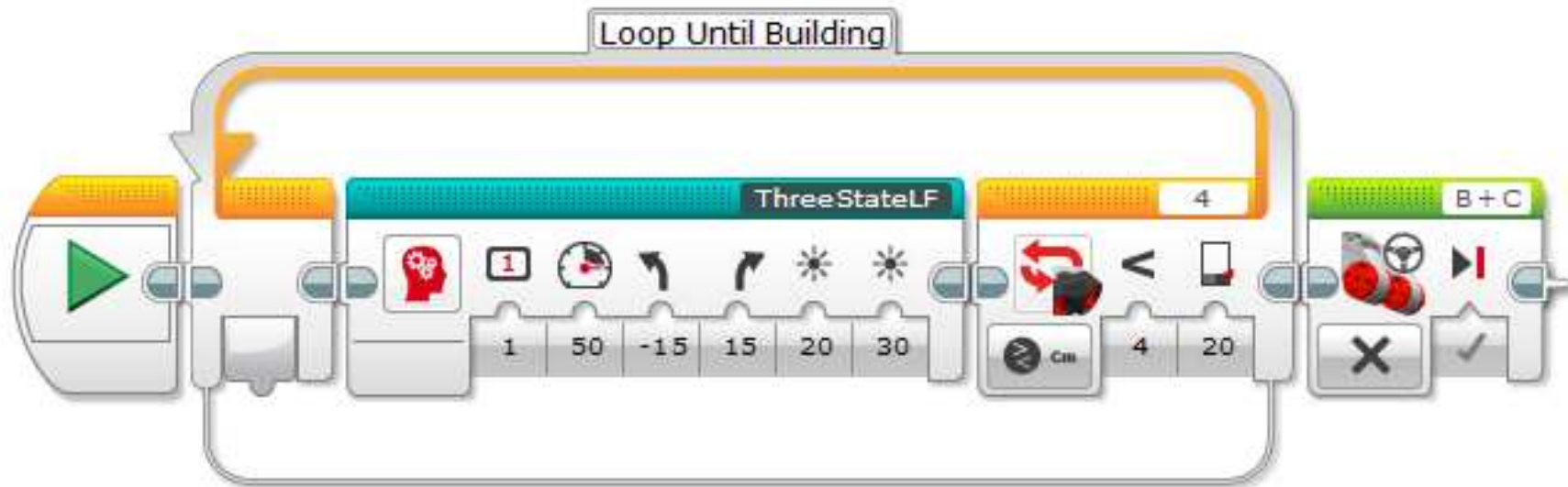


Program: LineFollowMyBlock.ev3



Stopping At The Building

- The last step is to instruct the robot to stop when it reaches the building
- Will use a sonar sensor to end the loop



Program: LineFollowStop.ev3

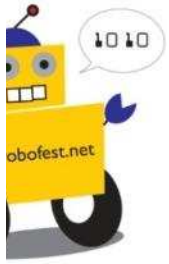


Task 2

Measure the width of the building

Watch the YouTube videos at:

<http://youtu.be/omX6h61myrk>



Solving The Key Tasks

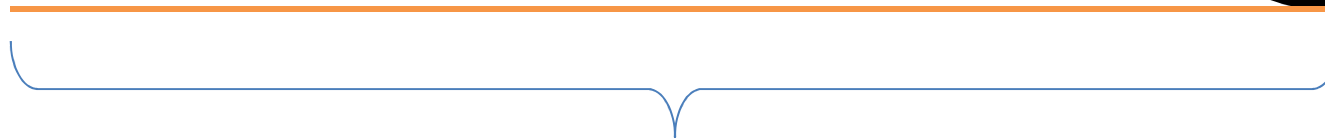
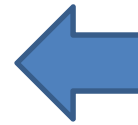
- Solution algorithm
 - Edge follow and search for the building
 - **Measure the width of the building**
 - Return home
 - Compute the building volume



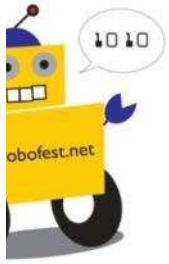
Measure Distances

- Determine how far the robot travels moving forward for 2 seconds

**Compute distance traveled
by measuring the number
of rotations of the wheel**

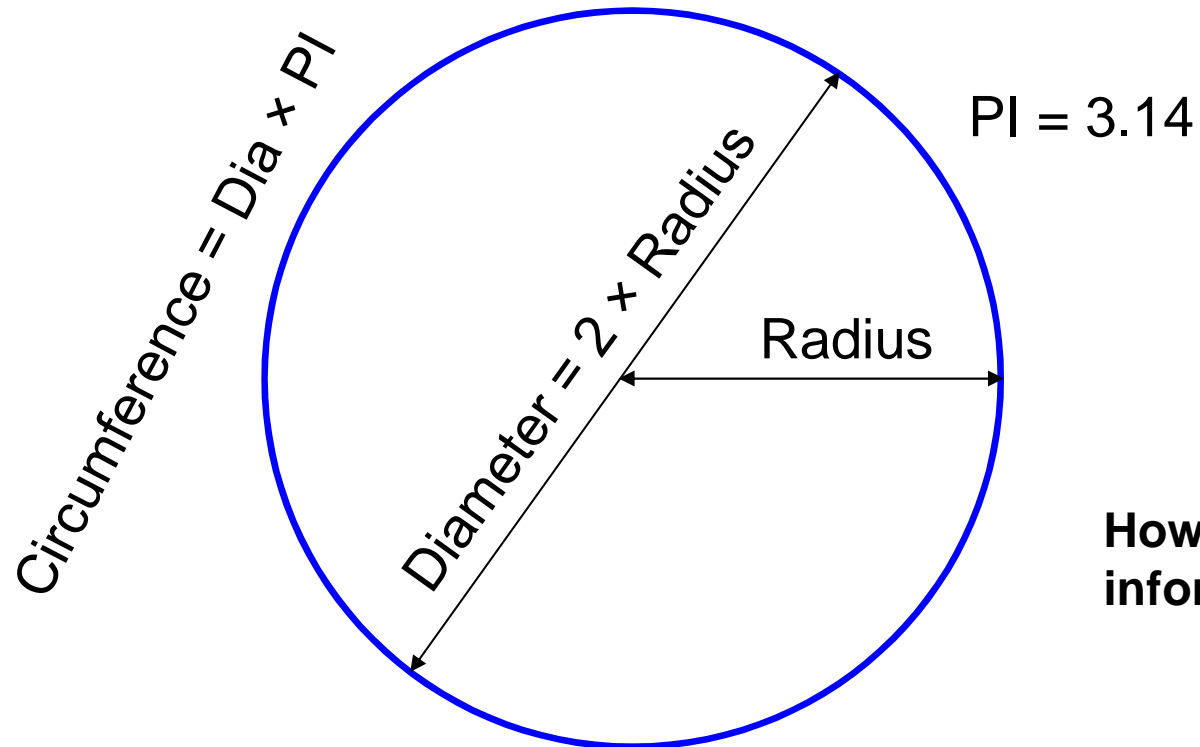


Distance



Measure Distances

- Use the wheel geometry

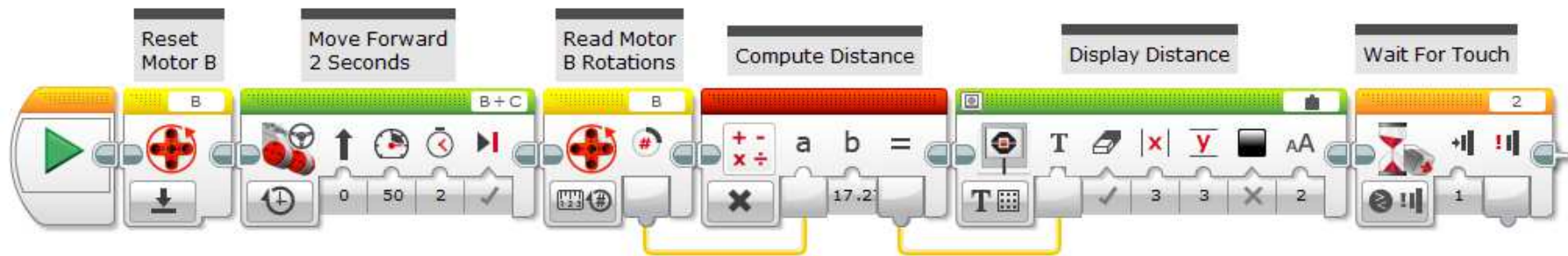


How can use this information?

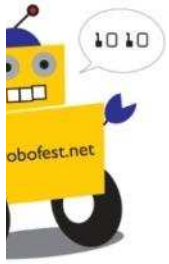


Measure Distances

- For each rotation of the wheel, the robot will travel (Wheel Diameter) x (PI)
 - Distance = (Wheel Diameter) x (PI) x (# Rotations)

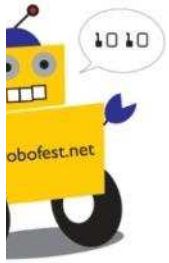


Program: MeasureDistance.ev3



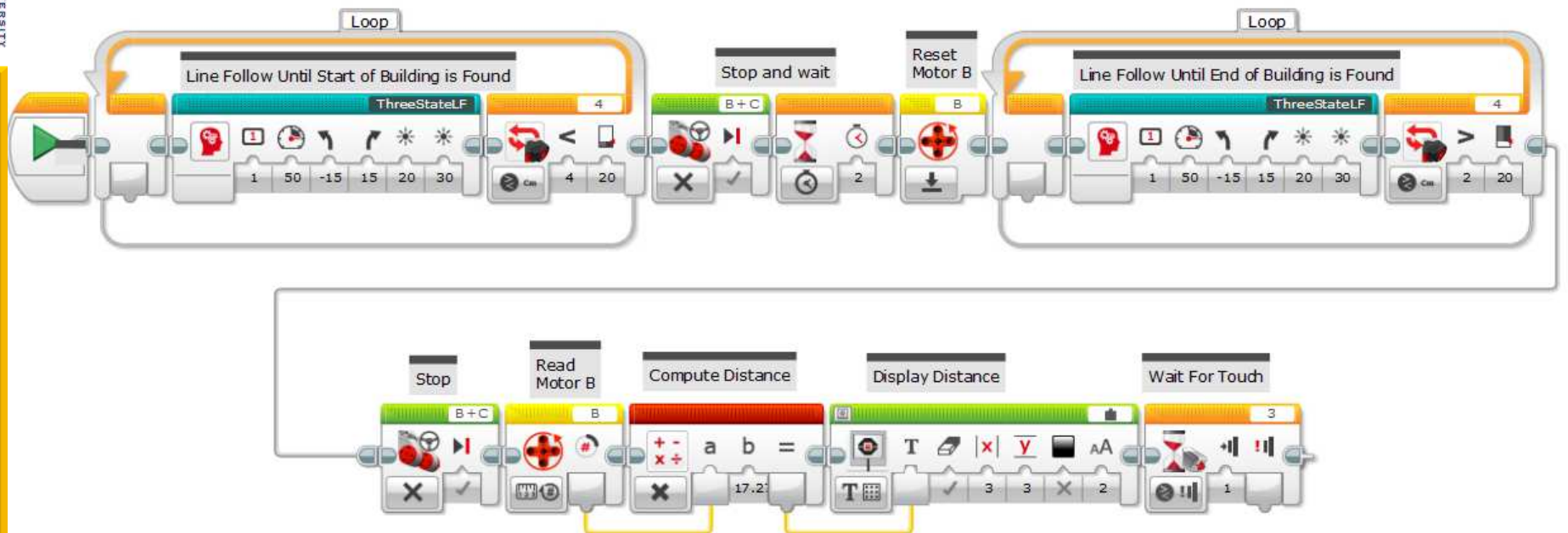
How to measure the building width

- One method would be:
 - Edge follow until building is reached
 - Stop
 - Reset motor sensor
 - Edge follow until the end of the building is reached
 - Stop
 - Compute the distance traveled



How to measure the building width

- Example of measuring building width



Program: MeasureBuilding.ev3



Task 3

Return home

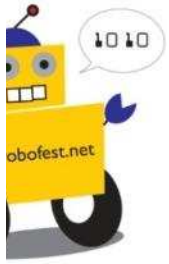
Watch the YouTube videos at:

<http://youtu.be/DBG-7FEejX0>



Solving The Key Tasks

- Solution algorithm
 - Edge follow and search for the building
 - Measure the width of the building
 - **Return home**
 - Compute the building volume



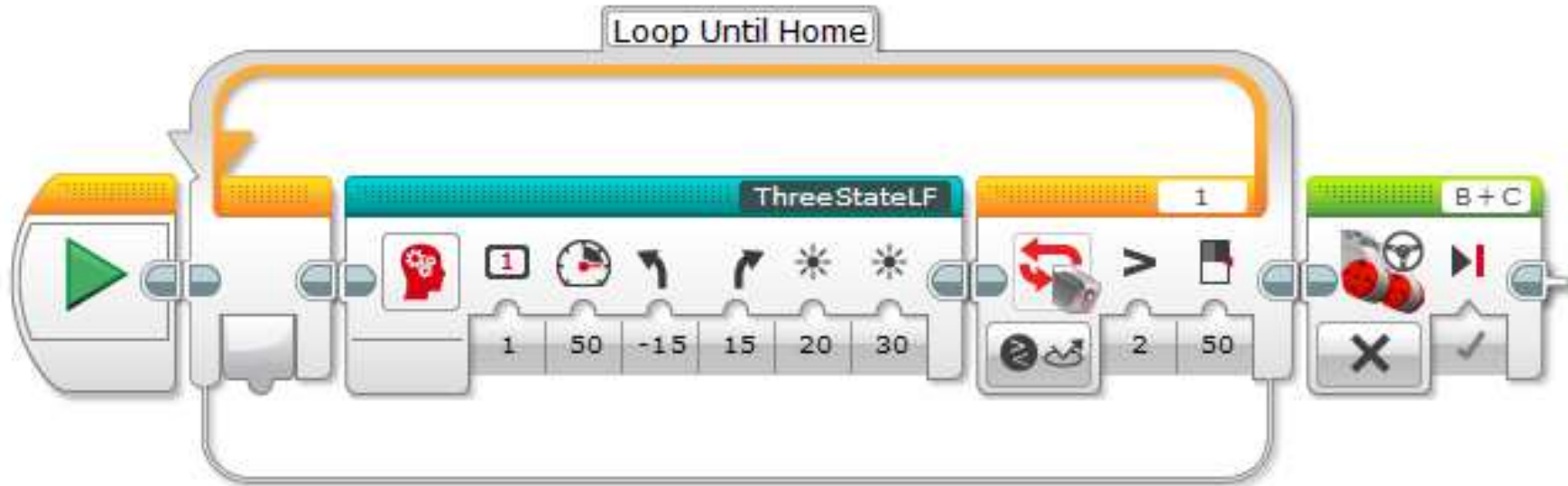
Return Home

- One method to have the robot return home is to line follow until home base is detected
- Using the same principal as line detection, we can determine the threshold for detecting home base
 - On table / off home base = 40
 - On home base = 60
 - Median threshold = $(40+60)/2 = 50$

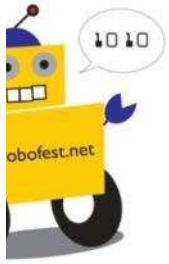


Return Home

- Two cases
 - Light sensor reading > 50 . On home base.
 - Light sensor reading < 50 . Off home base.



Program: FindHome.ev3



Task 4

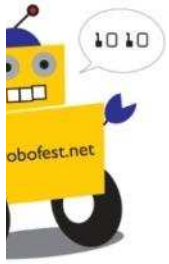
Compute the building volume



Solving The Key Tasks

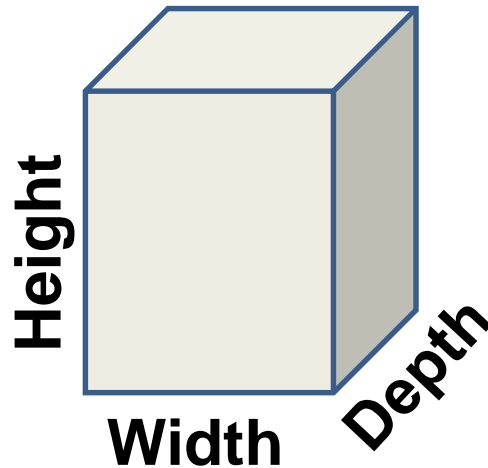
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- Solution algorithm
 - Edge follow and search for the building
 - Measure the width of the building
 - Return home
 - **Compute the building volume**



Compute The Building Volume

- To measure the building, we treat the building as a rectangular prism.



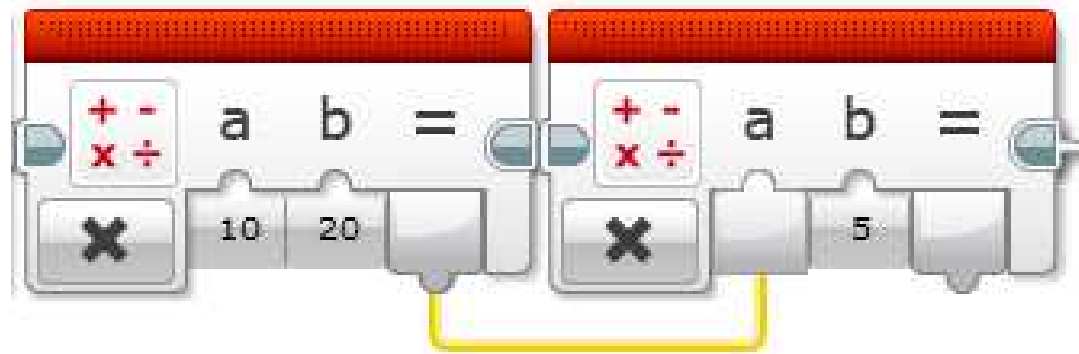
$$\text{Volume} = \text{Width} * \text{Depth} * \text{Height}$$

Please note that the depth and height are given at competition.



Compute The Building Volume

- We can use a math block to compute the building volume
- Math blocks can add, subtract, multiply or divide two numbers
- An example on how to compute $10 * 20 * 5$





Putting It All Together

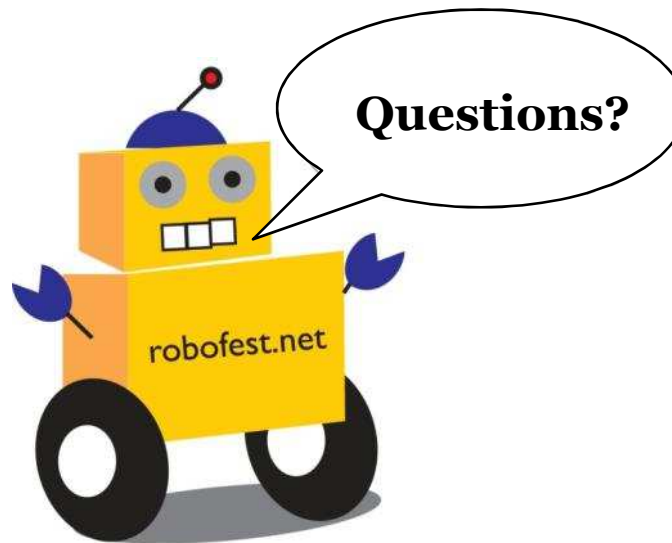
- In this course we learned how to
 - Follow the edge of the table and find the building
 - Measure the width of the building
 - Return home
 - Compute the building volume



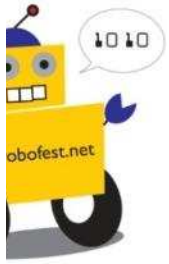
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Little Robots, Big Missions



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