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Smart Intruder Alarm

Introducing the 5 Big Ideas in Artificial Intelligence using Internet of Things in STEM education

T2.4 IoT Projects Design & Resources Development

29.08.2023 | SCHOLÉ
PROJECT NUMBER: 2022-1-FR01-KA220-SCH-000085611

AI4STEM IoT Projects Design & Resources Development
Project: Smart Intruder Alarm

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Table of Contents

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1.Introduction to the Project

This project uses the micro:bit and sensors to help teachers and students to explore the possibilities of AI in everyday life. In order to program the micro:bit, teachers and students can use the make code website (https://makecode.microbit.org/).
Through different lesson plans, that will help teachers explore the Smart Alarm project and discover ways to dive into the Five Big Ideas in Artificial Intelligence while exploring an understanding about AI concepts.

1.1 The scope of the Project

The scope of this project involves creating a Smart Alarm that integrates AI concepts, micro:bit programming, and communication between micro:bits and sensors. The project aims to provide an educational experience for students, introducing them to key concepts in artificial intelligence (AI), the Internet of Things (IoT), and programming using the micro:bit platform.

1.2 The target groups

This project aims to involve teachers and students aged 8 to 12 years old.

1.3 The purpose of this document

The aim of this document is to offer teachers specific ideas and learning activities that effectively introduce and teach students the concepts of AI and IoT, mainly to students with such young ages. This will be accomplished by framing the discussion within the context of Robotics and incorporating various hands-on tasks.

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2. Glossary of the Unit

Word	Definition
Micro:bit	A pocket-sized programmable computer designed to introduce children to coding and electronics.
Artificial Intelligence (AI)	The simulation of human intelligence in machines, involving tasks such as learning, reasoning, problem-solving, perception, and language understanding.
IoT (Internet of Things)	The network of interconnected devices that communicate and share data with each other, often through the internet. In this project, micro:bit, ESP8266, and the infrared sensor collectively contribute to the IoT framework.
IO extender for micro:bit	This pre-built Edge Connector Breakout Board for the micro:bit gives access to all the important pins on the bottom edge of the micro:bit.
Infrared Sensor	A sensor that detects infrared radiation, commonly used for proximity sensing. In this project, the infrared sensor is utilized to detect motion or changes in the environment.
Five Big Ideas in AI	A framework that encompasses key concepts in AI: Perception, Reasoning, Learning, Communication, and Societal Impact.
Perception	The ability of a system to sense and understand its environment, often involving sensors and data interpretation.
Reasoning	The process of making decisions and solving problems based on available information and logic.
Learning	The ability of a system to adapt and improve its performance over time through experience or data analysis.
Communication	The exchange of information between devices or systems, often involving sending and receiving data.
Societal Impact	The broader consequences and effects of technology on society, including ethical considerations and social implications.

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Block Programming	A visual programming method where code is represented as graphical blocks that can be dragged and dropped to create a program.
MakeCode	An online platform that provides a block-based programming environment for micro:bit and other devices.
Hardware Integration	The process of connecting and enabling communication between different hardware components or devices.
Adaptative Behavior	The ability of a system to adjust its behavior based on changing conditions or user interactions.
Remote Control	The ability to control a device or system from a distance, often facilitated by communication technologies
Ethical Design	The consideration and incorporation of ethical principles in the design and development of technology.
Hands-on-Activities	Practical exercises or experiments that involve direct interaction with hardware or software.
Sensors	Devices that detect and measure physical properties (e.g., motion, temperature). Micro:bit's built-in sensors are used to perceive the environment in the AI Intruder Alarm.

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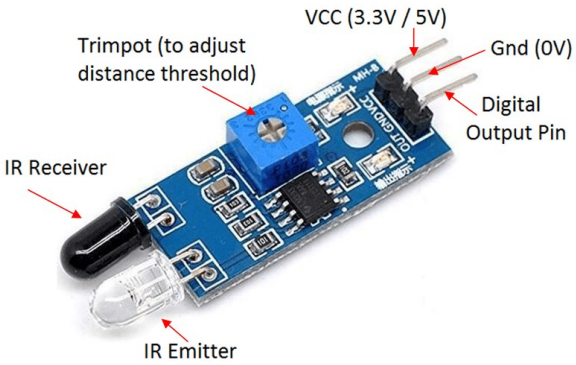
3. Introduction to the "Smart Intruder Alarm"

3.1 Description

This unit will introduce learners to technology and artificial intelligence! In this educational project, students aged 8 to 16 (mainly students 8 to 10 years old) will embark on a journey to build their very own Smart Intruder Alarm using the micro:bit platform. This project combines hands-on programming, hardware integration, and key concepts in AI to create a unique and interactive learning experience.

Note #1: This project can take place after students do some art & craft to build their own ideal houses or a smart house.

The teacher can challenge the students to find a way to keep the houses secure and, with the idea of an alarm, introduce the Smart Intruder Alarm.



Note #2: The teacher can adjust the infrared sensor sensibility by rotating the small screw to the right or left.

3.2 Learning objectives & outcomes

On successful completion of this unit, learners should be able to:

- Understand how the micro:bit perceives and communicates with external devices like sensors;
- Explore the concept of hardware perception in IoT devices.
- Explore Sensor Technology and gain insights into the functioning of infrared sensors and their role in environmental perception for security applications.
- Implement local decision-making on the micro:bit for setting the alarm using button-based interactions.
- Learn Natural Interaction with IoT Devices and understand how micro:bit can interact with external devices;
- Explore the concepts related to AI 5 Big Ideas using the micro:bit and the sensors.
- Explore the concept of learning in local systems.
- Modify micro:bit code to include communication blocks for interaction with the infrared (IR) sensor.
- Consider ethical design principles in the development of the smart alarm.
- Reflect on the societal impact of IoT devices and technology in everyday life.

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- Gain practical experience with block programming in MakeCode for micro:bit.
- Develop coding skills by using visual blocks to create functionality.
- Connect and set up communication between micro:bit and the IR sensor
- Understand the basics of hardware integration in IoT projects.
- Modify the micro:bit code to simulate adaptive behavior in the alarm system.
- Learn to adapt program behavior based on user interactions.
- Experiment with coding exercises to modify the micro:bit code for local and adaptive behaviors.
- Demonstrate the completed Smart Intruder Alarm project, showcasing the integration of AI concepts and micro:bit programming.
- Present and discuss how each aspect of the project aligns with the AI concepts and lessons learned.
- Apply critical thinking skills to problem-solving during the coding and hardware integration process.
- Analyze the consequences of adaptive behavior in the alarm system.
- Reflect on the ethical considerations and societal impact of the smart intruder alarm project.
- Consider how AI concepts and technology can be responsibly applied in real-world scenarios.
- Collaborate with peers during hands-on activities and project development.
- Share ideas and solutions to enhance learning outcomes.
- Develop effective communication skills through project presentation and discussion.
- Articulate AI concepts and technology applications to various audiences.

3.3 Estimated duration of the Unit

The overall duration of this unit depends on the duration of each Lesson.

Lesson 1: 90 minutes
Lesson 2: 90 minutes
Lesson 3: 90 minutes
Lesson 4: 90 minutes
Lesson 5: 90 minutes

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3.4 Lesson 1 - Exploring Device Perception

3.4.1 Description

In this engaging lesson, students dive into the world of AI by exploring the Perception Big Idea. The focus is on how devices perceive information from their surroundings. Using the micro:bit and the IR sensor, students learn the basics of hardware setup, block programming, and communication between devices.

The micro:bit, acting as a simple sensor, and the IR sendor send messages, simulating the concept of perception in AI. Through hands-on activities and an exercise, students gain a foundational understanding of how devices gather and exchange information, setting the stage for deeper exploration in subsequent lessons.

For this lesson plan, that has a focus on the Perception and an AI Big Idea, effective perception is crucial to identify potential intrusions or changes in the environment. The system needs to be aware of its surroundings and interpret signals from sensors, such as the infrared sensor used in this project, to distinguish between normal and potentially alarming situations.

3.4.2 Hardware

- Micro:bit board
- USB cables for micro:bit
- Computer with internet access
- Infrared sensor module
- Jumper wires
- IO extender for micro:bit

3.4.3 Setup

3.4.3.1 Wiring

- Connect the micro:bit and the IO extender for micro:bit
- Connect the VCC pin from the IR sensor to the 3V pin of the IO extender for micro:bit
- Connect the Out pin from the IR sensor to the 0 pin of the IO extender for micro:bit
- Connect the GND (ground) pin from the IR sensor to the 0V pin of the IO extender for micro:bit
- Ensure both devices are powered and ready for programming.
- Connect the system to a computer with the usb cable.

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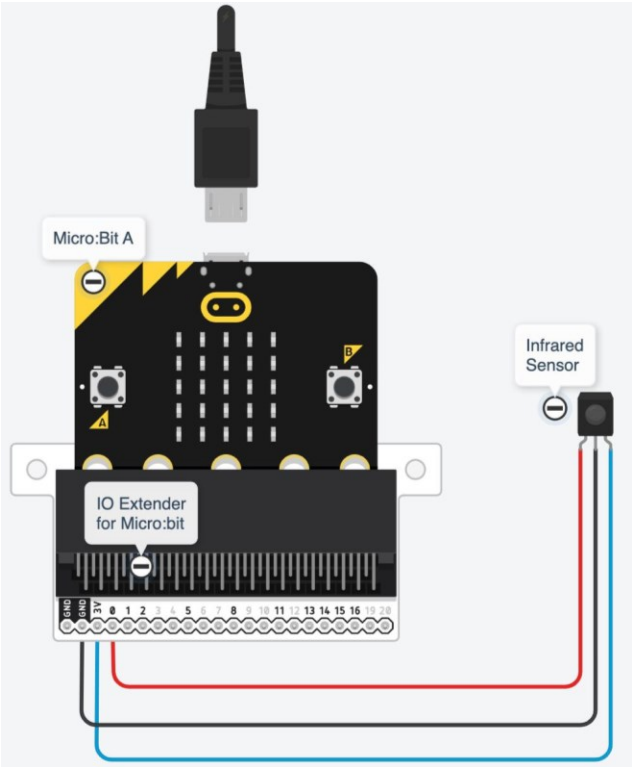
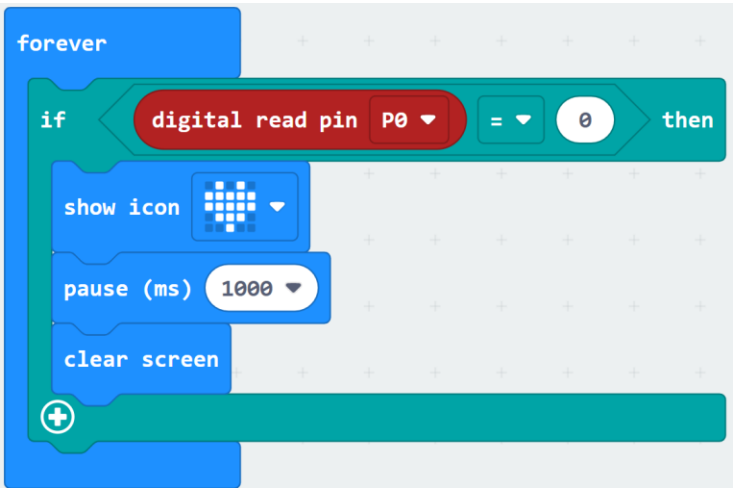


3.4.3.2 Code

For this activity we will try out the different sensors in the micro:bit and the IR sensor.
Connect the Micro:bit to a computer with an internet connection.
Use the make code website: https://makecode.microbit.org/ to create the code for the micro:bit.

IR sensor:



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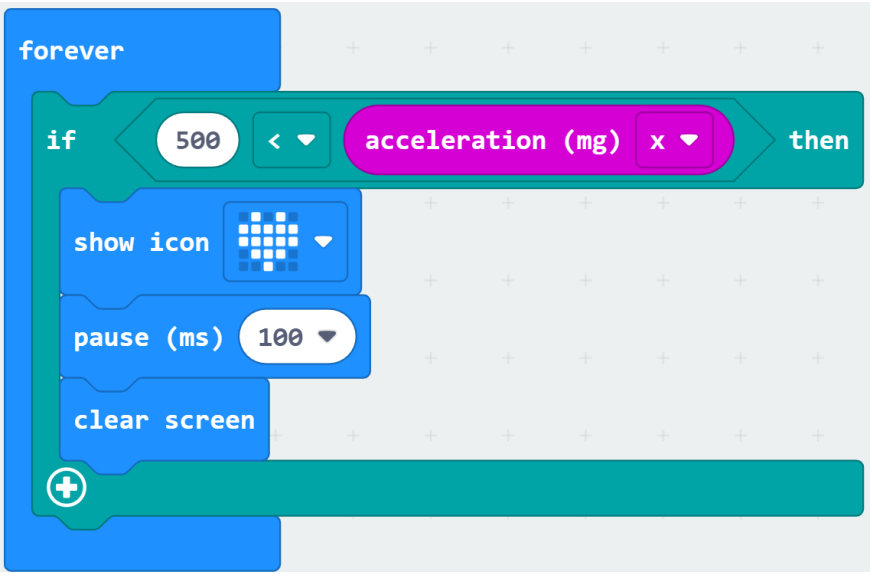
For the next sensors, disconnect the micro:bit from the edge connect and the IR sensor

Accelerometer



3.4.4 Activity

The teacher will challenge the students to program the micro:bit to do a response when one of the sensors collects data. This will help the students understand how the micro:bit perceives its surroundings but also how an AI can collect the information needed to engage a response.

In the IR sensor case, students will see that a heart shape will appear on the micro:bit every time their hand, or any object, passes in from of the sensor.

As for the accelerometer, when the students shake it, a heart shape will appear on the LED lights of the micro:bit.

The teacher can use this lesson plan to explore some discussion points, like:

- What is a sensor, and how does it work?
- How does the infrared sensor detect motion?
- How does the accelerometer detect motion?
- Why is it important for devices to perceive their environment?
- How can motion detection be useful in real-life scenarios?

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3.4.5 Questions

What happens when motion is detected by the sensor in the experiment:

a) Nothing
b) **The alarm sounds**
c) The micro:bit vibrates

What is the purpose of the infrared sensor in this project?

a) **Motion detect**
b) Voice recognition
c) Face recognition

Sensors enable devices to perceive their environment.

a) **True**
b) False

This activity helps us understand a little bit more about the Big Idea of Perception

a) **True**
b) False

3.5 Lesson 2 – Decision Making with Sensors: Representation and Reasoning

3.5.1 Introduction – Theory

This lesson focuses on representation and reasoning, two key components of AI. Representation involves encoding information in a format that machines can understand and manipulate, while reasoning involves making decisions or drawing conclusions based on that information. Students will learn how to represent sensor data in code and use conditional statements to make decisions, such as triggering the alarm only when motion is detected during specific hours.
Representation and reasoning are fundamental to AI systems, enabling them to process and act upon information. In programming, data is represented using variables, data structures, and other formats that facilitate manipulation and analysis. Conditional statements, such as if-else statements, allow AI systems to make decisions based on predefined criteria. By understanding how to represent data and make decisions in code, students gain insight into how AI systems operate and how they can be programmed to exhibit intelligent behavior.

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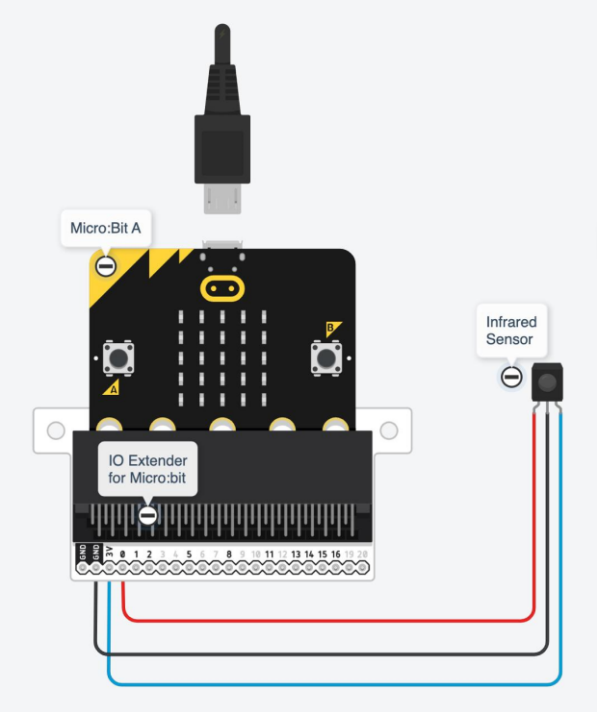
3.5.2 Hardware

- Micro:bit board
- USB cables for micro:bit
- Computer with internet access
- Infrared sensor module
- Jumper wires
- IO extender for micro:bit

3.5.3 Setup

3.5.3.1 Wiring

- Connect the micro:bit and the IO extender for micro:bit
- Connect the VCC pin from the IR sensor to the 3V pin of the IO extender for micro:bit
- Connect the Out pin from the IR sensor to the 0 pin of the IO extender for micro:bit
- Connect the GND (ground) pin from the IR sensor to the 0V pin of the IO extender for micro:bit
- Ensure both devices are powered and ready for programming.
- Connect the system to a computer with the usb cable.



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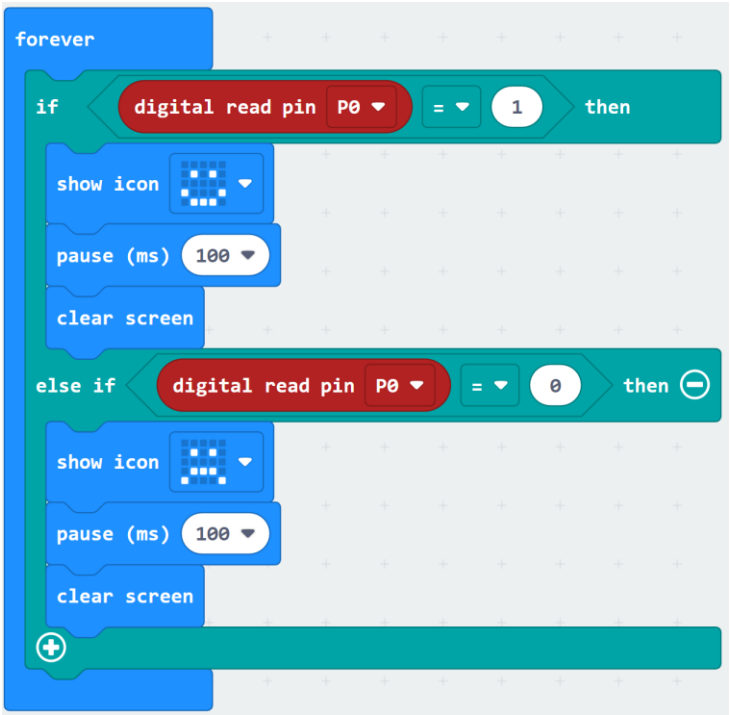
3.5.3.2 Code

Connect the Micro:bit to a computer with an internet connection.
Use the make code website: https://makecode.microbit.org/ to create the code for the micro:bit.



3.5.4 Activity

The idea in the activity is to help students understand how AI uses Representation and Reasoning. To do so, teachers can challenge students to use conditional functions (if...then...else) to create a program using the micro:bit and the IR sensor so that the micro:bit reacts when there is an intruder, but does something else when there is not.
In the code example above, we can see that the micro:bit will exhibit a smiling face when there is no danger and will change to a sad face when there is motion detected.
During the exploration of this content, the teacher can use the information and the programming to explore topics like:

- What are conditional statements, and how do they work in programming?
- Why is it important for devices to make decisions based on data?
- What are some other factors we could consider when deciding whether to trigger the alarm?

3.5.5 Questions

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What is representation and reasoning in AI?

a) Representing data and making decisions based on that data
b) Perceiving the surrounding environment
c) Understanding the dangers

What does a conditional statement do in programming?

a) It doesn't change the programming
b) It makes decisions based on certain conditions

The major difference between the programming in this lesson plan and the previous one, is a conditional statement.

a) True
b) False

The alarm will sound regardless of the time of day in the experiment.

a) True
b) False

3.6 Lesson 3 – Teaching Your Alarm: Learning from Data

3.6.1 Introduction – Theory

This lesson introduces the concept of machine learning, a subset of AI focused on enabling systems to learn and improve from experience without being explicitly programmed. Students will explore how the alarm system can "learn" from past data, such as adjusting the sensitivity of the sensor based on historical motion patterns.
Machine learning algorithms enable AI systems to learn patterns and relationships from data, allowing them to make predictions or decisions without explicit programming.
Supervised learning, one of the main branches of machine learning, involves training a model on labeled data to make predictions or classify new data. In the context of the alarm system, students can simulate supervised learning by adjusting the sensitivity of the sensor based on past data. Understanding the principles of machine learning empowers students to create intelligent systems that can adapt and improve over time.

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3.6.2 Hardware

- Micro:bit board
- USB cables for micro:bit
- Computer with internet access

3.6.3 Setup

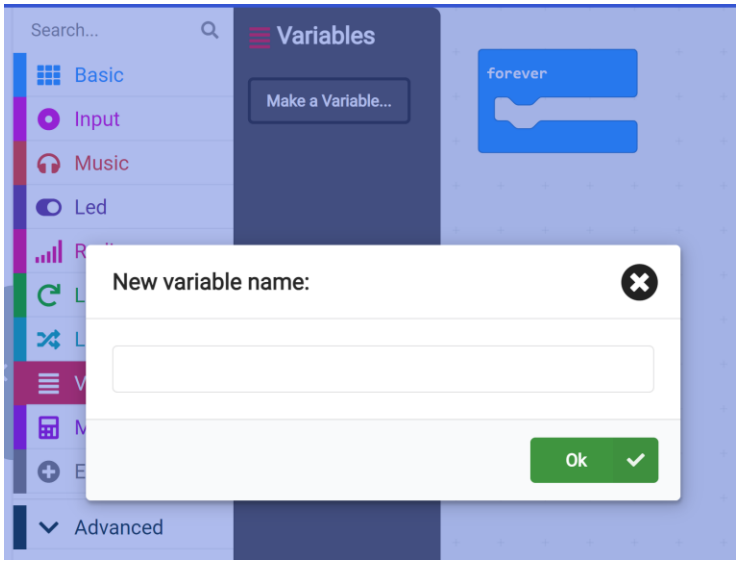
3.6.3.1 Wiring

- Connect the Micro:bit to a computer with an internet connection

3.6.3.2 Code

Create a variable:

Go to the Variables menu (in red) and press "Make a Variable":



Name the variable *sensitivity:*

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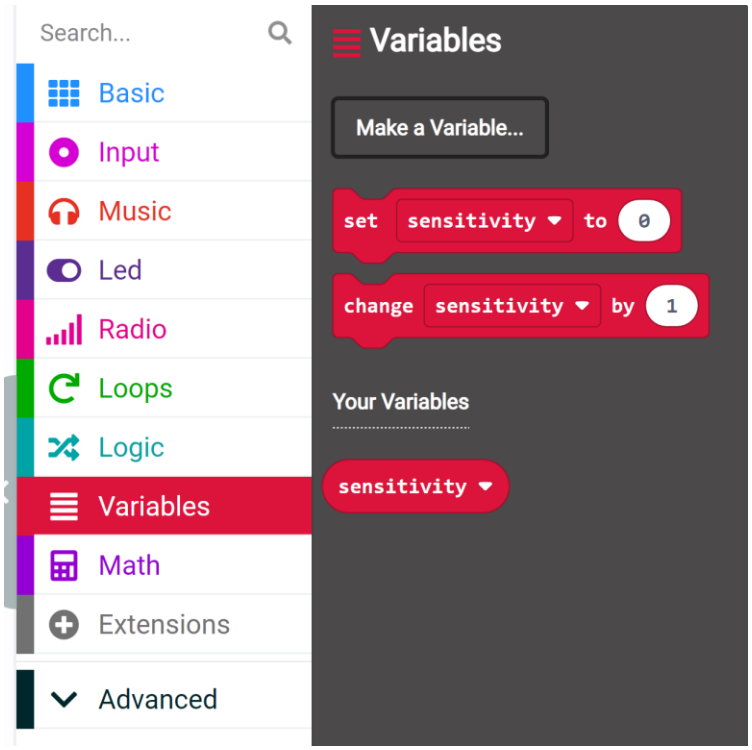
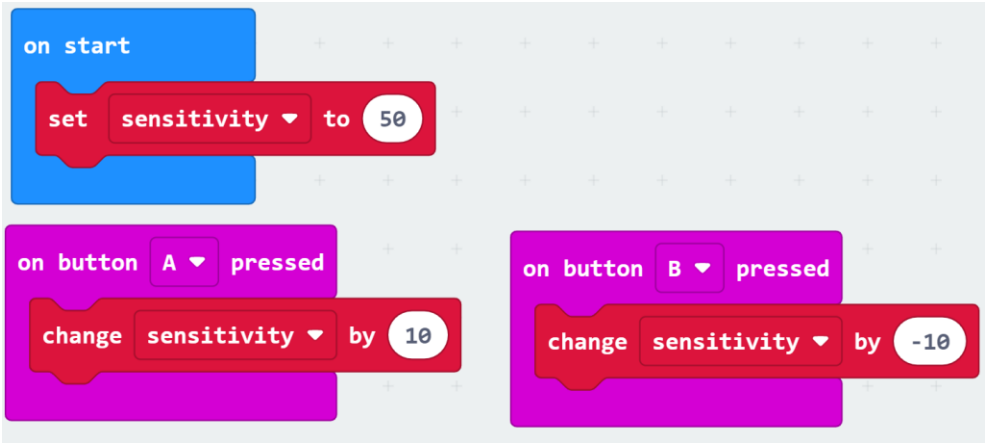


Write the code:



To make the exercise more suitable for the students, the teacher can adjust

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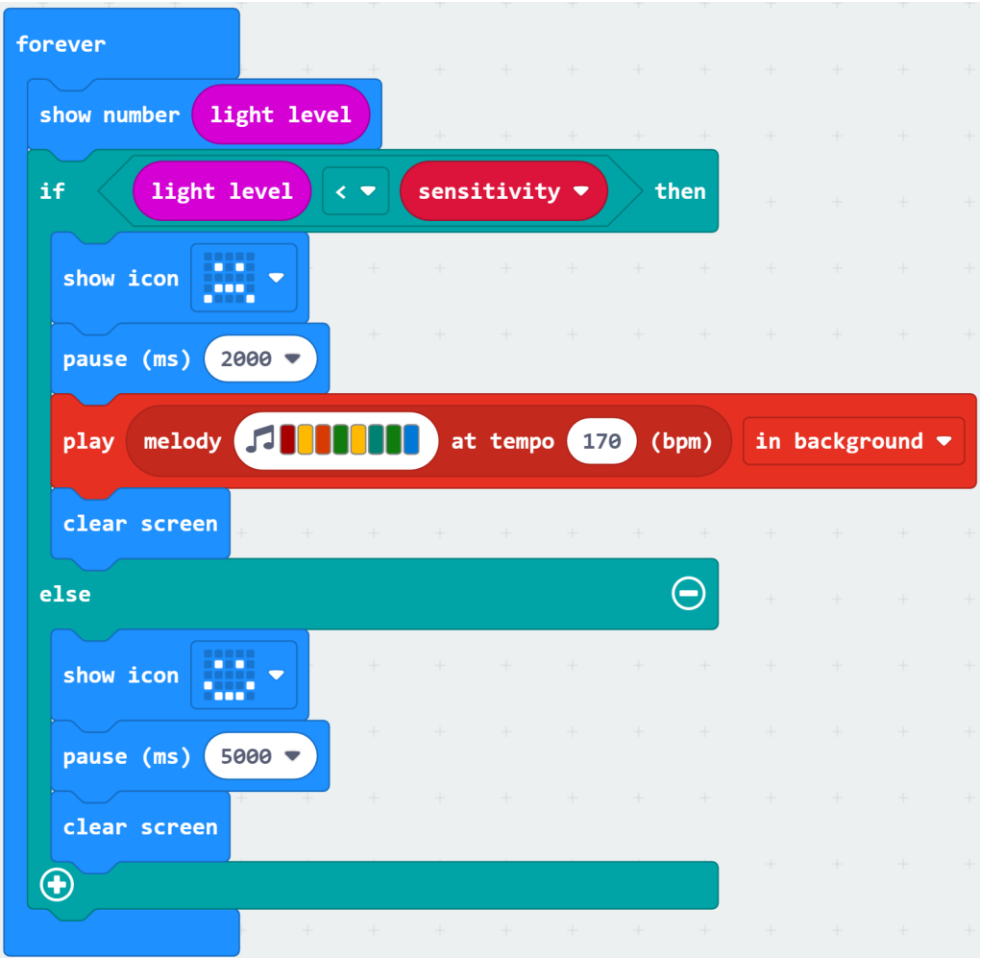

Example of a melody that can be used: (the teacher can ask the students to create their own melody)

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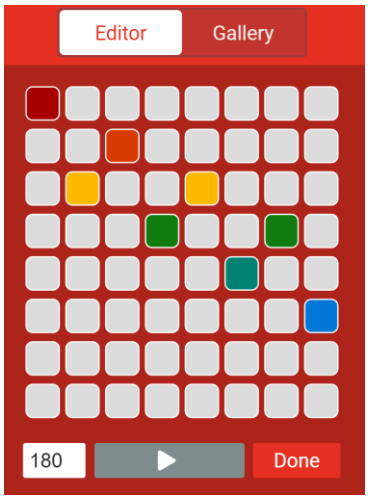

3.6.4 Exercise / Experiment 3

To help the students understand how the sensitivity affects the micro:bit, the teacher can start by asking the students to press the A button until they see the reaction of the micro:bit. Then, they can press the B button to resume to a lower sensitivity, allowing the micro_bit to return to the silent mode. With this activity, we can understand that the micro:bit is adjusting the sensitivity by memorizing the increasing and decreasing of its value.
The teacher can make the connection that AI uses the data it collects to be able to predict some events or a time with greater movement. The pressing of the button can mimic the learning and the action of the AI regarding the light intensity of the surroundings. In this case, the AI would adjust automatically it's sensitivity to light according to the light intensity.

In this lesson plan, the teacher can use the big idea of learning to explore issues like:

- What is machine learning, and how does it differ from traditional programming?
- How can the alarm system adapt and improve over time?
- What are some potential challenges or ethical considerations when implementing machine learning in devices?
- How can we balance the need for accuracy with privacy concerns when collecting and using data?

3.6.5 Questions

What is learning in AI?

a) Representing data and making decisions based on that data
b) Adapting to the environment based on experience or data
c) Understanding the surroundings

How can you simulate learning in the alarm system?

a) By increasing sensitivity to motion based on frequency of detection

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b) By using less the system
c) By standing in front of the sensor a long time

What does the variable track in this lesson?

a) Size of the person triggering the alarm
b) The time the person stands near the sensor
c) Frequency of motion detection

What happens to the alarm sensitivity as motion is detected more frequently?

a) It increases
b) It reduces

The alarm sensitivity remains constant in this lesson.

a) True
b) False

3.7 Lesson 4 – Communicating a presence - Natural interaction with Micro:bit

3.7.1 Introduction – Theory

This lesson explores natural interaction, emphasizing communication between devices using the micro:bit's radio communication. Students will create a system of 2 micro:bits that can interact with each other using radio waves to send messages. In this type of system, we call the micro:bit thar sends the signal, the sending and the one that captures the signal and gives the warning, the receiver. Natural interaction refers to the seamless communication between humans and machines, often mimicking the way humans interact with each other or the physical world. In the context of the micro:bit alarm system, students can simulate natural interactions using the radio waves to send signal from one micro:bit to another, warning the carrier of the receiver that there is an intruder near the alarm.
By designing intuitive controls and feedback mechanisms, students can create a user-friendly interface that enhances the user experience. Understanding natural interaction principles enables students to design and develop AI systems that are intuitive and easy to use.

3.7.2 Hardware

- Micro:bit board
- USB cables for micro:bit
- Computer with internet access

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- Infrared sensor module
- Jumper wires
- IO extender for micro:bit
- Micro:bit battery socket
- 2 AAA batteries

3.7.3 Setup

3.7.3.1 Wiring

- Connect the micro:bit and the IO extender for micro:bit
- Connect the VCC pin from the IR sensor to the 3V pin of the IO extender for micro:bit
- Connect the Out pin from the IR sensor to the 0 pin of the IO extender for micro:bit
- Connect the GND (ground) pin from the IR sensor to the 0V pin of the IO extender for micro:bit
- Ensure both devices are powered and ready for programming.
- Connect the system to a computer with the usb cable.

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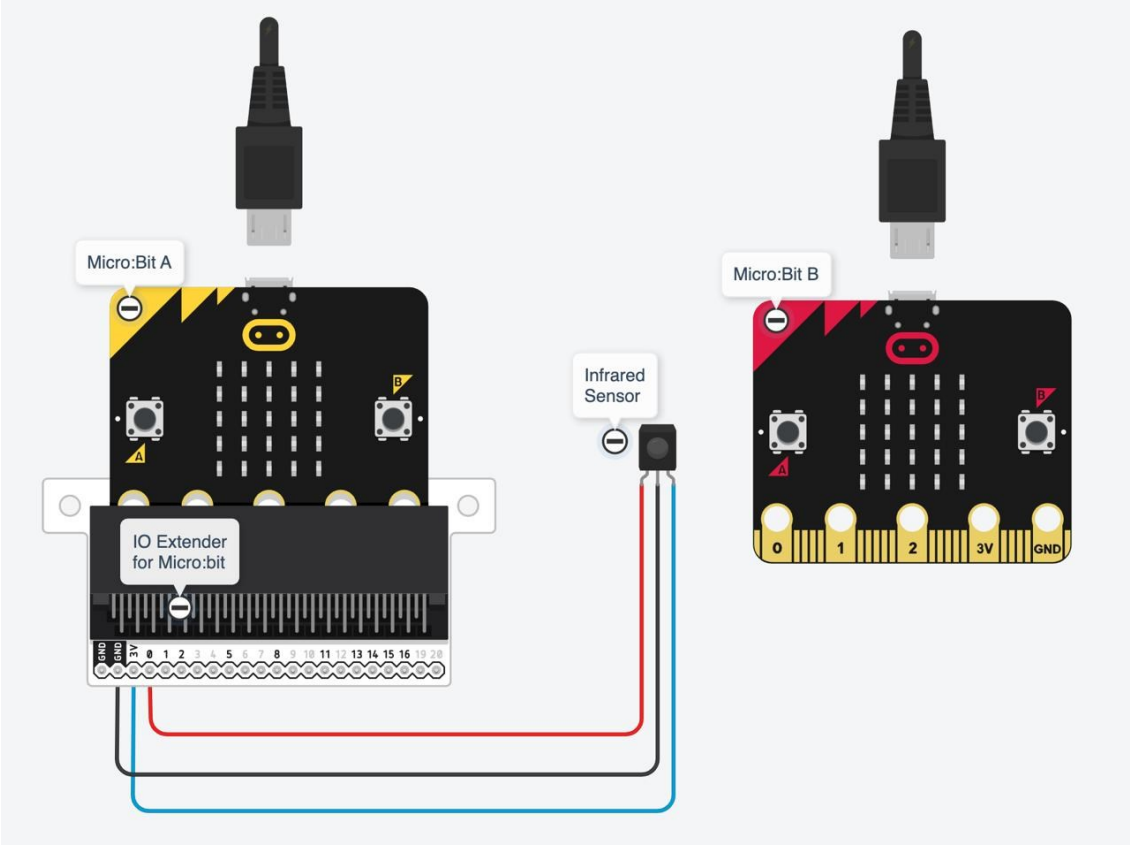

3.7.3.2 Code

Connect the Micro:bit to a computer with an internet connection

For the sending micro:bit:

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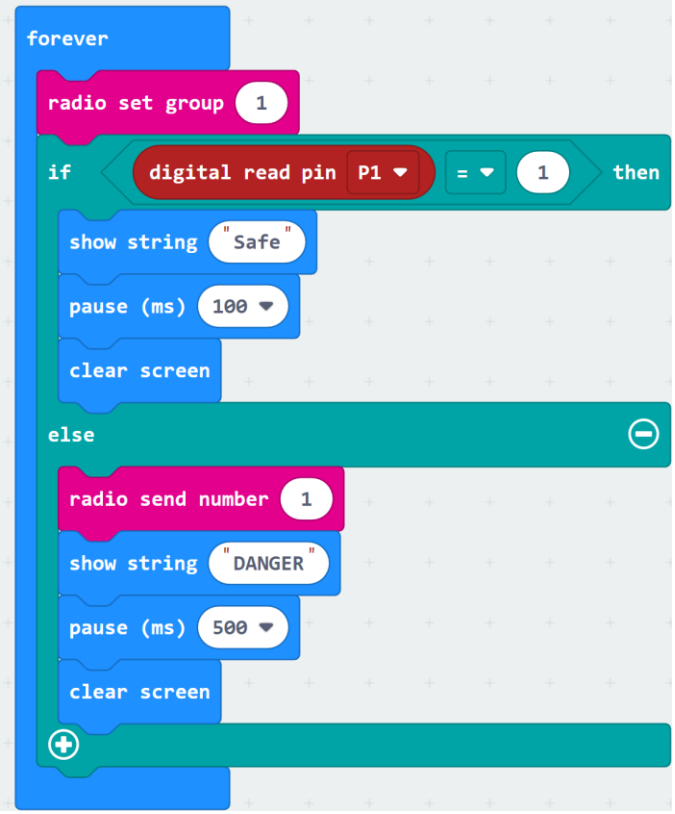
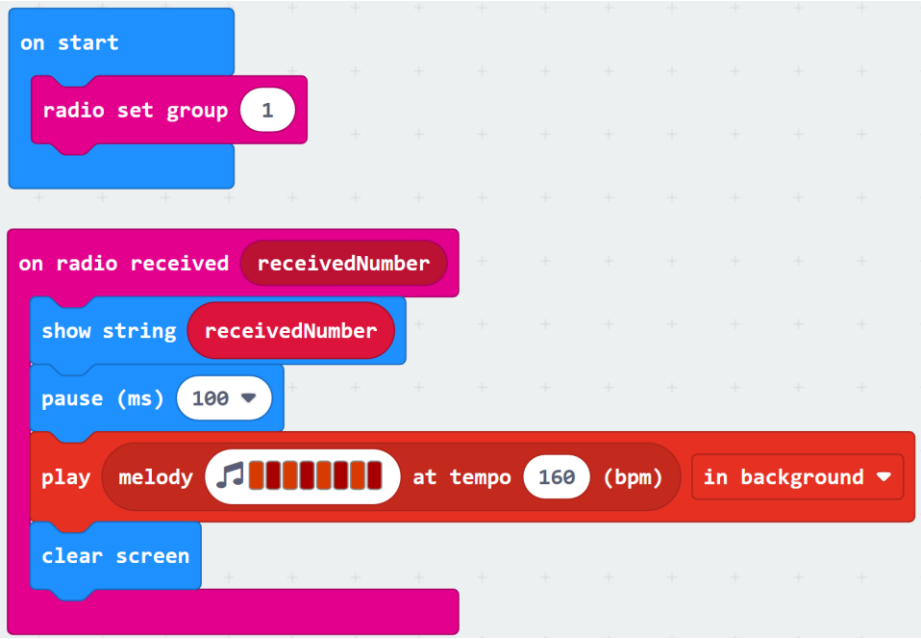


For the receiving micro:bit:



As for the melody, the teacher can challenge the students to create their own or they can use the following one as an example:

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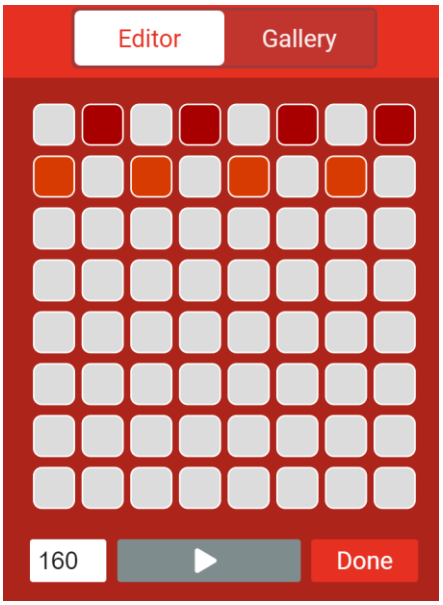

3.7.4 Activity

In this activity, students will receive the message from the micro:bit letting them know either they are safe or not.
This is one of the ways the micro:bit has to "communicate" with its user and it allows the teacher to explore the theme behind human and AI interactions, and the different ways it can be done.

In this lesson plan, the teacher can explore with the students the idea of communication and ways to interact:

- What are some different ways we can interact with devices?
- How does natural interaction enhance user experience?
- What are the advantages and limitations of using buttons, gestures, or voice commands to control devices?
- How can we design interfaces that are intuitive and easy to use for everyone?

3.7.5 Questions

How can you activate the alarm in this setup?

a) Representing data and making decisions based on that data
b) By simulating a trigger event such as holding the hand near the IR sensor.
c) Understanding the surroundings

What sensor can be used to simulate a knock or movement triggering the alarm?

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a) Temperature sensor
b) Infrared sensor
c) The accelerometer

What functionality of the micro:bit wasn't used to toggle the alarm state?

a) The light sensor
b) The infrared sensor

Natural communication using only one micro:bit involves using external devices to control the alarm system.

a) True
b) False

In this setup, the micro:bit's accelerometer is used to trigger the alarm system

a) True
b) False

3.8 Lesson 5 – Building Responsible Systems: Societal Impact of IoT Alarms

3.8.1 Introduction – Theory

This lesson focuses on the societal impact of IoT devices like alarm systems, emphasizing the social impact considerations and responsibilities associated with their design and use. Students will discuss topics such as emergency responses, privacy, security, and the potential consequences of false alarms. By examining real-world scenarios and discussing ethical dilemmas, students will gain a deeper understanding of the societal implications of AI and IoT technologies.
Social and ethical considerations are essential when designing and deploying AI and IoT systems, as they can have significant impacts on individuals, communities, and society. Privacy concerns arise from the collection and processing of personal data by IoT devices, while security vulnerabilities can lead to unauthorized access or misuse of sensitive information. False alarms not only inconvenience users but can also have serious consequences, such as unnecessary emergency responses. By discussing these topics and considering the broader societal implications of AI and IoT technologies, students learn to develop responsible and ethical AI systems that prioritize the well-being of users and society.

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3.8.2Hardware

- Micro:bit board
- USB cables for micro:bit
- Computer with internet access
- Infrared sensor module
- Jumper wires
- IO extender for micro:bit
- Paper cards available in the end of the project

3.8.3 Setup

3.8.3.1 Wiring

- Connect the micro:bit and the IO extender for micro:bit
- Connect the VCC pin from the IR sensor to the 3V pin of the IO extender for micro:bit
- Connect the Out pin from the IR sensor to the 0 pin of the IO extender for micro:bit
- Connect the GND (ground) pin from the IR sensor to the 0V pin of the IO extender for micro:bit
- Ensure both devices are powered and ready for programming.
- Connect the system to a computer with the usb cable.

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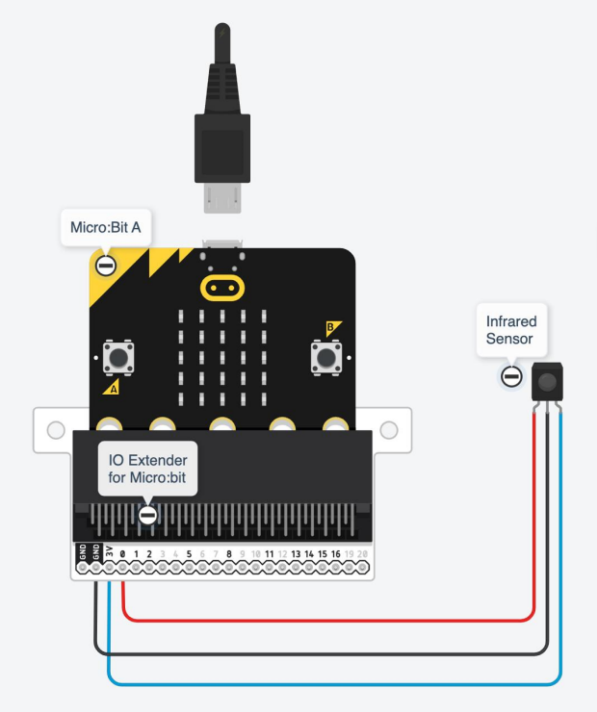

3.8.3.2 Code

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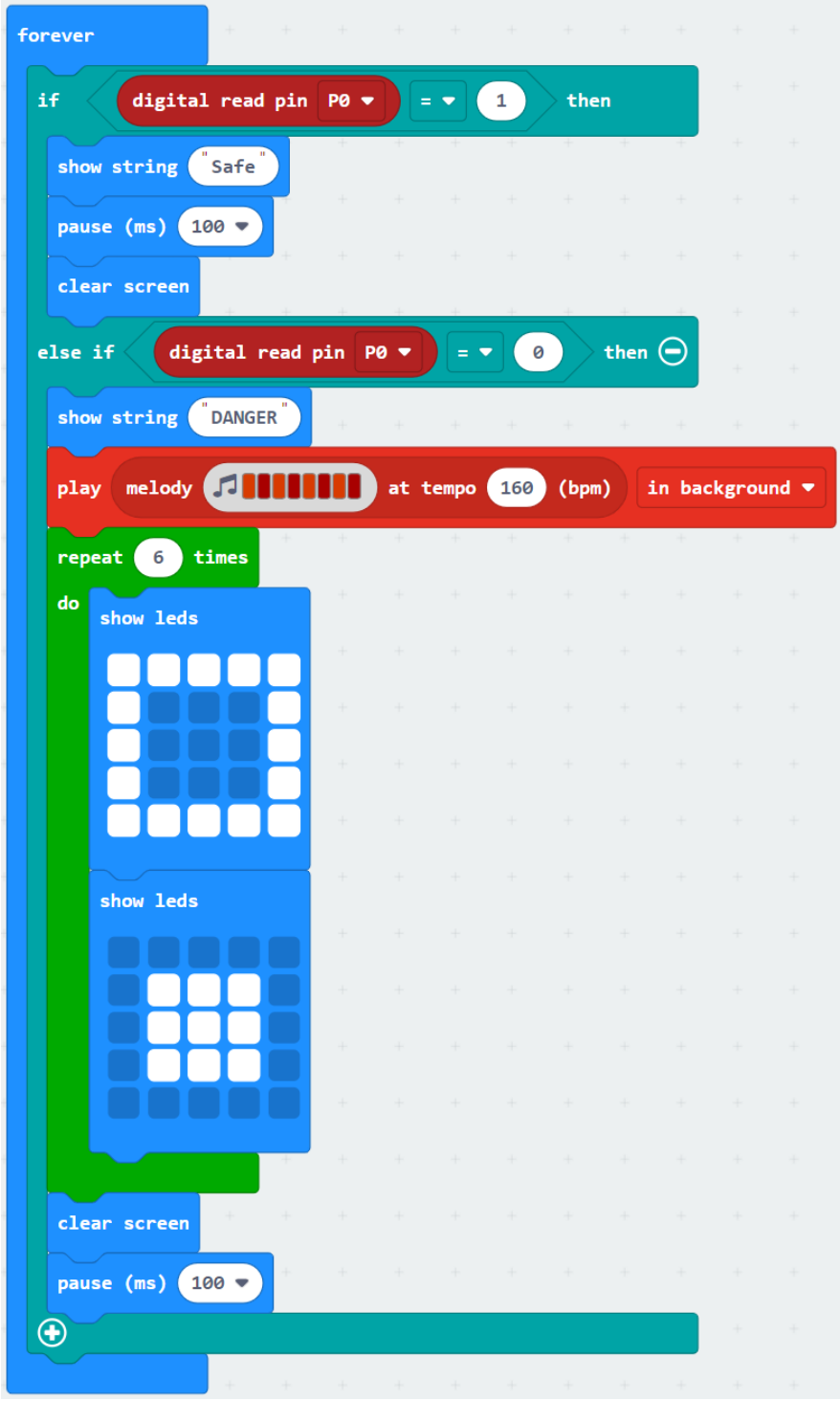

3.8.4 Exercise / Experiment 5

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This final lesson explores the societal impact of AI, focusing on the ethical considerations of using intelligent alarm systems.
The teacher can ask the students to randomly select one of the three cards and, without seeing it, place it in front of the IR sensor. They can then register whether the alarm went on or not. Students can then put that card aside and pick another one and do the same thing. After registering if the second card has triggered the alarm, students can use the third card. The point is that all three cards can trigger the alarm, but they represent different things (a human, a bird and a car). This means that two of the triggering events let to a false alarm.
With this conclusion, teachers can discuss with the students the negative impact of false alarms in the society, reinforcing that the emergency response spent to respond a false alarm might have left a real emergency unattended.

Students can afterwards brainstorm ways to mitigate potential risks associated with the alarm system, such as implementing encryption for data transmission or designing algorithms to minimize false alarms. They can also suggest the use of a camera, such as Huskylens (like the one used in the AI in vision project). The use of that camera will allow the alarm to recognize the face of the house owner and, apart from of warning when there is an intruder, it can also recognize different kind of objects, minimizing the false alarms.
Whoever, this option rises a few ethical issues, because it depends on reading and capturing peoples faces and this is a privacy violation because we don't ask people for permission to record their faces.

For this lesson plan, the teacher can take some time to explore the issues regarding ethics and dangers behind the use of the internet. From that exploration, the teacher can help students to apply that awareness and knowledge to the use of IoT and AI:

- What are some potential benefits of IoT alarm systems?
- What privacy concerns arise from having sensors and cameras in our homes?
- How can we ensure that IoT devices are secure from hacking or misuse?
- What are the implications of false alarms, both in terms of inconvenience and potential emergency response?
- How can we design and use IoT devices responsibly to minimize negative impacts on individuals and society?

Note: Teachers can explore the Huskylen as an improvement to the smart alarm, allowing students to have a clearer awareness of how AI functions and being able to recall the 5 Big Ideas but combined with another form of collecting data.

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3.8.5 Questions

What is societal impact in AI?

a) Representing data and making decisions based on that data
b) Adapting to the environment based on experience or data
c) The effect of AI on society, including ethical considerations

Name one potential risk associated with using AI-powered alarm systems?

a) Privacy invasion
b) Warning about an invasion

By implementing encryption for data transmission or designing algorithms we can minimize false alarms.

a) True
b) False

Ethical considerations are not important when developing AI technologies.

a) True
b) False

What are some examples of ethical considerations discussed in this lesson? (open answer)

Privacy, security, false emergency responses

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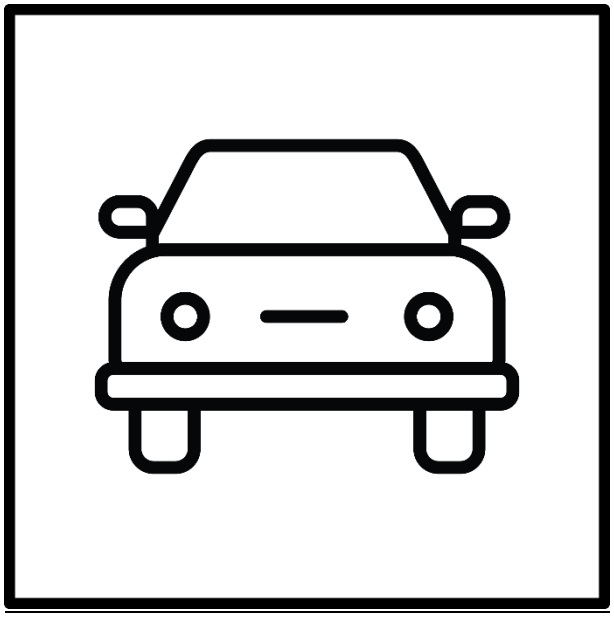
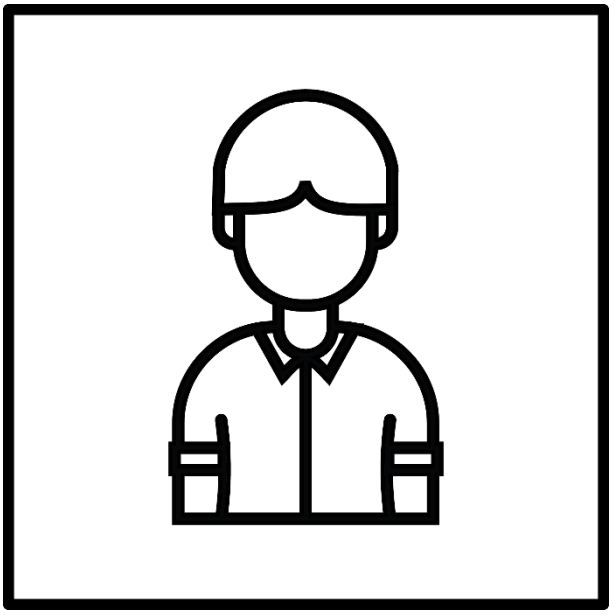
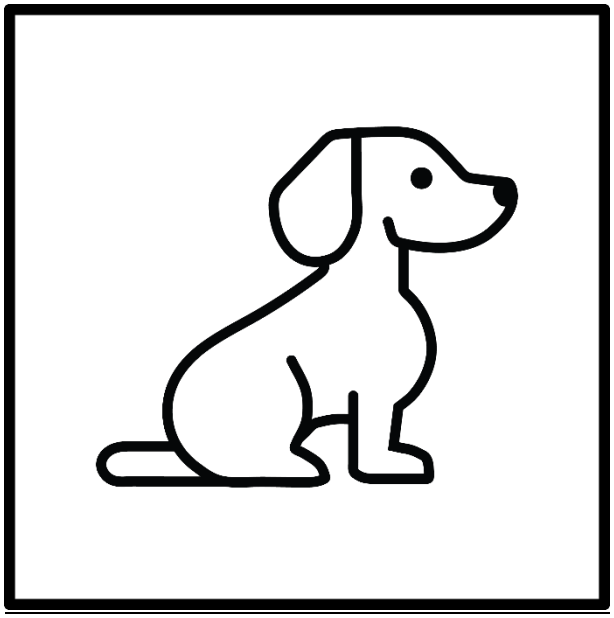
4. Cards for the lesson 5







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