PRIMARY + STEM

Teaching Resource

ACTIVITY: Robots

ACTIVITY OVERVIEW

Real-life is, increasingly, looking more like the realities depicted in science-fiction movies. From self-driving cars to bots (or internet robots) that mimic human activity on the internet, and from flying-delivery drones to friendly little robots that interact with family members - there is no escaping our growing reliance on automation and robots as we progress towards greater levels of efficiency and innovation. The possibilities are limitless for the ways we can use robots but what exactly is a robot? And how do we control it?

These are the questions students consider as they seek to find solutions to climate-related natural disasters in Australia - especially bushfires and floods that consume entire communities all too regularly. Students seek out problems to address and build model-robots to part of their solution to help out a mate. In this activity, students begin to think like robotics engineers, designing disaster-response robots with make-believe hardware (e.g. sensors and tools), and make-believe software, such as simplified sets of instructions that determine how the hardware operates.

SYNOPSIS

Real-life is, increasingly, looking more like the realities depicted in science-fiction movies. From self-driving cars to bots (or internet robots) that mimic human activity on the internet, and from flying-delivery drones to friendly little robots that interact with family members - there is no escaping our growing reliance on automation and robots as we progress towards greater levels of efficiency and innovation.

The possibilities are limitless for the ways we can use robots but what exactly is a robot? And how do we control it?

These are the questions students consider as they seek to find solutions to climate-related natural disasters in Australia - especially bushfires and floods that consume entire communities all too regularly.

Students seek out problems to address and build model-robots as part of their solution to help out a mate. In this activity, students begin to think like robotics engineers, designing disaster-response robots with make-believe hardware (e.g. sensors and tools), and make-believe software, such as simplified sets of instructions that determine how the hardware operates.

Foundation – Year 2

- Identify and explore digital systems (hardware and software components) for a purpose (VCDTDS013)

Year 3 – 4

- Explore a range of digital systems with peripheral devices for different purposes, and transmit different types of data (VCDTDS019)
- Define simple problems, and describe and follow a sequence of steps and decisions involving branching and user input (algorithms) needed to solve them (VCDTCD023)
- Explain how student-developed solutions and existing information systems meet common personal, school or community needs (VCDTCD025)

Year 5 - 6

- Define problems in terms of data and functional requirements, drawing on previously solved problems to identify similarities (VCDTCD030)
- Design, modify and follow simple algorithms represented diagrammatically and in English, involving sequences of steps, branching, and iteration (VCDTCD032)
- Explain how student-developed solutions and existing information systems meet current and future community and sustainability needs (VCDTCD034)

ACTIVITY, MATERIALS AND INSTRUCTIONS

Activity

What exactly are robots? And how can we use them to help us when there are fires or floods? Through this activity, students identify problems that their model-robots can help solve.

Materials

- Items from recycling bin, such as (cleaned and dried) cardboard boxes, plastic milk jugs, toilet rolls, etc.
- Adhesives (e.g. glue, masking tape)
- Assortment of art and craft materials, including yarn, pompoms, pipe cleaners
- Markers

Instructions

1. Find out what students know about robots.

   What are robots? Where can we find them? Do students have any in their homes? What do robots do?

2. Show videos of robots that students have mentioned.

   Here are some suggestions:

   • Ameca Humanoid Robot https://youtu.be/RiTfe-ckD_g

   • Tesla self-driving car https://youtu.be/tlThdr3O5Qo

   • Amazon Robot Warehouse https://youtu.be/TUx-ljgB-5Q

   • Tesla automated car assembly process https://youtu.be/8_lfxPI5ObM

3. Theory

   What is a robot?

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

With increasing automation in our devices and processes, the distinction between a robot and any other machine is becoming fuzzier.

A clear definition for students could be that 'a robot can observe what is happening around it and bring changes to the environment, based on what it has been observing'.

What are the main parts of a robot?

A tiny computer (circuit board containing the Central Processing Unit, CPU, for decision making and memory to store instructions). Some latest developments integrate CPU and memory together.

Inputs (e.g. sensors for light, colour, sounds, pressure, etc.).

Outputs (e.g. motors, speakers, light, radio signals, etc.).

Electricity is required to make these three parts communicate with one another.

What do people do to make a robot do things?

Program the instructions, telling the robot precisely what to do, in a step-by-step fashion. These lines of codes (instructions) are stored in the computer memory.

In an automatic door, for instance, a motion-detecting sensor above the doors informs the CPU when there is something moving towards it.

Based on the programming, the CPU takes the decision to execute the action of opening the doors. It sends electrical signals to the motors (output device) to make this happen.

4. Discuss some aspects of the recent natural disasters that have afflicted Australia in recent times.

   What do students remember? What problems can students identify? How can robots be part of the solution?

   Here are some images of fires and floods to support the discussion:

   - Look back at the 2011 Queensland floods - ABC News (Australian Broadcasting Corporation)
   - Ten impacts of the Australian bushfires (unep.org)

   For more comprehensive information:

   - Plan for an emergency: Bushfire - ABC Emergency
   - What to do Before During and After a Flood (bom.gov.au)

5. Working in groups, students brainstorm problems for their robots to solve. These problems could relate to any part of the natural disaster, such as prevention, dealing with the direct impact during the crisis itself, or in the aftermath. Some examples include: different robots to clear an area after a fire or a flood, where it might be dangerous for humans, due to unstable structures, or contamination brought about by bacteria; robots to remove people or animals from dangerous zones; robots to see through the smoke to help drivers navigate their way; robots that can speak bird language; robots to monitor the health of people who have been rescued; floating robots; flying robots... the possibilities are endless!

*Use the accompanying worksheet, as well as the table 'List of Sensors', to help students plan.

6. Build robots

   Students identify the sensor/s and output/s required for their robot. It is best to limit students to one or two per robot. They also briefly describe simple algorithms to show how and when the sensor/s and output/s work. Younger students could verbalise or use drawings to explain the instructions to their robots, while older students could describe these simple algorithms using words, flow diagrams, or tree diagrams.

   Other considerations:

   Does the robot have a battery source? Robots are electronic machines and require electricity to work. How are the sensors, CPU, and outputs connected to one another? Are there wires connecting them together?

7. Present robots to the class for feedback and review.

   Teams present what problem their robots are designed to solve, then describe how their robots can achieve it. What are their sensors, outputs, and instructions (algorithms)?

   The audience responds by checking if they think the instructions are clear enough for the robots to work as intended. Can they identify circumstances that the team might not have considered in their design?

   Take, for example, a drone with an infrared camera to detect people in a fire. Would that camera work if the surrounding area is too hot and cannot distinguish between living things among burning trees?

8. Students revisit their robot and worksheet to make improvements to their robot design, based on feedback.

HOW TO USE THIS ACTIVITY WITH YOUR STUDENTS

Foundation - Year 2

Can students transfer what they have learnt about their model-robots to actual robots? Popular educational robots used in schools include BeeBots and Blue-Bots, Edison Robots, Spheros, M-Bots, Lego Robots. All these robots possess sensors, outputs and CPUs.

Teachers assemble different types of robots for students to play with. As they explore how the different robots work, can they identify the sensors and outputs? Can they see the CPU? Are students able to figure out some algorithms which have been programmed into the robots (e.g. the Edison robots have a light-tracking function that uses a light sensor with the ability to distinguish between different amounts of light)? The instruction to the motors and wheels is to go in the direction of greater light intensity.

Years 3/4

After creating their robot, students discuss what defines a robot. With increasing automation in devices and processes, there is great debate - even among scientists and engineers - about what defines a robot. Students will have to tease out how everyday machines work, to determine whether a machine qualifies as a robot or not. There will be lively debate, especially for items that could be either a robot or not, depending on their capabilities (e.g. a regular car vs a self-driving car).

As an extension activity to this, give students a list of objects (e.g. tree, calculator, drone, remote control, automatic doors, laptop, kettle, coffee machine, trains, traffic signal, motorised scooter, mobile phone, etc.). Invite students to distinguish between what a robot is and isn't, based on the criteria: 'A robot can observe what is happening around it and bring changes the environment, based on what it has been observing'.

Are students able to describe each object's function, identify what sensors it possesses, determine whether it has a CPU to make decisions independently, and decide whether it can carry out actions using its output devices?

If they are not robots, why not? What changes can be made to some of these machines to turn them into robots?

Years 5/6

Students extend this activity into creating solutions with multiple robots. Are there other robots in their class that they can work with collaboratively to solve the same problem? This activity follows in the spirit of collaboration between researchers and engineers to find the best solutions.

Student teams select one or two other robots to work with and describe how these robots will function together, or in sequence, using simple algorithms (instructions). They may represent these algorithms using words, flowcharts, or tree diagrams, etc. For example, a robotic drone flying overhead can alert a self-driving robotic boat to pick up stranded flood victims. Or, in the event that the boat is not able to access the people, it communicates this information to another robotic delivery drone to drop-off emergency supplies.

DISCUSSION SECTION AND KEY THEMES

KEY THEMES

What is a robot?

When we think of a robot, the image that often springs to mind is most likely a humanoid that looks, behaves, and even shows emotions like humans. While there have been great advances in artificial intelligence, resulting in amazing humanoids like Ameca and Sophia, most robots look nothing like what is imagined in movies.

Automated teller machines (ATMs), automatic doors, vending machines, and robotic arms used in manufacturing are also robots. They share the following characteristics:

- They can sense their surroundings by gathering information about their environment
- They can think about how to react to the information
- They can act by carrying out a response

By that definition, even an ordinary computer or mobile phone can be considered a robot since – it can gather data and carry out actions independently, based on its programming!

What are the main parts of a robot?

Sensors

Similar to how a human uses his or her senses, a robot can 'see' with light sensors or cameras, 'hear' with microphones, and 'feel' with the help of pressure sensors.

However, there are also many more exciting sensors that are different to human senses (e.g. proximity sensors using infrared waves, motion sensors based on radio waves, moisture sensors to detect if sprinklers need to be deployed, etc.).

Sensors are devices that input information into a robot's system, and they tend to be specific in nature. This means that one type of sensor picks up one type of information. Some sensors require direct contact between objects while others can work from a distance. The kinds of sensors found on robots depends on what they were made for. All sensors convert information about their environment into electrical signals and these signals get sent to the robot's central processing unit (the robot's brain).

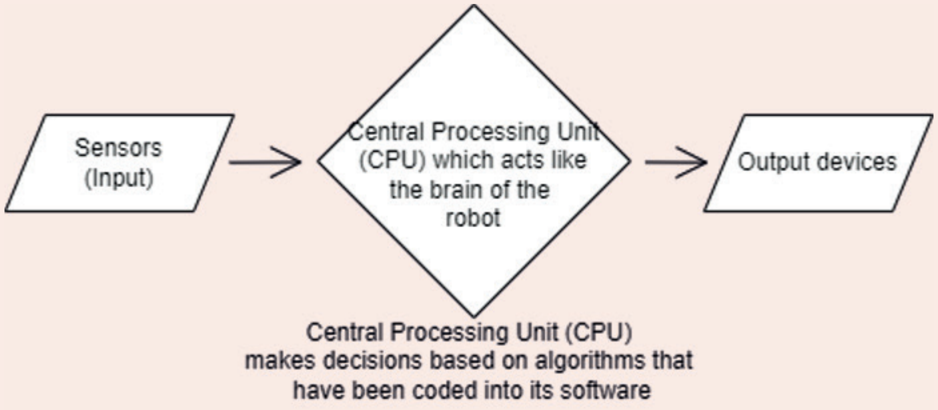
Central processing unit

Every robot has a central processing unit (CPU), which functions like the human brain. The CPU in a robot receives information from the sensors, runs the appropriate program, and performs the necessary actions. For robots to be able to make decisions, they first need to be programmed with instructions (by humans!) – programs that tell the robots precisely what to do in a step-by-step fashion.

Outputs

Robots use motor and wheels, just as humans use legs and feet. And where humans have hands and fingers to peel a banana, robots could have finger-like grippers to do the same. But beyond these human-like components, output devices may also take the form of lights, speakers, ultraviolet light emitters, actuators (these are small motors that act like muscles, to bring about movement), etc.

Outputs can take just about any form (e.g. movement, sound, lights, or wireless communication), and they perform tasks upon instruction from the CPU. Once the computer processor has decided which course of action to take, it sends electrical signals to specific output devices to carry out their actions.



Programming a robot

Programming a robot is telling it what tasks to do and how to perform them. This is done in a logical, step-by-step fashion. Algorithms describe a set of steps written in this manner and include calculations, reasoning, and data processing. Once the algorithms are established, a programmer then codes the instructions into the computer's CPU. Any mistakes in a program will lead to a robot failing to complete a task in the way it was intended.

The CPU operates in machine language (binary code), so to control a robot's CPU, the algorithms will eventually be converted to patterns of 1s and 0s. However, coding a robot using binary code is highly impractical for most people.

Software programmers use programming languages that have English keywords and mathematical symbols to write code. A compiler or interpreter then translates these codes into machine language. Popular programming languages include C/C++ , Python, Java and MATLAB.

QUESTIONS AND ANSWERS

Are drones robots?

The jury is still out on this one! According to a RACI (Royal Australian Chemical Institute) article published in 2016, drones are not robots, yet the Institute of Electrical and Electronic Engineers (US) have included drones in their list of robots. It's safe to say that there are many types of drones, with varying levels of autonomy.

Most drones are unmanned vehicles that are guided by humans using remote control – these are not considered robots. But with more powerful and complex drones being programmed, it's a matter of time before they become more and more autonomous (robot-like).

How many types of robots are there?

The Institute of Electrical and Electronics Engineers (US) has defined 15 categories of robots. It includes aerospace, consumer, disaster response, drones, research, and military. For the full list and images, visit:

- Types of Robots - ROBOTS: Your Guide to the World of Robotics (ieee.org)

Which language is best programming language to learn if I want to program robots?

Popular languages for coding robots are C++, Python, and Java. Coincidentally, these languages are also used by serious game developers!

For most students, these languages will be too difficult to learn as a first language. Fun, easy, and free languages for younger children include block-based programming languages like Scratch (developed by MIT) and Blockly (developed by Google).

Python is a good programming language to start with for older students. It is free to use and more easily readable than Java or C++ because it uses English keywords, where other languages use punctuation. It is also commonly used for developing games, websites, and software.

Where can my parents get a self-driving car in Australia?

Even though cars already on the road feature many assisted driving technologies, such as forward collision warning, lane departure warning, and blind spot warning, robotic, driverless cars are not yet on Australian roads, except for testing purposes. There are still many safety issues to be worked out until robotic cars are allowed on the roads. Between 2016 to 2018, Uber vehicles in self-driving mode were involved in 37 crashes, with one fatality. In 2018, the Uber self-driving car collided into a woman riding a bike, because the car did not recognise the bicycle as a potential object to avoid.

Watch this video to see a robotic car driving a passenger.

- https://youtu.be/tlThdr3O5Qo

What is artificial intelligence (AI)?

Oracle, a software company, defines artificial intelligence as systems or machines that mimic human intelligence to perform tasks and can improve themselves based on the information they collect.

AI is possible in robots when they are programmed using algorithms with rules that make them collect data each time they carry out a task, then analyse the data, and do the task better the next time. The result is robots that are capable of reasoning, learning, problem-solving, and making quick decisions.

Prominent examples of AI include robots in manufacturing that become more efficient over time, robots in surgeries, and even robots to help shoppers enjoy a better online shopping experience!

What is a humanoid?

Humanoids are robots that look like humans. Famous humanoids include Sophia and Ameca. Meet Ameca, the humanoid robot, and the engineering team that made her possible on this show produced by Wired.

- https://youtu.be/6iO6XhbVQfs

Do human robots have rights like human beings?

In response to Sophia the humanoid being granted citizenship status in Saudi Arabia, writer Lauren Sigfussion approached experts in artificial intelligence, computer science and human rights for their opinions on the matter and published the article in Discover Magazine (2017).

The consensus from these experts is ‘no’. Humanoids are machines, not humans.

But, most agree that the issue of rights will have to be addressed as we use more and more sophisticated robots in our daily lives.

Currently, big companies are given some of the same rights as humans so it may be just a matter of time.

- Do Robots Deserve Human Rights? | Discover Magazine

What are bots?

According to Kaspersky, a security software company, bots (short for robots), are software programs that perform automated, pre-determined, repetitive tasks. Bot typically imitate or replace human users. There are good bots and there are bad bots.

Companies use bots to replace simple, repetitive tasks like interacting with customers because they can perform it much faster than humans.

Unfortunately, malware bots, which are programmed to hack into user accounts, and scan for contacts to send spam or other harmful acts, can also perform this quickly.

In fact, it is estimated that up to half of internet traffic is made up of computer bots carrying out tasks.

One way that malware bots infect computers is through downloads – be careful what you click!

What is the best way to protect ourselves when there is a bushfire?

Knowing what to do and when to act is the best way to protect ourselves. The NSW Rural Fire Service has issued a bush fire survival plan in four simple steps.

Step 1: Discuss with family members what to do if a bush fire threatens your home

Step 2: Prepare your home for bush fire season by keeping the grass low and having a cleared area around your home

Step 3: Know the bush fire alert near your home

Step 4: Keep all the bush fire information numbers and websites in the smartphone app

- GetReadyforaBushFire.pdf (nsw.gov.au)
- CFA Bushfire Survival Planning Template

Is there any good that can come out of bush fires?

Some positives from bush fires to surrounding wildlife and vegetation include germination of certain plants that require the heat to crack their seed coats, releasing of certain seeds from seed pods that require heat to open, clearing of thick undergrowth to reduce competition for smaller plants, and creation of hollows in logs and trees for nesting and shelter.

- How fire affects plants and animals | NSW Environment and Heritage

OUTSIDE OR SUPPLEMENTARY READING

What is a robot?

- What is a Robot? | National Geographic Society

Lecture: Prof Andrew Davison from Imperial College London

- https://youtu.be/WAmuvbc5fko

TEDx talk: Robots are not human, even if we want them to be

- https://youtu.be/wPK2SWC0kx0

Issues with self-driving cars

- Uber in fatal crash had safety flaws say US investigators - BBC News

More about bushfires

- Australia fires: A visual guide to the bushfire crisis - BBC News
- Bushfire | Geoscience Australia (ga.gov.au)

TOPIC WORDS

- Algorithms
- Data
- Software
- Hardware
- Input
- Output
- Detectors (Sensors)
- Signal controller
- Processor
- Information systems
- Components
- Computational thinking
- Data collection
- Decisions
- Transmit data

WORKSHEET: WHAT PROBLEM WILL OUR ROBOT HELP WITH? WHAT CAN OUR ROBOT HELP WITH?

Select one/two sensors and one/two outputs for your robot, and describe the instructions to be programmed into CPU so that your robot knows what to do. See:. https://youtu.be/wPK2SWC0kx0

Sensor --›	Algorithm (Instruction) --›	Output --›

LIST OF SENSORS

SENSOR	DESCRIPTION
Acceleration	detects how much an object is tilting, or how fast an object is moving
Vision and imaging	detect presence of objects or colours. Used by some cars to detect road signs
Touch or contact	detects sensors touching another object. Used to avoid obstacles
Temperature	detects temperature or changes in temperature. Used in ovens and fridges.
Radiation	detects radiation, somewhat like Geiger counters
Proximity	detects presence of nearby objects from a distance. Used in cars.
Pressure	detects forces on an object. Used on robot vacuums.
Navigation and position	detect the location of an object using GPS
Photoelectric	detects objects that are passing by. Light is emitted and received by these sensors. Used in automatic doors.
Particle	detects dust and other airborne particles
Motion	detects movement and stoppage of objects. Used in conveyer belts.
Metal	detects presence of metals, even specific types of metal
Level	detects the heights of liquids, solids, or gases in tanks or bins.
Leak	detects discharge of liquids or gases. Used in checking pipe and seals in vacuum packages
Humidity	detects the amount of water in the air
Gas and chemical	detects gas and chemical leaks in confined spaces
Force	detects how much strain an object is under. Used in bathroom scales, detecting how many seats in a car are occupied.
Flow	detects movement of gases, liquids, or solids. Used in processing industries.
Flame	detects presence of flames. Used when working with highly combustible material, in high temperature working area
Electrical	detects electrical current
Sound	detects sound levels. Used in baby intercom, home smart devices.

Source: [https://www.thomasnet.com/articles/instruments-controls/types-of-sensors/#:~:text=List of Sensors 1 Vision and Imaging Sensors,... 10 Metal Sensors. ... More items...](https://www.thomasnet.com/articles/instruments-controls/types-of-sensors/)

PRIMARY + STEM

For more teaching resources, visit

WWW.PRIMARYANDSTEM.ONLINE

Supported by

The Invergowrie Foundation

Swinburne University