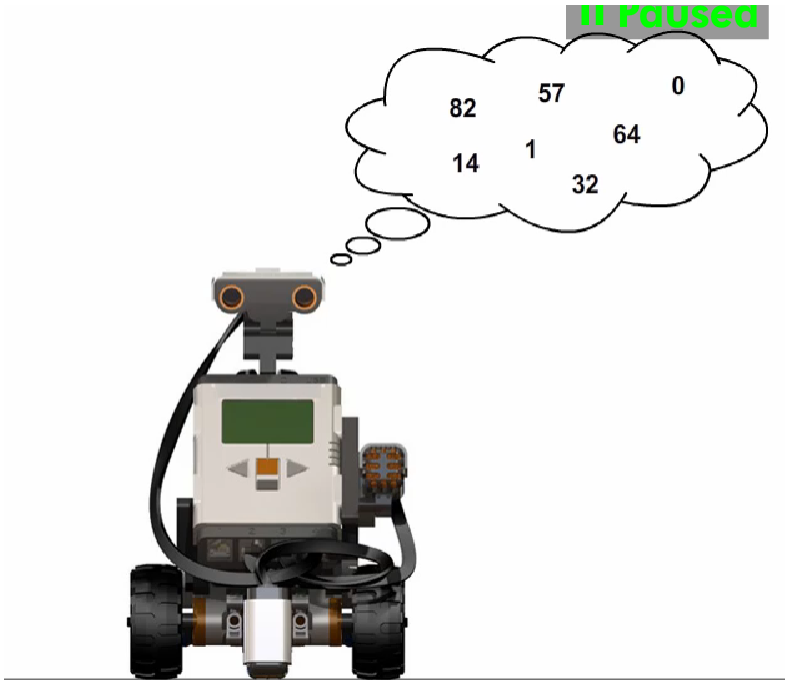
CISC 1003 - EXPLORING ROBOTICS

ROBOT DECISION MAKING

CISC1003

How a Robot Thinks

- Robot can ‘learn’ the world using their sensors
- Sensors return data in number format



http://cmra.rec.ri.cmu.edu/previews/nxt_products/nxt_video_trainer2/

How a Robot Thinks

- The robot can answer ‘yes’ or ‘no’ questions
- Example:
  - Is the touch sensor bumped?
  - Is the audio level in the room above 50%?
- This ability is based on a special logic
  - Called ‘***Boolean logic***’

How a Robot Thinks

- Programmers can give the robot its decision-making capability
  - By combining the numbers provided by the sensor with robot ability to answer questions
- This requires the following:
  - Robot is programmed to ask questions
  - Act one way if the answer is ‘yes’
    - and another if the answer is ‘no’

How a Robot Thinks

- Boolean operators are used when asking the questions, such as:
  - < ‘less then’ ,
  - > ‘more than’,
  - == “equal to’
  - etc.

How a Robot Thinks

- Example: We want the robot to stop moving before it runs into a wall
  - Use the feedback from an ultrasonic sensor
  - Use ‘less than’ operator
    - with a certain distance threshold
      - E.g., 10 inch
- This will result in a program that moves the robot until it detects an obstacle
  - Within the distance specified (10 inch)

How a Robot Thinks

- How does the program work?
- The robot moves forward
- It repeatedly asks the questions:
  - “Am I 10 inch away from anything?”
- If the answer is no, the robot continues moving forward
  - If the answer is ‘yes’, it stops

Conditional Statements

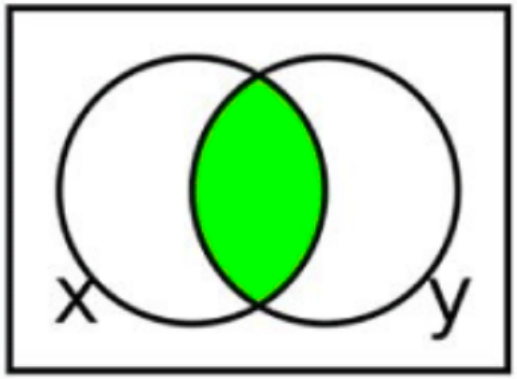
- The parts of the program where the robot choose an action
  - Depending on a certain condition
    - Typically expressed as Boolean values

Boolean Expressions

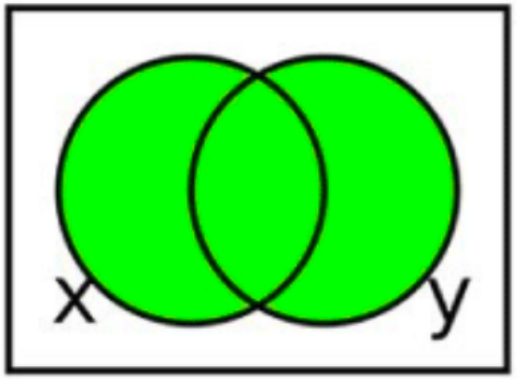
- boolean expression: A logical statement that results in a boolean value
  - either be True or False
- Boolean values are expressed by:
  - True
    - Can also be expressed by the number 1 and ‘Yes’ value
  - False
    - Can also be expressed by the number 0 and ‘No’ value

Boolean Algebra Operations

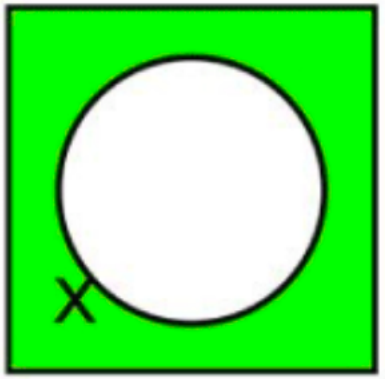
- There are three basic operations:
  - AND operation
  - OR operation
  - NOT operation



$x \wedge y$



$x \vee y$



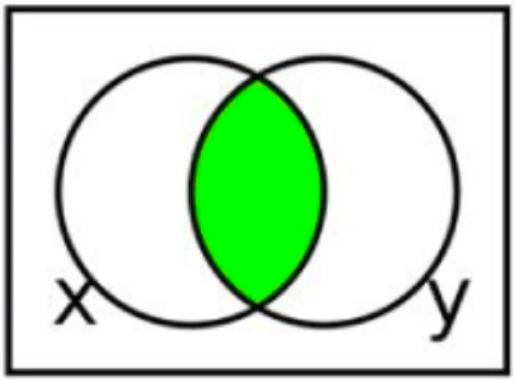
$\neg x$

https://byjus.com/maths/boolean-algebra/

Boolean Algebra Operations

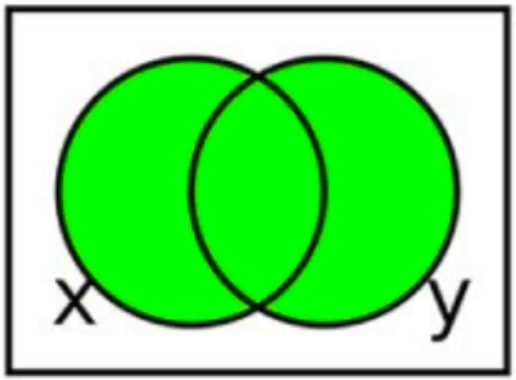
- There are three basic operations:

AND



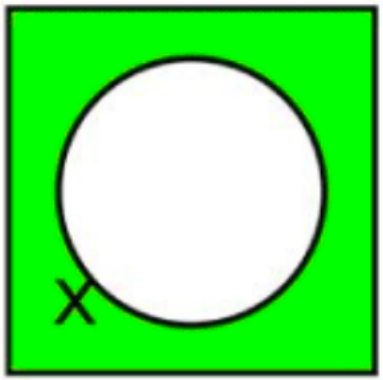
$x \wedge y$

OR



$x \vee y$

NOT



$\neg x$

https://byjus.com/maths/boolean-algebra/

Truth Tables

A	$\neg A$
True	False
False	True

A	B	A∩B (AND)	A∪B (OR)
True	True	True	True
True	False	False	True
False	True	False	True
False	False	False	False

Precedence of operations

- Operators are used in order of precedence
  - To change order, use brackets for operations that should be done first

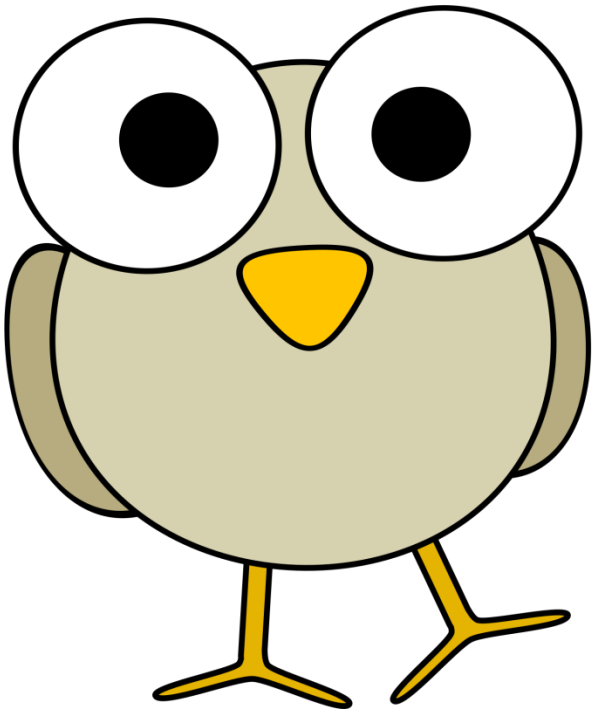
Operator	Symbol	Precedence
NOT	‘ (or) ¬	Highest
AND	. (or) ∧	Middle
OR	+ (or) ∨	Lowest

https://byjus.com/maths/boolean-algebra/

Precedence of operations

- Example:
  - $\neg 0 \cup 1 = ?$
  - $\neg(0 \cup 1) = ?$

https://byjus.com/maths/boolean-algebra/



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Precedence of operations

- Example:
  - $\neg 0 \cup 1 = 1 \cup 1$ = ?
  - $\neg(0 \cup 1) = \neg 1$ = ?

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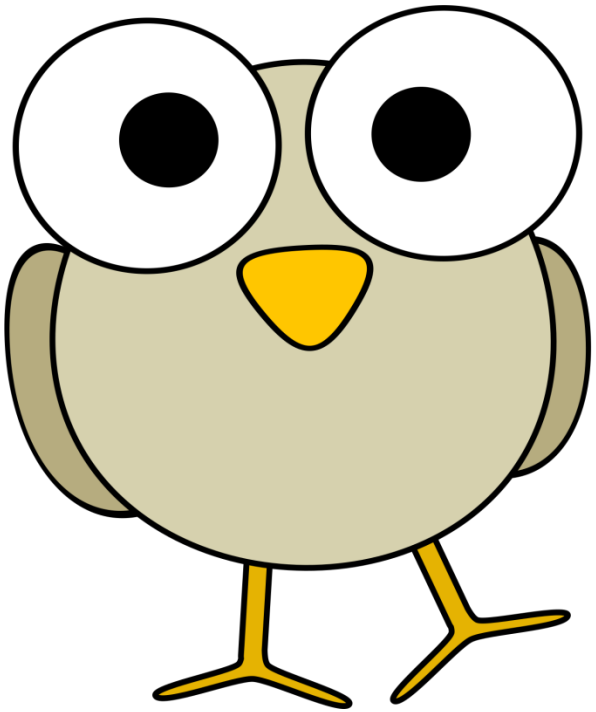

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Precedence of operations

- Example:
  - $\neg 0 \cup 1 = 1 \cup 1 = 1$
  - $\neg(0 \cup 1) = \neg 1 = 0$

https://byjus.com/maths/boolean-algebra/

Summary

- We can create conditional statements
  - by combining sensor output and Boolean operators
- This allows the robot to make decisions

How a robot thinks

- What kinds of questions can a robot ask?
  - “yes” or “no” questions
  - Questions that have only two possible answers
- What can a robot do with the answer to the question?
  - Use the answers to choose between two different actions
    - E.g., move forward or stop


QUESTIONS