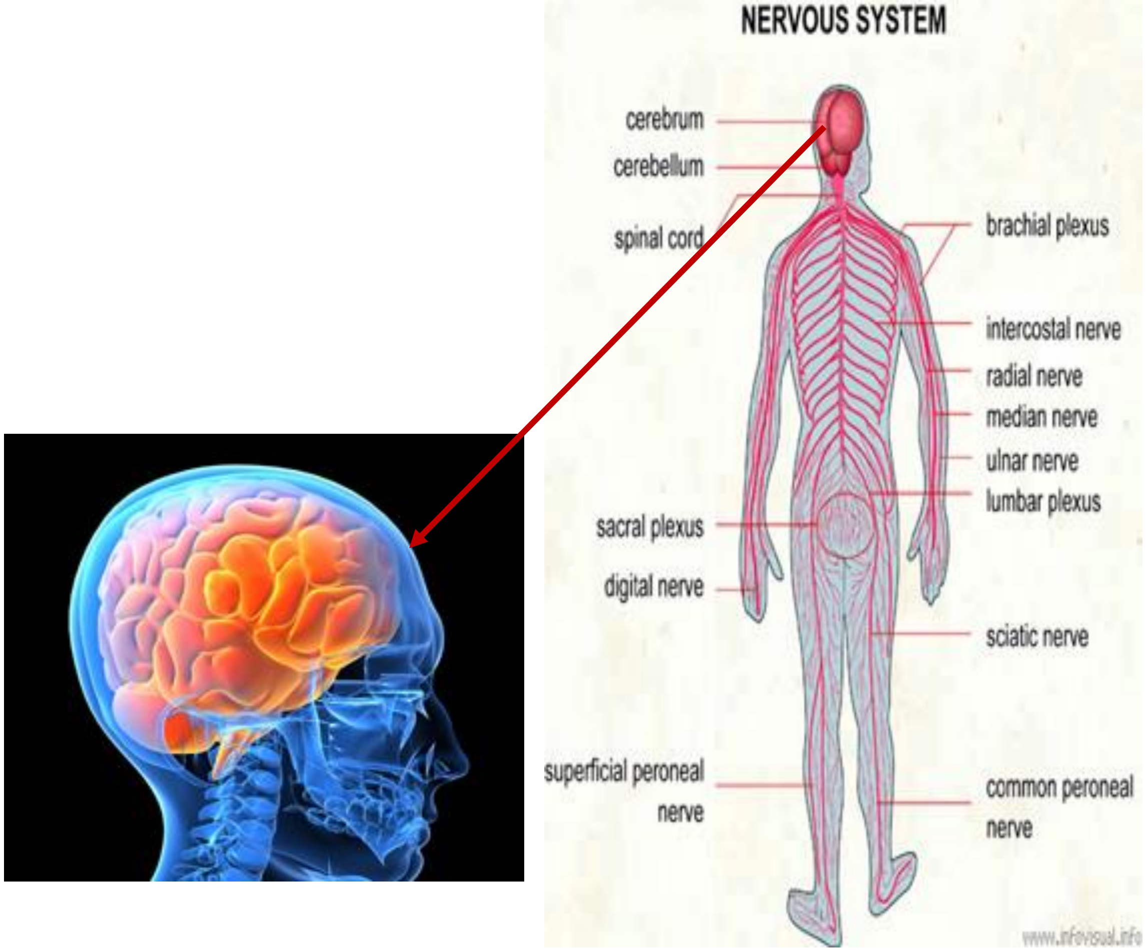
TeachEngineering

THE BRAIN AND THE NERVOUS SYSTEM ARE A COMPUTER

LEARNING OBJECTIVES

1. A review of how a human compares to a robot, to set the context for the lesson.
2. Comparisons of the human brain with the robot computer.



DAY 1 PRE-ASSESSMENT SHEET

THE BRAIN IS A COMPUTER?

1. Describe how your brain helps you command your arm to pick up a glass of juice.

2. Your brain is the controller for your body. List four functions it performs.

3. Are there differences between a robot and a machine? Explain with at least two examples of each.

DAY 1 PRE-ASSESSMENT SHEET ANSWERS

THE BRAIN IS A COMPUTER?

1. Describe how your brain helps you command your arm to pick up a glass of juice.

Once your brain decides to pick up the glass, neurons in your motor cortex command the muscles in your hand to move appropriately and pick up the glass. In the process, your brain uses feedback from your eyes (such as whether it is going toward the glass, picking it up, etc.) and makes sure it is done as intended!

2. Your brain is the controller for your body. List four functions it performs.

Example answers: Breathing, pumping blood by controlling heart, walking, drawing, thinking, planning, memory, speaking, sensing, etc.

DAY 1 PRE-ASSESSMENT SHEET ANSWERS

THE BRAIN IS A COMPUTER?

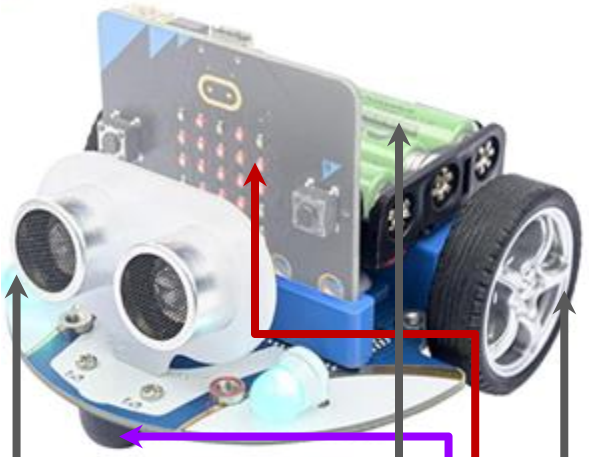
3. Are there differences between a robot and a machine? Explain with at least two examples of each.

Robots are programmable devices (machines) **that can take inputs** about their environment **(sensors)** and use this information to decide (**think**, algorithm) on task and instructions, and exert forces (actuators, transducers, motors) **that impact their surroundings in a physical way** either in a simple or complex manner. **Examples: unitree robot, autonomous vacuum cleaner.**

Machines are devices (maybe programmable) that **follow a specific set of instructions** (specific, limited). **Examples: washing machine, drying machine, blender, vending machine, etc.**

DAY 1 PRE-ASSESSMENT SHEET ANSWERS
THE BRAIN IS A COMPUTER?

Differences and Similarities	
Differences	Similarities
Autonomy: Robots generally have a higher degree of autonomy and can make decisions based on their programming and sensors. Machines typically follow a fixed set of instructions without adapting to their environment.	Both robots and machines are human-made devices designed to perform specific tasks or functions.
Complexity: Robots are usually more complex, often incorporating artificial intelligence, sensors, and advanced control systems. Machines can be simpler in design and function.	They both typically rely on some form of energy input (e.g., electricity, fuel) to operate.
Versatility: Robots are often designed to be more versatile and adaptable to different tasks or environments. Machines are typically specialized for specific functions.	Both can be programmed or configured to perform repetitive tasks with precision.
Interaction: Robots can often interact with their environment and, in some cases, with humans. Machines usually have limited interaction capabilities.	



Micro:bit chip (brain/nervous system)

Color sensor (eyes)

Ultrasonic sensors (eyes/ears)

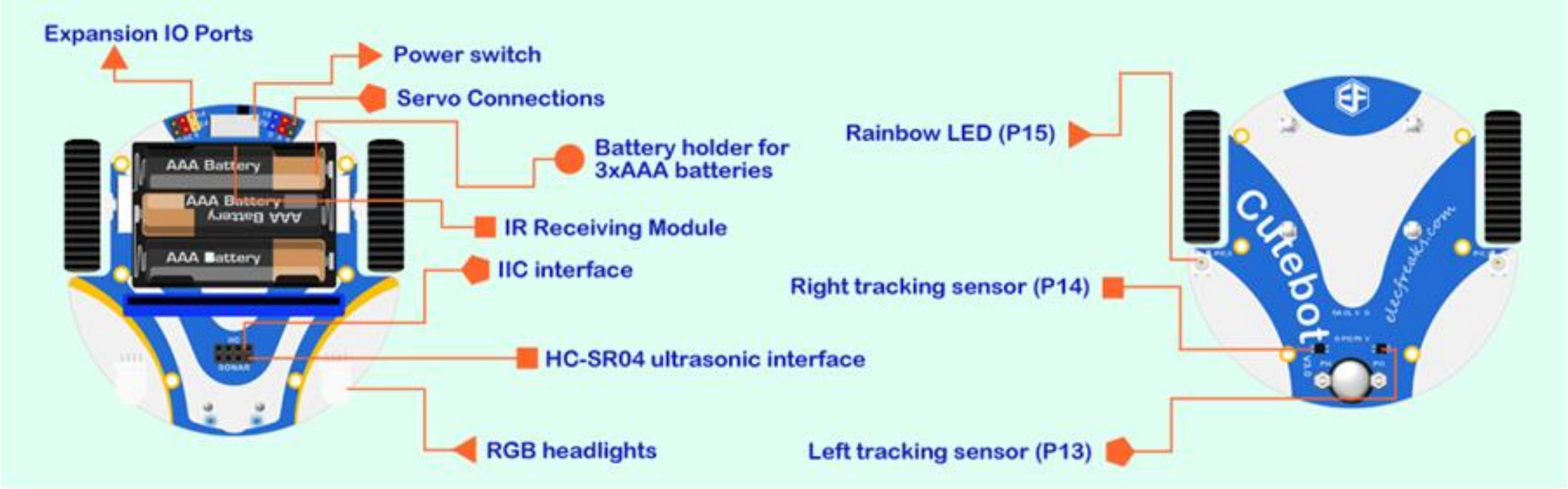
Tires (arms/legs)

Battery (food-energy source)

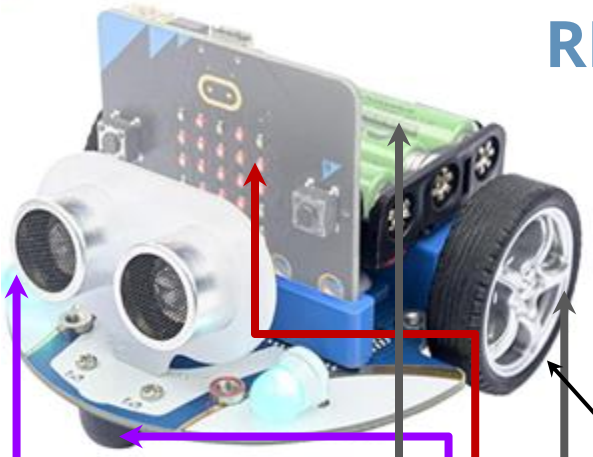
OPTIONAL SLIDE TO SHOW MORE DETAILS

TOP VIEW

BOTTOM VIEW



REVIEW: ELECFREAKS MINI CUTEBOT



Micro:bit chip (brain/nervous system)

Color sensor (eyes)

Ultrasonic sensors (eyes/ears)

Tires (arms/legs)

Battery (food-energy source)

Robots have three components:

1. Sensors are devices that allow robots to perceive the world.
2. Actuators are devices that produce motion or action.
3. Programs are sets of instructions for carrying out tasks.

Cutebot kit vs. a Human

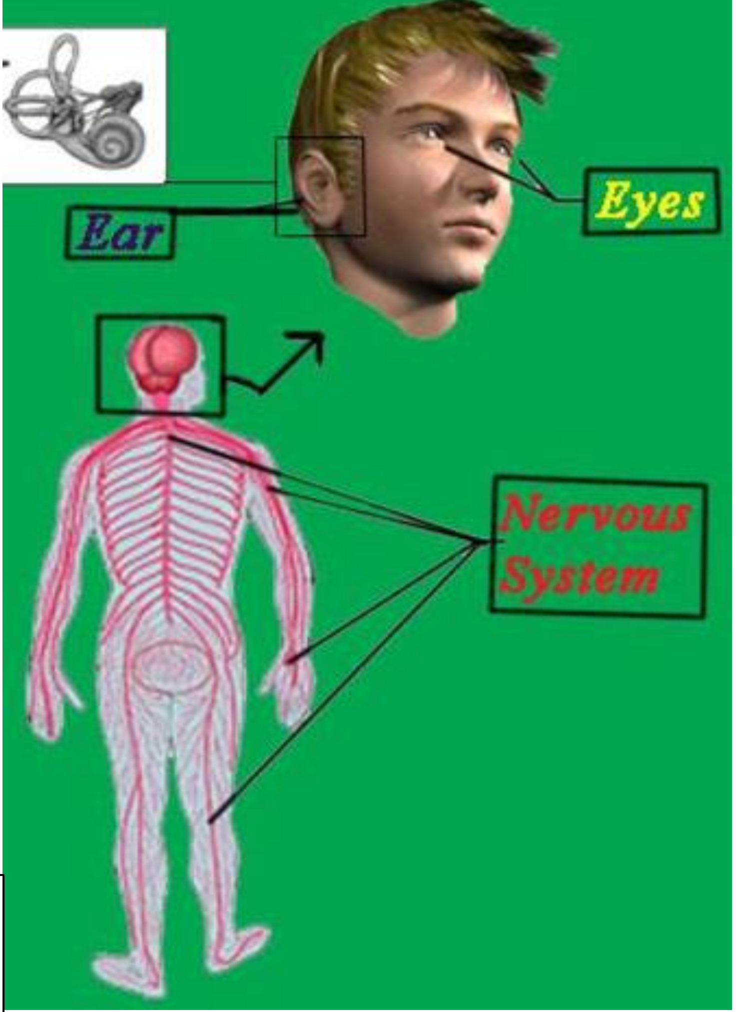
Micro:bit chip (brain/nervous system)

Color sensor (eyes)

Ultrasonic sensors (eyes/ears)

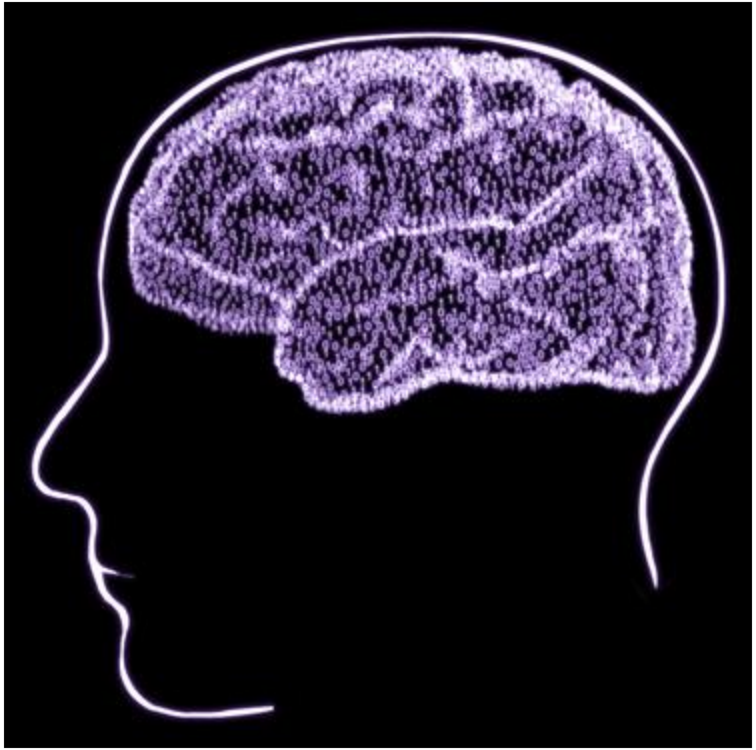
Tires (arms/legs)

Battery (food-energy source)



- DECISIONS/THINKING – computer (+ wires) vs. brain (nervous system)
- SENSING – robot sensors vs. human senses
- MOVEMENT – muscles vs. DC motors (hands/legs vs. wheels)

REVIEW: BRAIN AND COMPUTERS



Can you list some things that your brain does for you?

- think, plan
- memory
- speech
- move
- balance, posture
- feel emotions
- breathing, heart rate, blood pressure
- see, hear, feel, taste, smell

REVIEW: BRAIN AND COMPUTERS

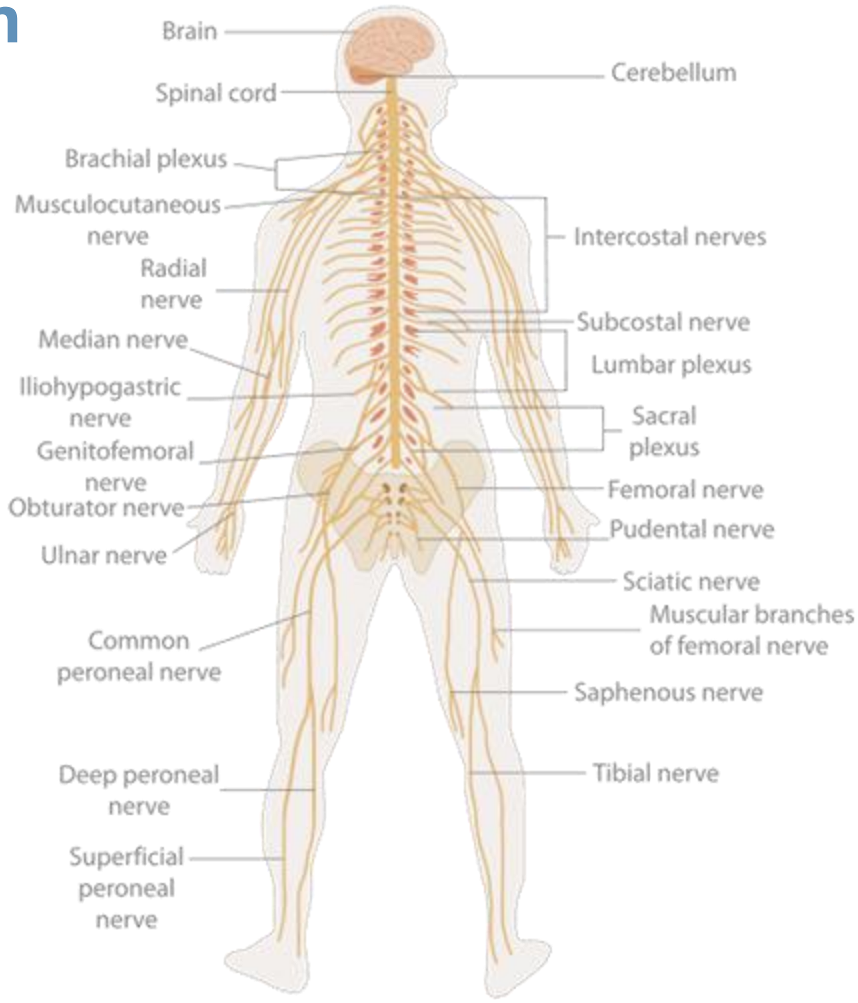
- Makes different types of **decisions** for you. For instance, it tells you when you are hungry.
- **Controls all your bodily functions**, even without your knowing it! For instance, actions such as breathing, blinking, beating the heart, and many others (that you will learn later in biology), are all controlled subconsciously by the brain all the time.

- **Learns new things,** such as riding a bicycle, swimming, languages, playing instruments, games or sports, and lots and lots of such skills.
- Sensors provide continuous input to the brain through your eyes, ears, nose, skin, and mouth. It must **"understand" what the sensors tell it and make decisions**. For example, to run when you see a snake!
- It does all this using about ***100 billion neurons*** (humans) that talk to each other – right now we don't really know how!

REVIEW: Human Nervous System

The nervous system is the set of wires (called nerves) that allow the sensors to talk to the brain, and the brain to talk to the muscles (think of it as a dual carriage highway).

- Through one set of nerves, **the sensors tells the brain what they sense.**
- Through another set of nerves, **the brain tells the muscles to contract, causing the body to move.**

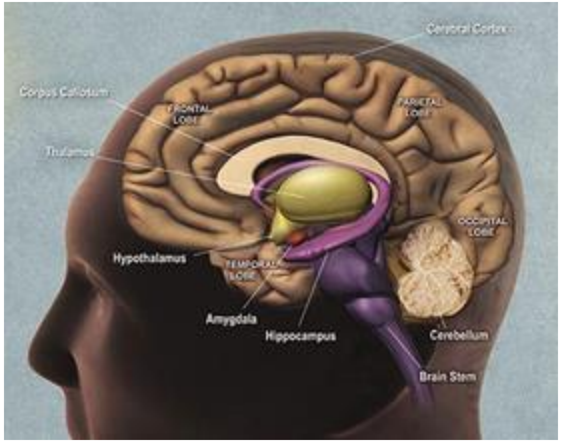


HOW DOES THE BRAIN WORK? (HUMAN COMPUTER)

The brain is the **decision center of the body.**

How does the brain and nervous system move our hands?

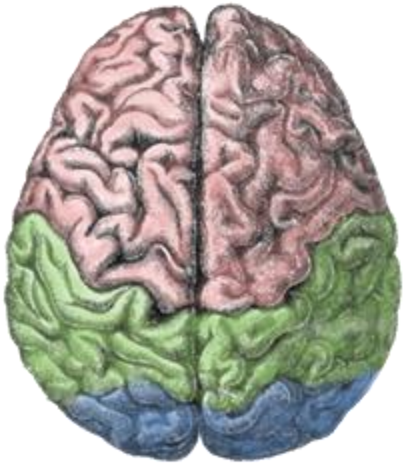
- When a hot object is touched, the touch sensors are activated.
- Nerves transmit information from the touch sensors to the brain.
- The brain decides to move the arm back to protect the finger.
- The brain sends signals along nerves to muscles to move the arm.
- The muscles then move the arm.
  (We will look at details later.)



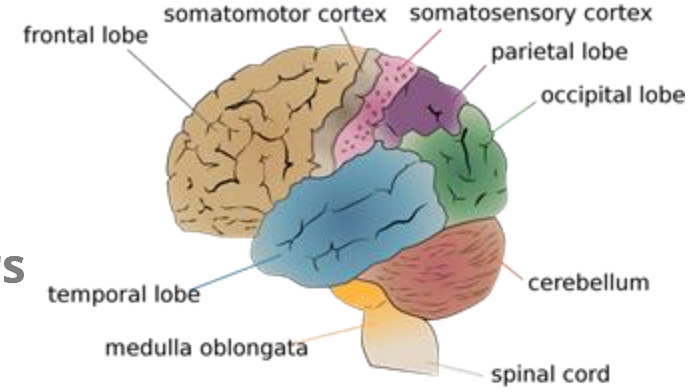
HOW DOES THE BRAIN WORK? (HUMAN COMPUTER)

The brain is the **decision center of the body.**

1. The human brain looks like a cauliflower and is about the same size.
2. It is divided into right and left hemispheres.
3. Human brains are divided into four lobes.

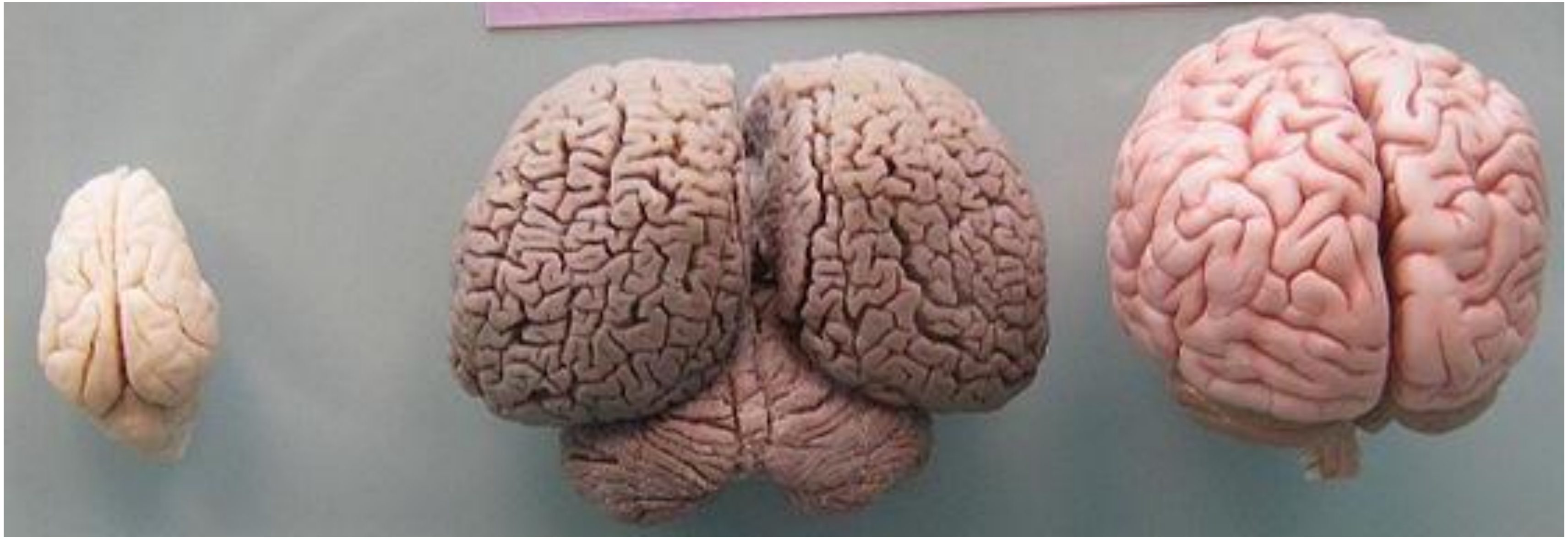


Left and Right Hemispheres of the Brain



The brain is not colored like this (usually it appears gray); color is added in the drawings just to distinguish the lobes.

Scale Models of Brains (and Sizes)

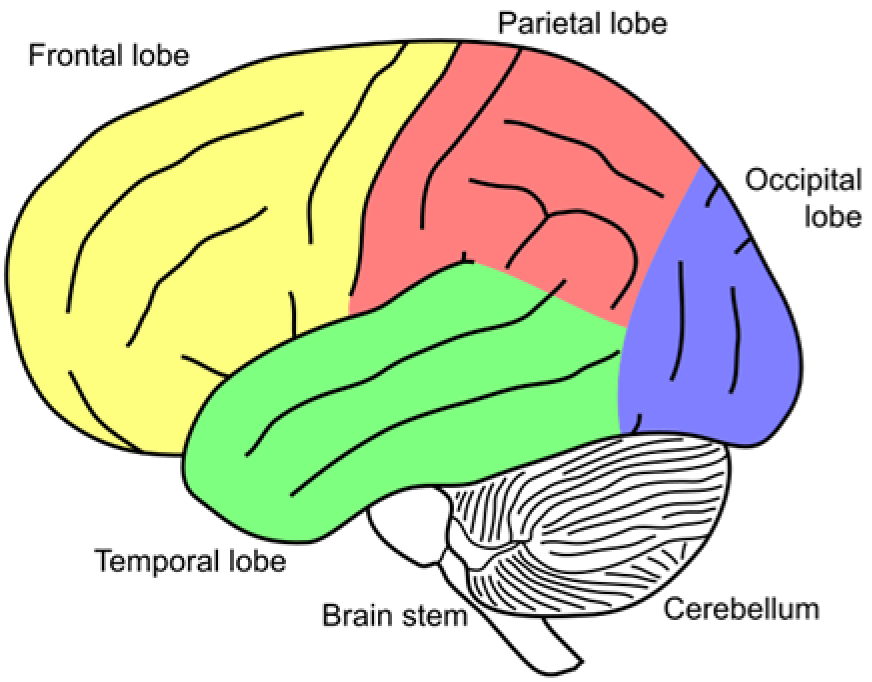


wild pig (left) bottlenose dolphin (middle) human (right)

~0.15kg 1.6 kg 1.4kg

Fun Fact: Dolphins have a relatively large brain compared to their body size, which is considered a sign of high intelligence

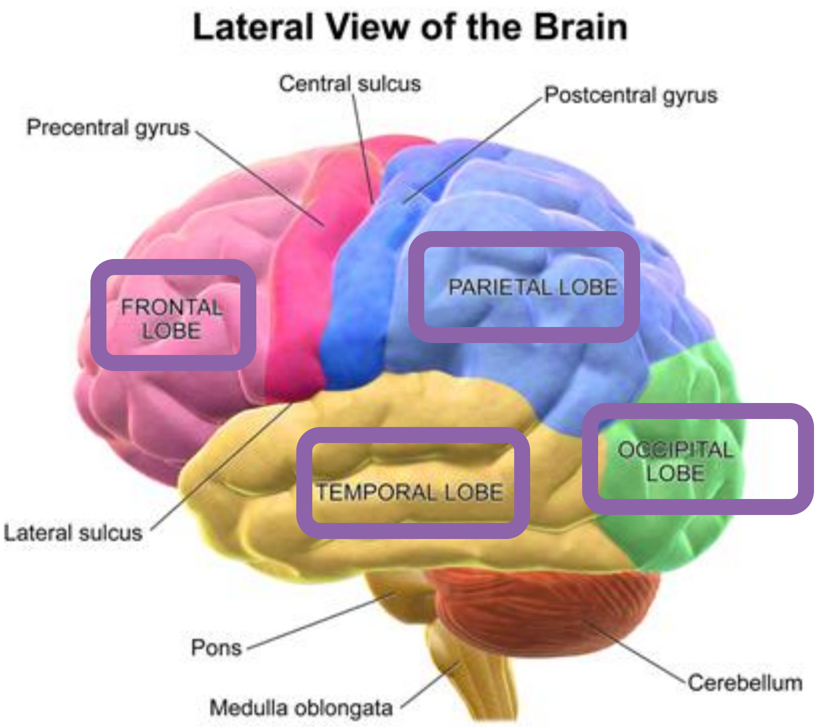
Four Lobes of the Brain



Check out details about the different lobes with a moving cursor at this website:

http://thebrain.mcgill.ca/flash/d/d_01/d_01_cr/d_01_cr_ana/d_01_cr_ana.html#1

HUMAN BRAIN REVIEW



Frontal Lobe:

- Executive functions (planning, decision-making, problem-solving)
- Voluntary movement control
- Emotional regulation
- Personality
- Language production (Broca's area)

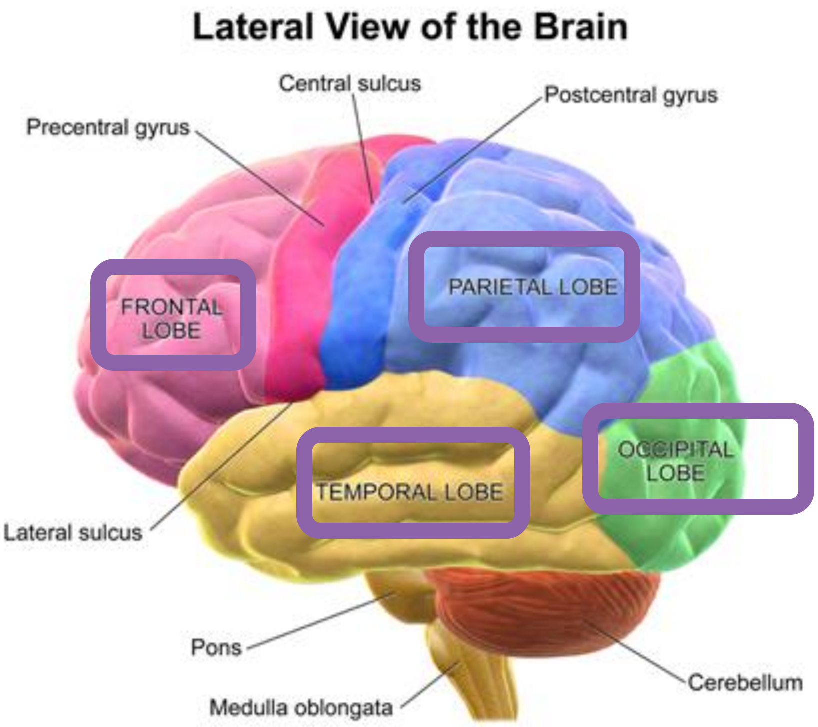
Parietal Lobe:

- Sensory information processing (touch, temperature, pressure)
- Spatial awareness and navigation
- Mathematical calculations
- Language comprehension
- Body awareness

Temporal Lobe:

- Auditory processing
- Memory formation and storage
- Language comprehension (Wernicke's area)
- Emotion processing
- Visual recognition of faces and objects

HUMAN BRAIN REVIEW



Occipital Lobe:
- Visual processing
- Color recognition
- Reading and visual comprehension
- Depth perception

Cerebellum:
- Motor coordination and balance
- Fine-tuning of movement
- Motor learning and memory
- Some cognitive functions (attention, language)

Brain Stem:
- Vital life functions (breathing, heart rate, blood pressure)
- Sleep-wake cycles
- Arousal and consciousness
- Relaying information between the brain and spinal cord

Lesson Recap-Post Assessment

1. **Sketch a human brain and label the four lobes. Name at least one function for each of the lobes.**

2. **EXTENSION:**
   For the five parts of the brain in Slides 18 and 19, are there areas that overlap? If you had to represent the brain and the nervous system, what type of circuit would you use to describe it? Explain.
   Revisit this idea with Slides 30-31. You can assign homework a reading material.
   https://faculty.washington.edu/chudler/plast.html or
   https://theconversation.com/what-is-brain-plasticity-and-why-is-it-so-important-55967

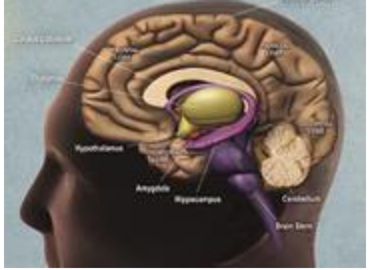
End of Day 1

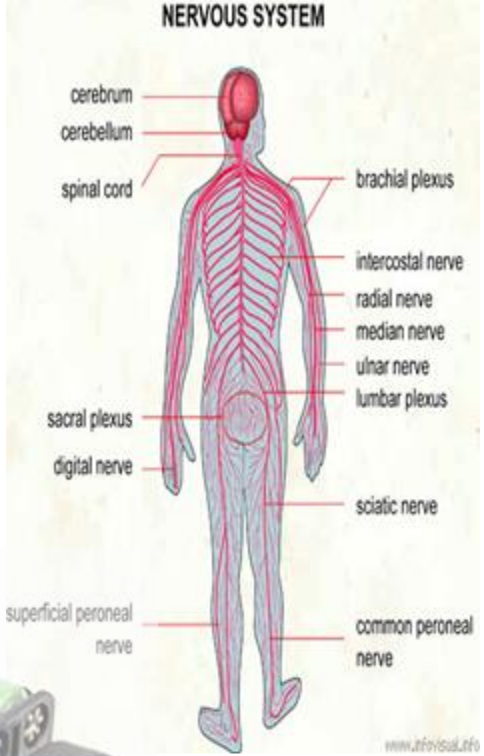
DAY 2

SUMMARY SO FAR

LEARNING OBJECTIVES

1. You will create a program to tell the mini cutebot how to use its input **(sensors)** and outputs **(actuators)**.





PRE-ASSESSMENT SENSORS

1. How does a sensor function?

2. Explain how sensors are important for our everyday life with examples.

SENSORS REVIEW

1. Explain and describe how a sensor functions.
   Sensors are devices that measures a quantity of interest and sends (processes) this information so that an action/instruction/decision can be implemented. There are 2 types of sensors: Detect a stimulus (Type 1), and detect the quantity/value of a stimulus (Type 2). For example, Type 1 tells you whether a vibration was detected and Type 2 tells you the intensity/magnitude of the vibration.

SENSORS REVIEW

2. Explain how sensors are important for our everyday life with examples.

   Just as our sensory organs provide information to our brain to help us function as humans, sensors provide useful information that allows us to make decisions that can aid and improve how we function as well as provide safety to things we may not directly see, feel, or know.

   Example: Your smartwatch can monitor your heart rate or oxygen levels or body temperature.

SENSORS REVIEW

Everyday life examples …

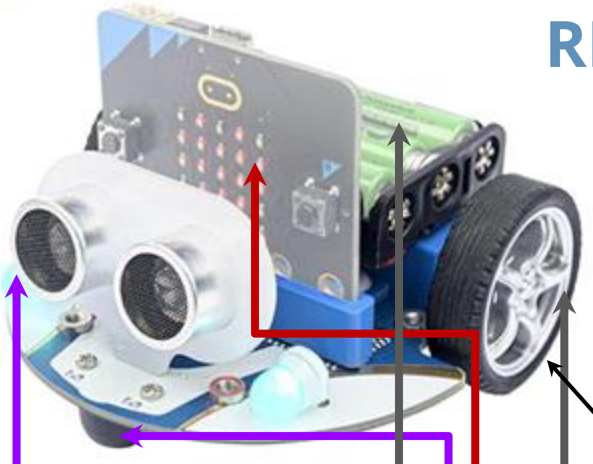
to monitor our health.

to monitor our performance.

to monitor our cars.

to monitor our buildings.

REVIEW: ELECFREAKS MINI CUTEBOT



Micro:bit chip (brain/nervous system)

Color sensor (eyes)

Ultrasonic sensors (eyes/ears)

Tires (arms/legs)

Battery (food-energy source)

Robots have three components:

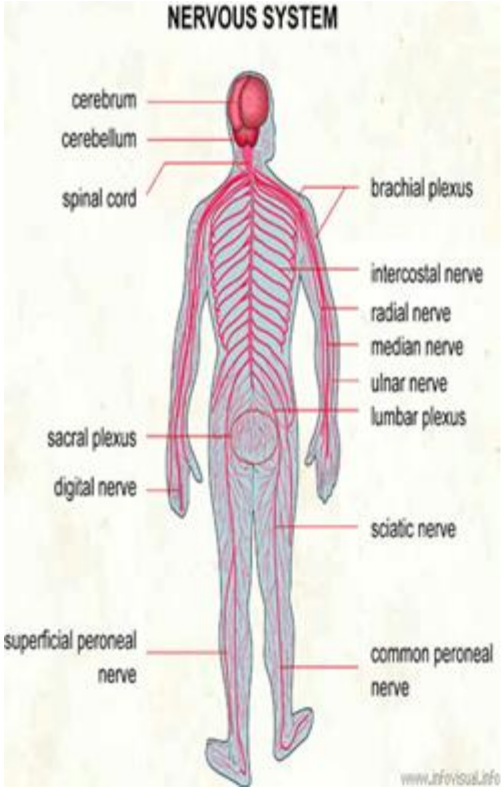
1. Sensors are devices that allow robots to perceive the world. (**INPUTS**: 5 SENSES- touch, smell, taste, sight, sound)
2. Actuators are devices that produce motion or action. (**OUTPUT:** actions/reflexes)
3. Programs are sets of instructions for carrying out tasks. (**BRAIN/NERVOUS SYSTEM**)

HUMAN SENSORS SIGNAL TRANSMISSION - For Teacher

When the sensors of the human body detect a stimulus, they send this information through the nervous system (like wires) to the brain. It has two main parts,

One is called the **peripheral nervous system**, which is a series of branches of single nerves. These are nerves that connect to every sensor in your body. They send signals to other nerves, which send signals to more nerves, until the signal reaches the second part of the nervous system: the central nervous system.

The **central nervous system consists** of your spinal cord and your brain. The spinal cord is made up of bundles of nerves that are surrounded by bones for protection. Once a signal from a sensor reaches the spinal cord, it is sent up the cord to the brain. The brain decides what to do based on the information received.



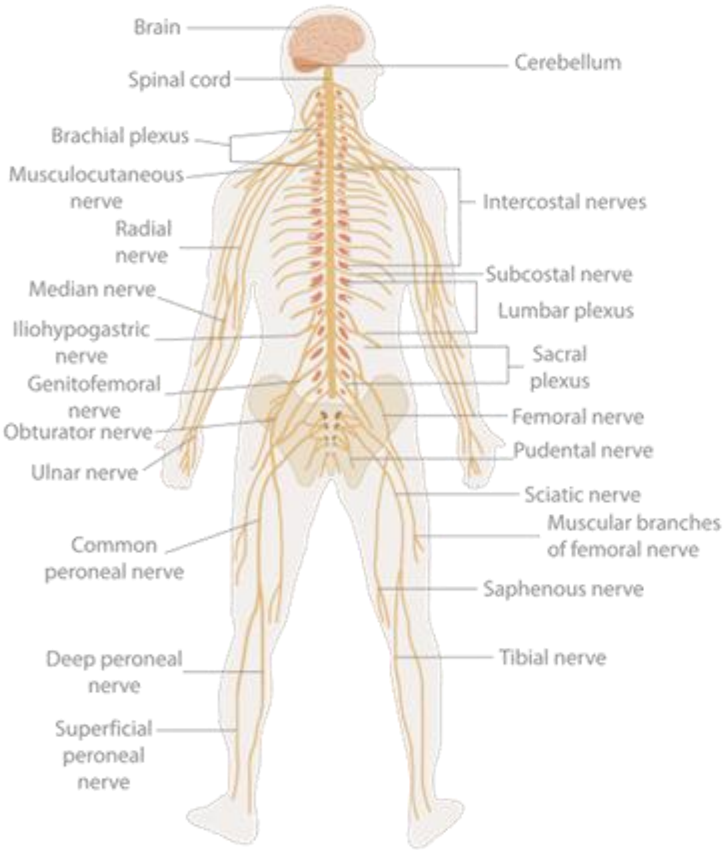
Human Nervous System

HUMAN NERVOUS SYSTEM - For Teacher

The nervous system is the set of wires (**called nerves)** that allow signal **(neurons)** flow in an electrical circuit. This circuit might be simple as how a flashlight works to how the lights in your house are connected (series and parallel circuits).

How can you relate this to how we function?

In another lesson, we see how engineers can use this to program neural chip implants or assisted technologies to help the impaired.



Activity Part I – For Teacher DAY 2

- Split the students into **pairs.**
- Mark **four points on the ground** – say on the corners of a 5-foot square. Space the points farther apart to increase degree of difficulty. *(If this is a challenge, you could use an open gym and have a computer cart for the students.)*
- Have one person in each group close their eyes and have the other member direct the first around the room with verbal commands. *(It is interesting to see who does not get confused by other team's command.)*
- The **goal is to become the first group to have the member with his/her eyes closed touch all four points**, following the RULES on the next slide.

Activity Part I – **Student Rules**

- The command-giving partner can *only give commands that follow a specific format*: **The command must tell the partner to walk a certain number of steps in *one* direction.**
  - Example: Move three steps to your right.
  - Example of incorrect command: Move a little to your right then turn slightly left and walk forward.
    - Why above command is incorrect: First, it specifies movement in multiple directions, instead of only one direction. Also, it doesn't specify an exact number of steps to walk.
- ***NO COMMAND CAN BE GIVEN WHILE THE PARTNER IS IN MOTION!!*** **Commands can only be given after previous commands have been executed.**

Activity Part II – **For Teacher**

- First, ensure that each kit has all the parts supplied. See this link. It also has examples of programs you and your students can explore.
- The micro:bits are purchased separately. See materials list in the document.
- Familiarizing yourself with the kit and the micro:bit platform takes 15-30 minutes. Ensure that you are familiar with the basic process (see Slide 36).
- The slides that follow assume that you did the precheck of all the supplied parts and have gone through the basics.
- Students can easily follow and even exhibit proficiency with the micro:bit platform.
- Always ask students to create a flowchart for their codes! Helps with troubleshooting.

Activity Part IIa – For Students

Getting started

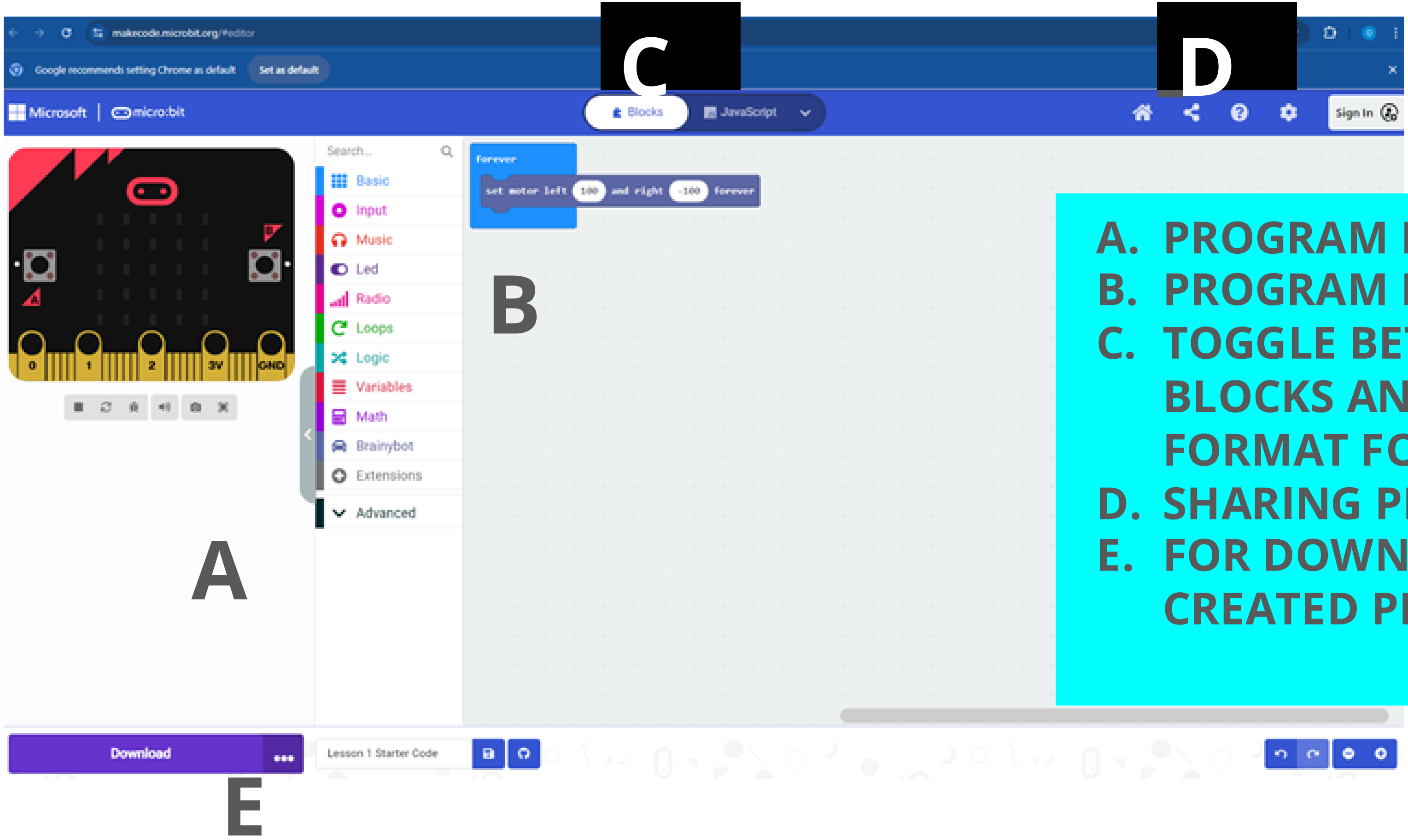
Step 1: Remove the cable from the plastic box and plug it into the computer.

Step 2: Remove the micro:bit from its cardboard package.

Step 3: Plug the cable into the top of the micro:bit. If the micro:bit is brand new, it will play sounds and flash lights in a special tutorial mode.

Step 4: Go to Pages 4-7 of the provided booklet in the ELECFREAKS kit.

ACTIVITY PART IIA – **FOR STUDENTS**



A. PROGRAM BLOCKS
B. PROGRAM PAGE
C. TOGGLE BETWEEN BLOCKS AND JAVA FORMAT FOR PROGRAM
D. SHARING PROGRAMS
E. FOR DOWNLOADING CREATED PROGRAM

Activity Part IIa – **For Students**

Getting Started: First Program

Step 1: Go to Page 8 of the supplied booklet and practice with the DANCE LIKE A BEE!

Step 2: Page 9 gives the flowchart of what the program is meant to do. **NOTE: Always draw a flowchart for your program. This is a good practice skill; it helps you troubleshoot easily.**

Step 3: Download the finished code.

Step 4: Remove the cable from the micro:bit.

Step 5: Attach the 'brainbox' to the cutebot with the **A and B buttons facing forward**! (Slide 38)

Step 6: Turn on robot. Hurray, you created your first code!

Step 7: **Try** adding **new codes** using the suggestions on **Page 14.**

Activity Part IIa – **For Students**

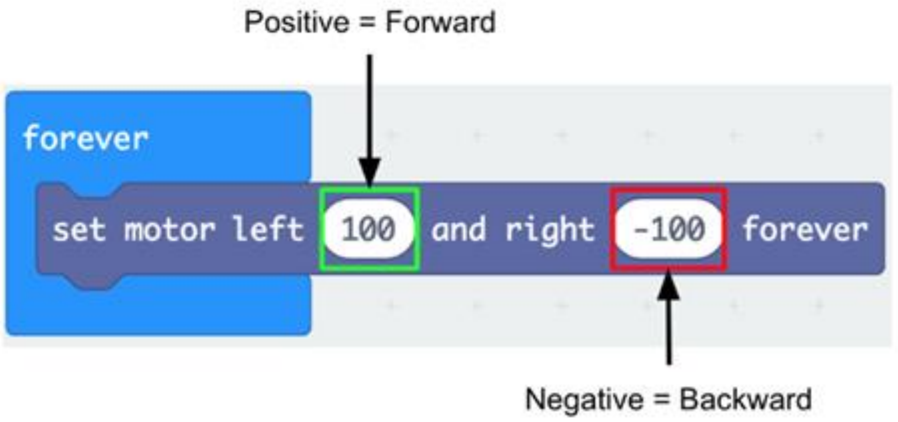
Getting started

This is what the final setup would look like after you have put your program into the micro:bit chip, the brainbox of your robot.

Step 9: Slide the micro:bit into the middle of the robot, between the head and the batteries. **Make sure the strip of metal on the bottom is completely covered up, and the micro:bit's lights are facing the front!**

Activity Part IIa – **For Students**

Explaining the code



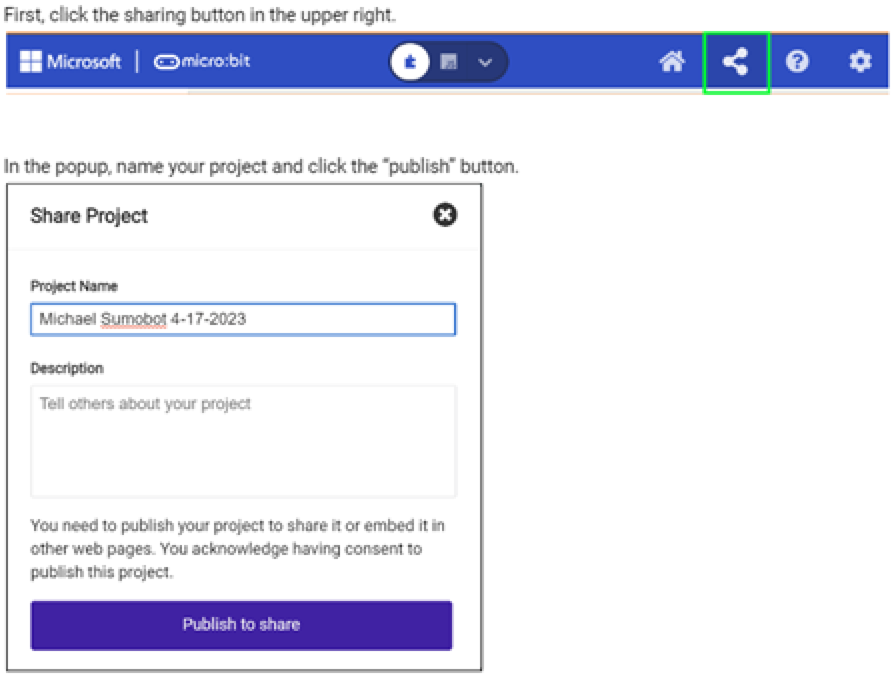
Because the numbers are equal, this would produce a circular motion.

What happens:

a. If both numbers are positive?
b. If the left number is smaller or greater than the right?
c. If both numbers are negative?

ACTIVITY PART IIB – **FOR STUDENTS**

Saving your code



1. Click on the share icon.
2. Give your project a name. (e.g., Your name and title of project/ challenge and date).
3. Write a short note.
4. Click copy link and save the link by emailing to yourself or to Google classroom.

ACTIVITY PART IIB – **FOR STUDENTS**

EXTENSION (if there is time)

Add new blocks **SEE PAGE 14**

Take a look at the list of blocks and see which one you want to add to the program to make the robot do something different. There's music, lights, and even radio communication so you can talk to other robots!

Here are some things you can try:

- Play the "Middle C" note.
- Trace out a shape of your choice (square, triangle) and then reverse directions.
- Play a melody.
- Play a "mysterious" sound.
- Spin in one direction for 2 seconds, then reverse spin direction.
- Spin while moving only one wheel.
- Light up the LEDs on the micro:bit in a pattern of your choosing.

PRACTICE WITH OTHER EXAMPLES IN LESSONS 2-4.

DAY 3

TeachEngineering

CHALLENGE 1:
Create a program that gets your Cutebot through the maze.

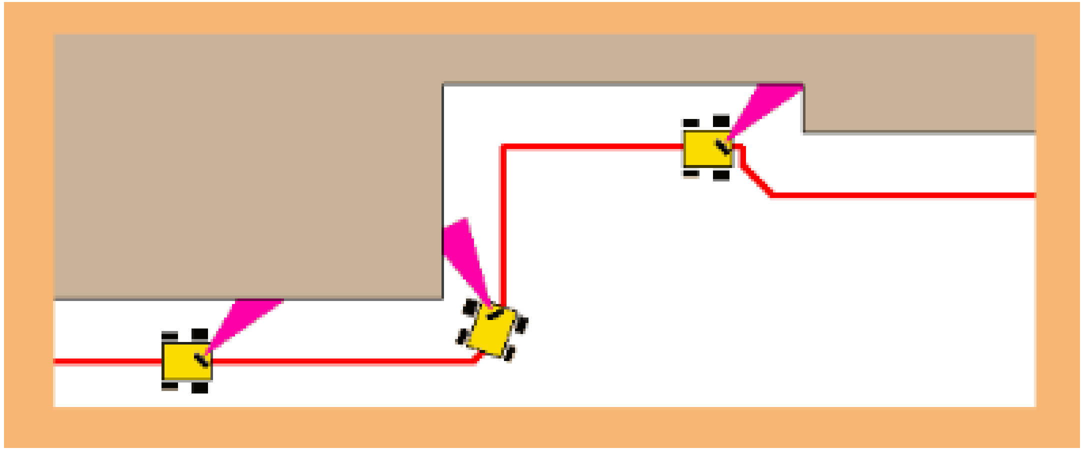
Activity Part III – **For Teacher**

- Create a maze with wooden planks (or any other solid objects forming walls of the maze) – increase the size of the maze (add more turns) to increase difficulty.
- Use the PowerPoint slides that follow (Slides 36-41) to review with the students how to program using the micro:bit platform.
- **Engineering Design Challenge - Ask students to use the micro:bit platform to create programs to get their Cutebots through the maze (or to navigate the path) provided.**
- Suggestion – Slides 36 through 41 can be printed and provided to the students so that they can use them to troubleshoot when they begin writing their programs or guided notes.

Activity Part III – **For Teacher**

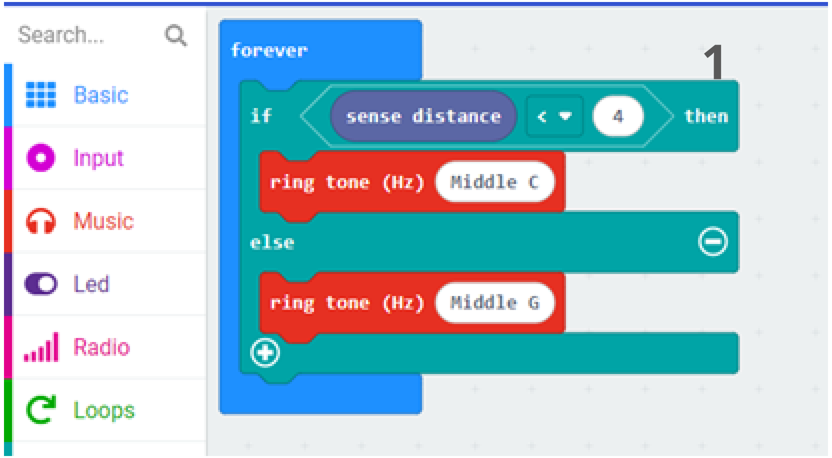
- **Engineering Design Challenge - Ask students to use the micro:bit platform to create programs to get their Cutebots through the maze provided.**
- Suggestion – hints

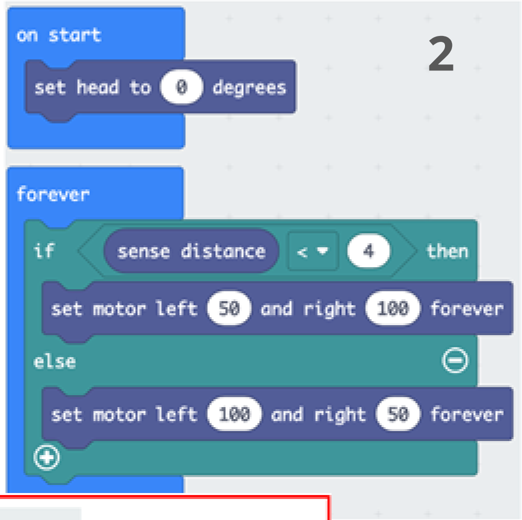
Ask the following prompts

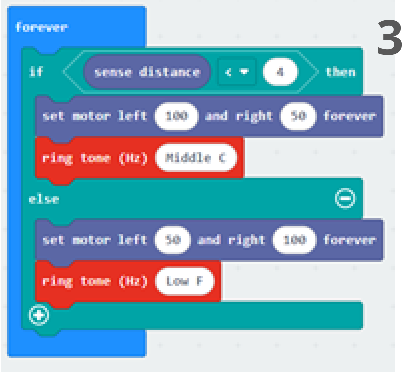


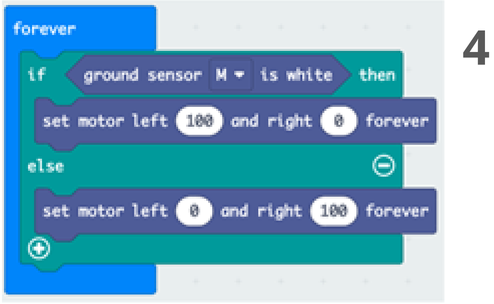
What sensors might you use? Ultrasound or linetracker?
What is the robot doing at each point? (while, if else?)

Activity Part III – **For Teacher**









This says: If the sensor M sees white, move toward the right. If not, move toward the left.

Demo codes for follow

1. The wall with sensors
2. Same above
3. Same with extensions
4. Using line tracker

BEFORE THE CHALLENGE

You can ask students to try out some other examples from the micro:bit page to boost their confidence:
https://microbit.org/projects/make-it-code-it

Activity Part V – **For Students**

- **Engineering Design Challenge I - Ask students to use the micro:bit platform to create programs to get their Cutebots through the maze (or to navigate the path) provided.**
- **EXTENSION:**

  Each time your robot changes direction, let it play a sound.

  Use a different sound for a different direction.

  Let the LED light light up as it changes direction.

  Upon completion of the maze, display a victory sign, tune.

Activity Part VI – **For Students**

- **Engineering Design Challenge II**
  - **EXTENSION - Ask students to use the micro:bit platform to create programs to get their Mini Cutebots to communicate to another bot their directions for navigating the maze.**

Post assessment Sheet: What is a Robot?

1. Describe in one sentence below what you understand by the term *robot*.

2. What are the main parts of a robot? Describe its similarities and differences to a human brain.

3. What do you need to do to make a robot move?

Post assessment Sheet: What is a Robot Key

1. **Describe in one sentence below what you understand by the term *robot.***

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

2. **What are the main parts of a robot?**

   Computer (to make decisions), input ports (connected to sensors), and outputs (connected to motors, for example).

3. **What do you need to do to make a robot move?**

   They program it using software telling it precisely what to do, step by step.

VOCABULARY

Computer: A human-created electronic device that processes data, performs mathematical and logical calculations, displays graphics, and helps you connect to the internet.

Robot: A mechanical device that sometimes resembles a human and is capable of performing a variety of often complex human tasks on command or by being programmed in advance.

Sensor: A device that converts one type of signal to another. For instance, a tachometer displays the speed that your car is traveling.

Actuator: A device that causes a machine or other device to operate.

Image Sources

Image 1: X-ray like image showing shoulders, spinal cord, and brain in a head; filename: MP900438746-225x300.jpg; source: AZ Dept. of Health Services Director's Blog http://directorsblog.health.azdhs.gov/wp-content/uploads/2013/02/MP900438746.jpg
Image 2: Components of mini cutebot; filename: N/A; source: Amazon.com https://a.co/d/bub7QxI
Image 3: Nervous system; filename: TE-Nervous_system_diagram.svg.png; source: Wikimedia Commons http://commons.wikimedia.org/wiki/File:TE-Nervous_system_diagram.svg
Image 4: Picture of the brain; filename: CCN.png; source: http://commons.wikimedia.org/wiki/File:CCN.png
Image 5: Human brain showing left and right hemispheres; filename: Płaty mózgu.png; source: Wikimedia Commons http://commons.wikimedia.org/wiki/File:P%C5%82aty_m%C3%B3zgu.png
Image 6: Four lobes of the brain; filename: Gehirn, lateral - Lobi eng.svg; source: 2007, NEUROtiker, Wikimedia Commons http://commons.wikimedia.org/wiki/File:Gehirn,_lateral_-_Lobi_eng.svg

Image 7: Makecode platform; source: 2024, https://makecode.microbit.org/#editor

SOLUTIONS

Maze navigation
https://makecode.microbit.org/_HUeeWxEF4Csu

Maze Navigation-Radio to another bot
https://makecode.microbit.org/_X0hey7AYzazF

VIDEOS AND IMAGES-