

# ARTIFICIAL INTELLIGENCE STARTER KIT Tutorials



**DFROBOT**  
DRIVE THE FUTURE

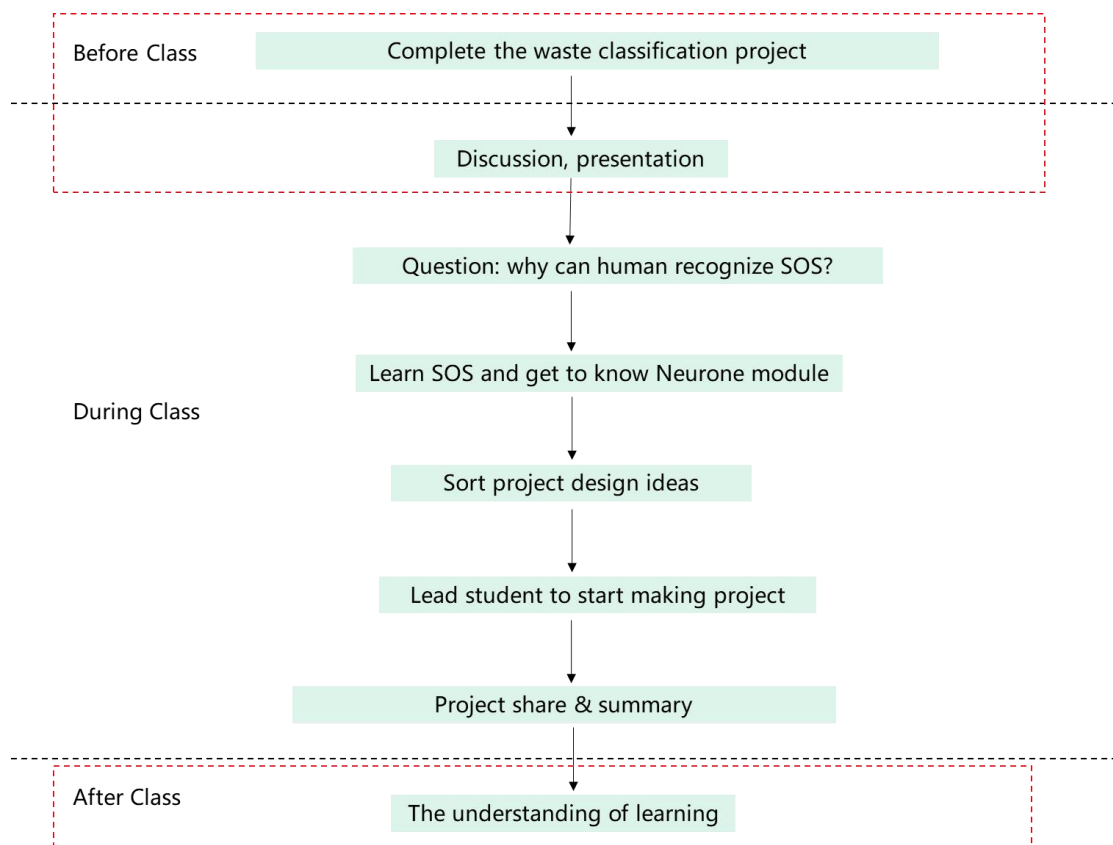
# Project 1 Ignite the Light of Wisdom

## Objectives

By the end of the lesson, students should be able to:

1. Understand and use the Neurone Module
2. Complete the project under the guidance of teachers
3. Summarize the general learning methods

## Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

## Materials Preparation

**Teachers:**

BOSON Artificial Intelligence Starter Kit (Power Mainboard\*1, Neurone Module\*1, Button\*1, LED\*1, Buzzer\*1)

### Students:

Textbook, pen

## Content

**Preface:** This is the first lesson of *How Does a Machine Learn?* in this chapter, also the first course of the part "Initial decipherment of Artificial Intelligence". In the previous lessons, we have experienced three kinds of AI technologies: natural language processing, computer vision, and expert system. The rapid development of the former two is closely related to the support of Machine Learning, of which the neural network is the vital part. This lesson initially decrypts the AI neural network in Machine Learning by the Neurone Module. In this course, students will use the Neurone Module to simulate the process of human identifying SOS and explore the essence of learning under your guidance.

### 1. Lead-in

**For reference:** In this part, you can introduce the famous shipwreck in history to students to lead in the topic, bring out the driving question, and analyze the function requirements step by step.

**Intro Question:** Do you know the history of Titanic? What is SOS?



**Driving Question:** From understanding that SOS is a distress signal to using SOS to rescue others or ask for help, why can humans accurately recognize SOS signal in this process?

#### Function Decomposition:

Function 1: send SOS;

Function 2: recognize SOS;

Function 3: respond to SOS

### 2. Knowledge & Skills

**For reference:** This part mainly includes the knowledge and skills related to the project and makes a brief introduction to SOS signal and Neurone Module.

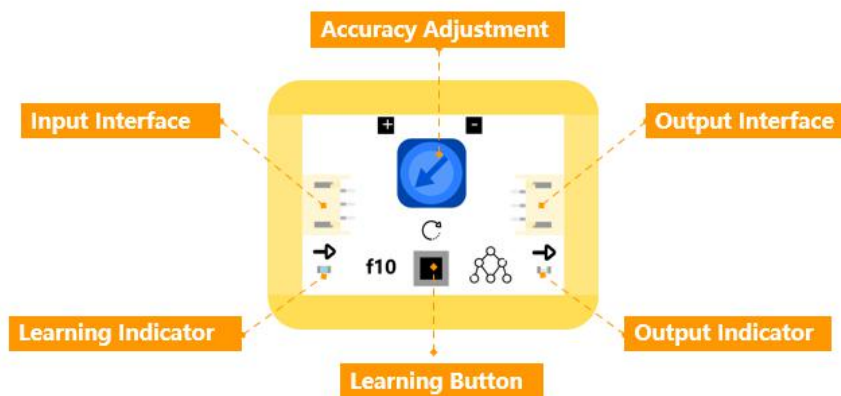
## SOS

SOS is a universal Morse code distress signal. It is a combination of three dots followed by three dashes followed by three dots(. . . \_ \_ . . .), which is easy to send and easily recognized. Any untrained people can easily use things at hand to send such signals or identify them.

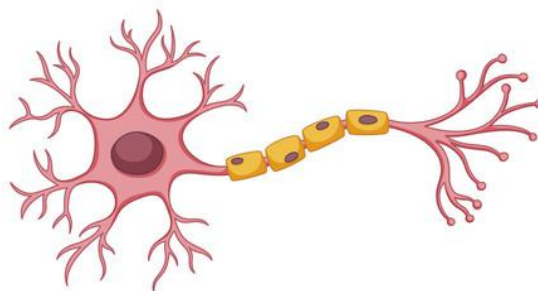


## Neurone Module

Neurone module helps us understand the function module of neural network in “Machine Learning” . It simulates the neurons in our brain.



Neuron is the basic structure and functional unit of neural network, which is responsible for receiving, integrating, and transmitting information in human body.

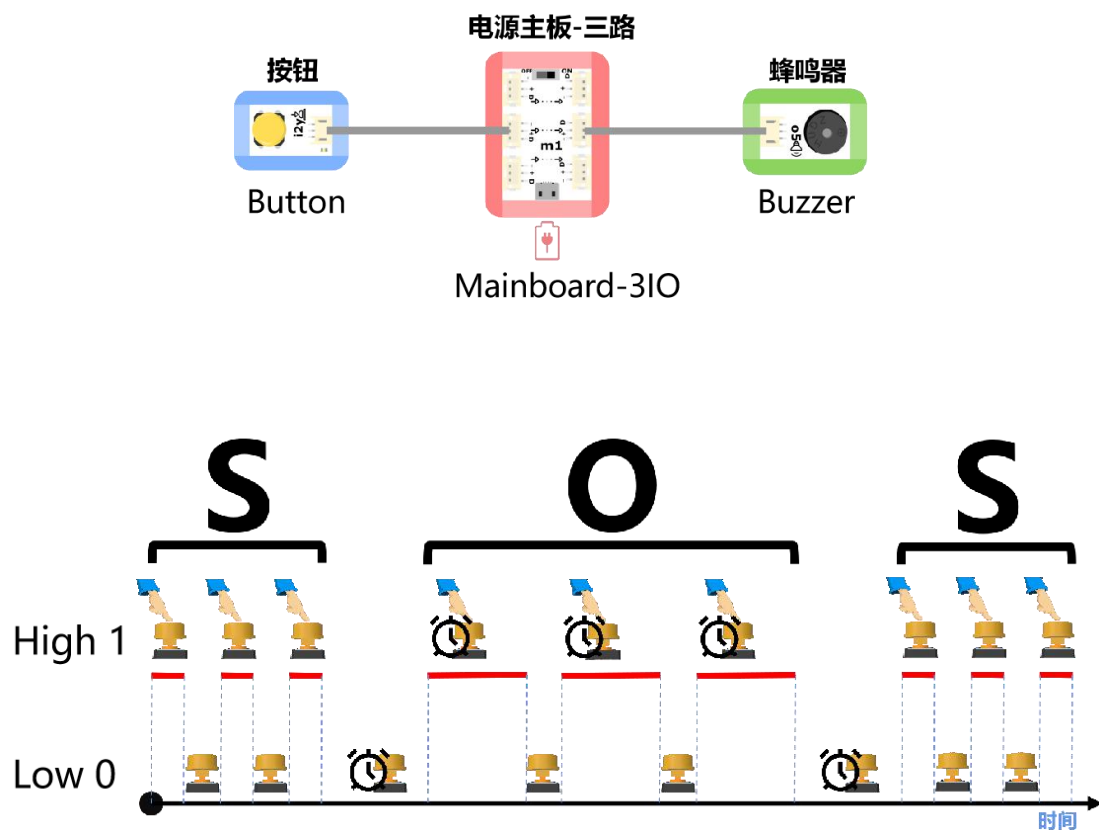


### 3. Design Analysis

**For reference:** This part aims to help students formulate design ideas based on the knowledge and skills learned in the previous part.

#### Design Ideas

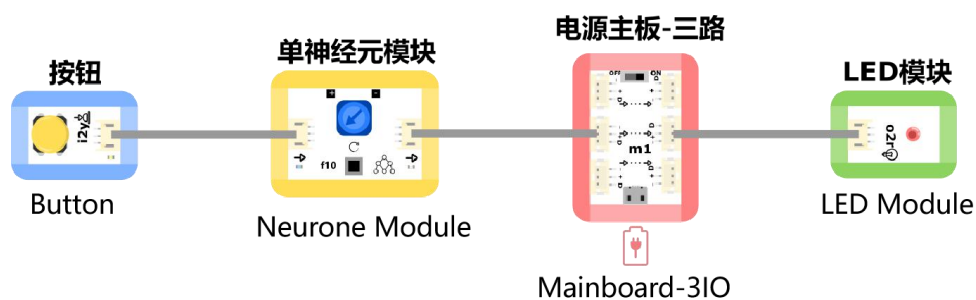
Pressing and releasing the button module repeatedly can help to send the SOS signal(function 1), and it seems that "learning" and "output" functions on the neurone module can realize the function 2 and 3.



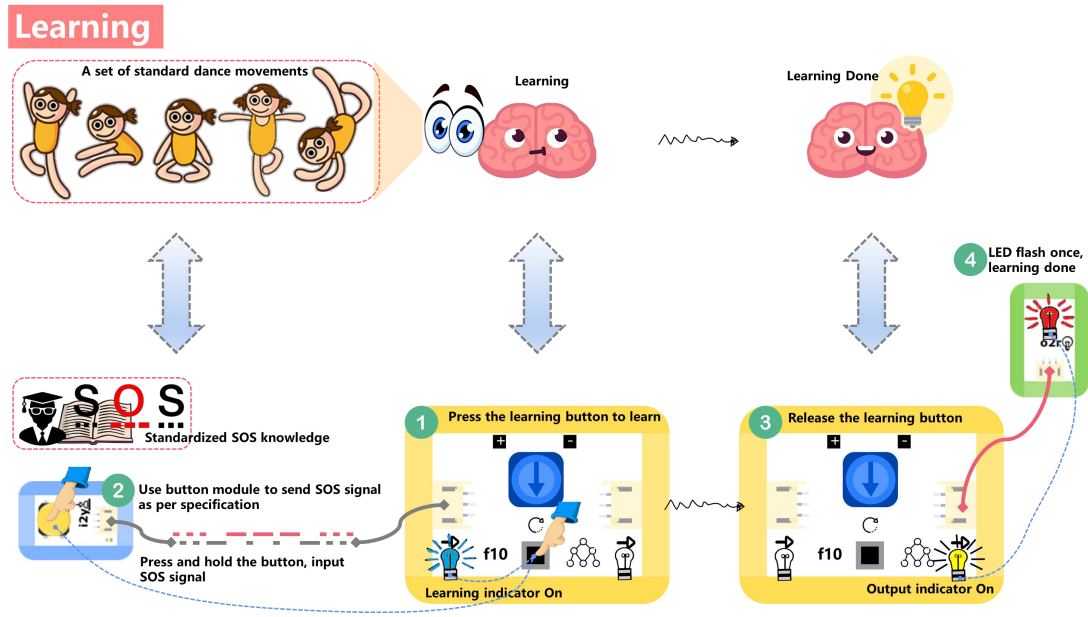
### 4. Project Implementation

**For reference:** Since the principles behind this project are abstract and not easy to understand, you need to lead students to complete the project and make a detailed explanation.

#### 1. Hardware Connection



## 2. Learning

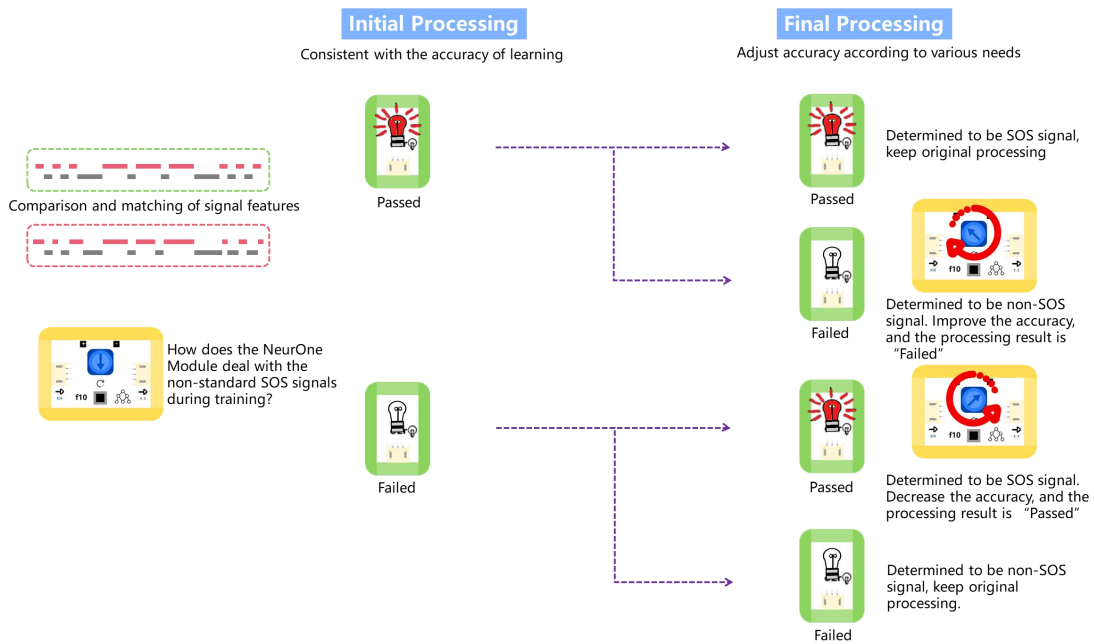
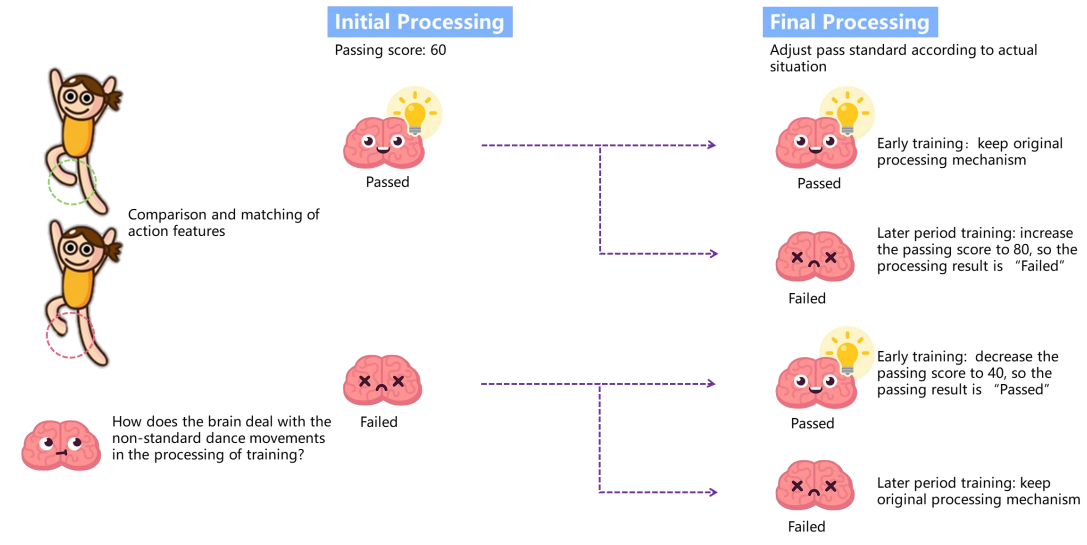


\* The NeurOne Module can only learn to record data once. When users press the learning button to record data again, the last recorded data will be overlaid with new data.

\* The NeurOne Module can learn multiple data at one time. For example, press the button 10 times(must be within 10 seconds).

### 3. Adjustment

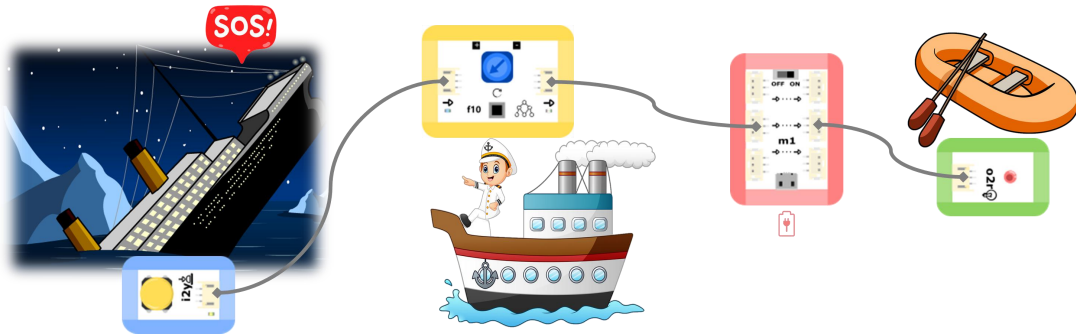
## Adjustment



### 4. Hands-on Practice

## Hands-on Practice

Continuous training and adjustment enable the brain to quickly and accurately identify SOS signal and make the decision of rescue.



## 5. Project Share

**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? ; Do you encounter any difficulties in making, and how do you overcome them; What do you think about Artificial Intelligence? Let two students share their work and ideas after a given time.

## 6. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Question:** Now can you answer the driving question at the beginning of this lesson---" Why can we recognize SOS signal?"

**Answer:** We remembered the characteristics of SOS signal in the process of learning and training, so in practice, we can identify whether it is SOS by comparing and matching the received signal with that in our brain.

## Extended

**For reference:** At the end of this lesson, you can assign homework to students as the extension of the course.

**Question:** Does this lesson bring you any ideas on effective learning methods, or as the title says, how to ignite the light of your wisdom?

**Answer:** Learning is not just simple memory. It requires us to think and extract the characteristics of knowledge, and then constantly adjust, optimize, and expand in actual practice.

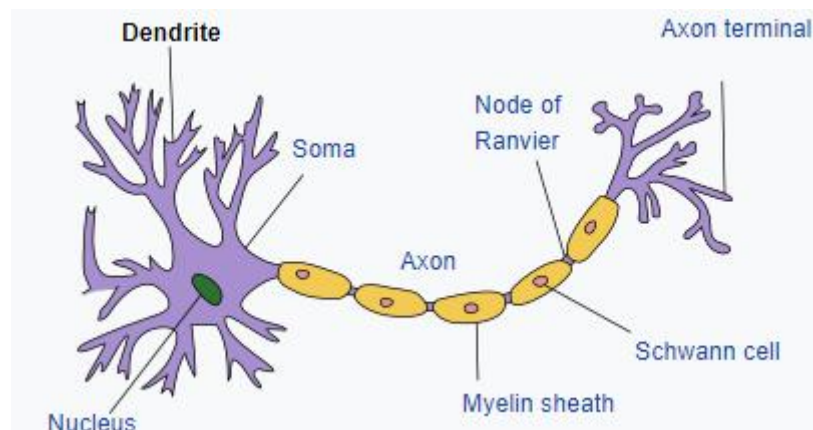


## Resources

### Neuron & Neural Network

Neuron, also known as nerve cell, is the basic unit of communication in the nervous system. It senses changes in environment and receives signal, and then transmits information to other neurons to allow them to react. Neurons account for about half of the nervous system, and the rest are mostly composed of Glial cells. The basic part of a neuron includes dendrites, cell bodies, axons, and synapses. In order for neurons to communicate, they need to transmit information both within the neuron and from one neuron to the next. This process utilizes both electrical signals as well as chemical messengers. The dendrites of neurons receive information from sensory receptors or other neurons. This information is then passed down to the cell body and on to the axon. Once the information has arrived at the axon, it travels down the length of the axon in the form of an electrical signal known as an action potential.

There are about 86 billion nerve cells in a human brain, of which 70 billion are cerebellar granule cells.



**Biological Neural Networks** generally refer to the network composed of biological neurons, cells and contacts, which is used to generate biological consciousness and help organisms think and act.

#### Definition of Human Learning

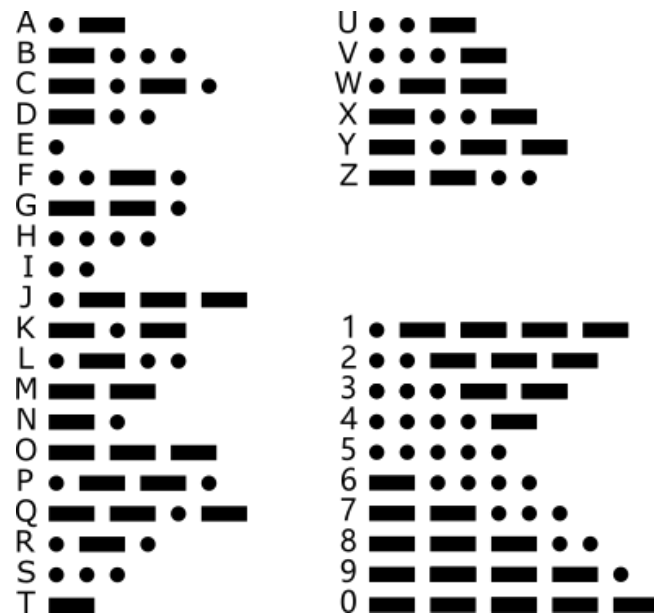
Human learning is a process in which a person forms a certain comprehension or sums up a certain rule about a kind of problem based on his experience, and then utilizes these principles to analyze and determine new problems.

#### Definition of Machine Learning

Machine learning (ML) is the study of computer algorithms that improve automatically through experience and by the use of data. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so.

### Morse Code

Morse Code, invented by Alfred Weir and Samuel Morse in 1836, is a method of transmitting textual information using a series of on/off signals of two different lengths,



The timing in Morse code is based around the length of one "dit". From the dit length we can derive the length of a "dah" (or "dash") and the various pauses:

- Dit: 1 unit
- Dah: 3 units
- Intra-character space (the gap between dits and dahs within a character): 1 unit
- Inter-character space (the gap between the characters of a word): 3 units
- Word space (the gap between two words): 7 unit

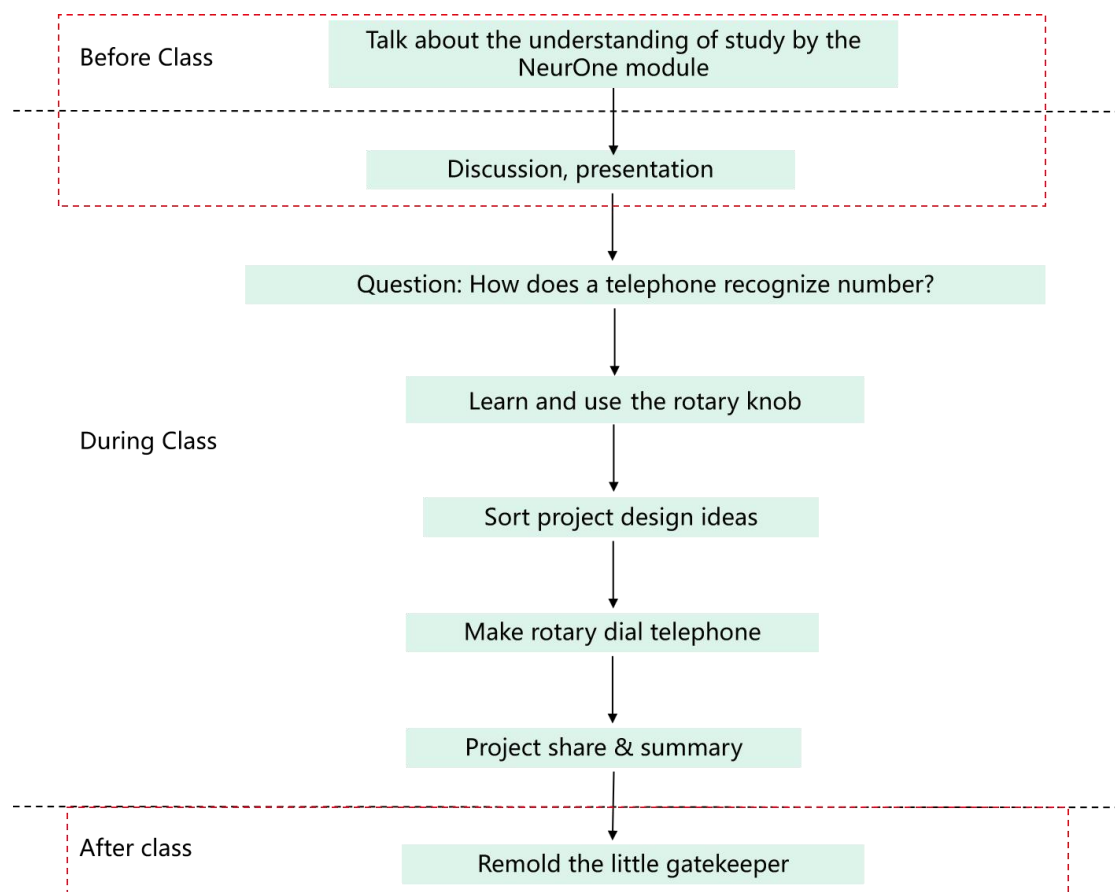
## Project 2 Rotary Dial Telephone

### Objectives

By the end of the lesson, students should be able to:

1. Understand and use the rotation Module
2. Complete the project under the guidance of teachers
3. Further comprehend the general learning methods

### Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

### Materials Preparation

Teachers:

Computer with Mind+ installed, BOSON Artificial Intelligence Starter Kit (Microbit\*1, Expansion Board\*1, Neurone Module\*1, Rotation module\*1)

### Students:

Textbook, pen, scissor, utility knife, double-side adhesive tape, paper box, ice cream stick

**\*The tools and consumables required for the project can be freely selected.**

## Content

**Preface:** This is the second lesson of *How Does a Machine Learn?* In the previous lesson, we learned and used the Neurone module. In this chapter, we are going to continue to make a project with it for further understanding. Starting from the rotary dial telephone that was used in the recent period, students will make a telephone that can recognize the phone number using the neurone module.

### 1. Lead-in

**For reference:** This part uses the old-fashioned rotary dial telephone to lead in the topic, which aims to improve students' ability to find and analyze problems. The teacher puts forward the problems to trigger students to discuss, and then discover the driving problems of this project, disassemble the functional requirements and general steps, and connect with the knowledge and skills mastered in the previous lesson to initially clarify their own design ideas.

**Intro Question:** Do you know the rotary dial telephone? What is the difference between it and modern telephones?



**Driving Question:** In the last lesson, we learned that a neurone module can recognize SOS, so in this lesson how do you use a neuron module to recognize a phone number?

#### Function Decomposition:

Function 1: dial the number

Function 2: recognize the number

Function 3: respond to the recognized number

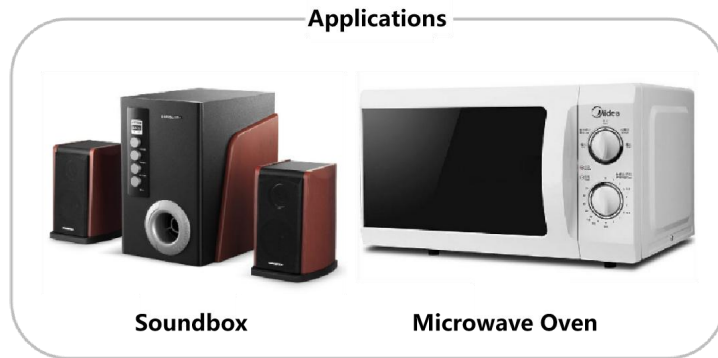
## 2. Knowledge & Skills

**For reference:** This part mainly includes the knowledge and skills related to the project, let students learn and use the rotation module.

### Rotation Module



Rotation Module, No. i1  
Blue Module (refers to input)



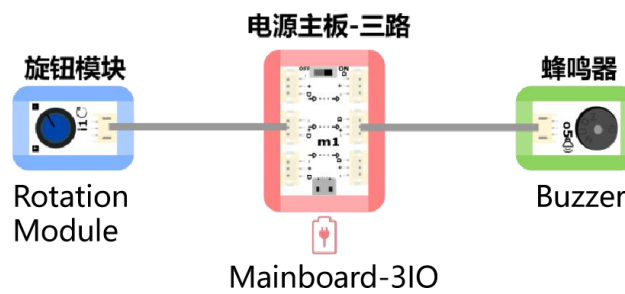
Soundbox

Microwave Oven

**Instruction:**

There is a rotation arrow marked on the module. Adjust the knob to control the input analog signal value.

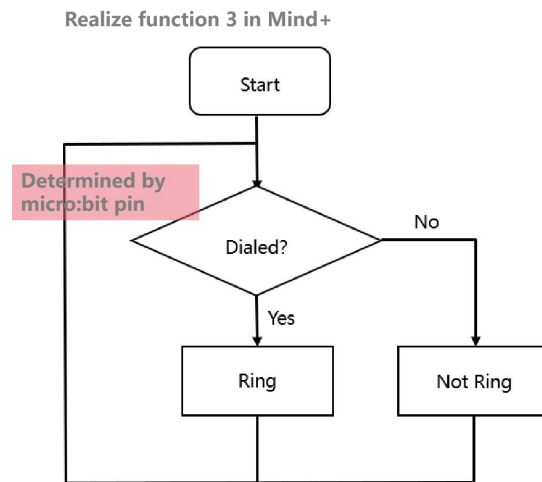
Adjusting the volume by rotation module:



## 3. Design Analysis

**For reference:** This part aims to help students formulate design ideas based on the knowledge and skills learned in the previous part.

## Program Logic Diagram



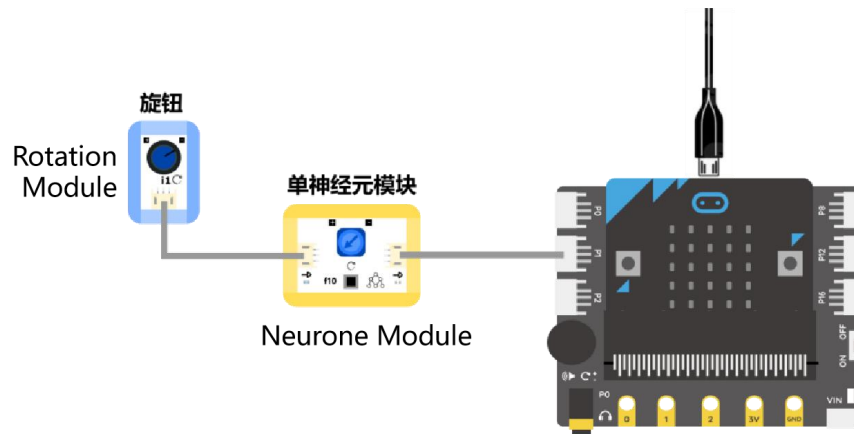
## Structure Design

Function	Design Sketch
The structure design of number input in function 1	<i>#Combining real telephones and knobs to design</i>

## 4. Project Implementation

**For reference:** Implements the project by arranging stage scenes, writing programs, and building structures. You should lead students to complete them step by step.

## 1. Hardware Connection



## 2. Arrange Stage Scenes

*Background:* upload background-"emergency center.png"

*Role:* upload character-"telephone.sprite3"



## 3. Write Programs

*Phone role program*

#When the program starts, every time the knob turns to 1, 2, 0, the phone on the stage vibrates and plays the ring sound.

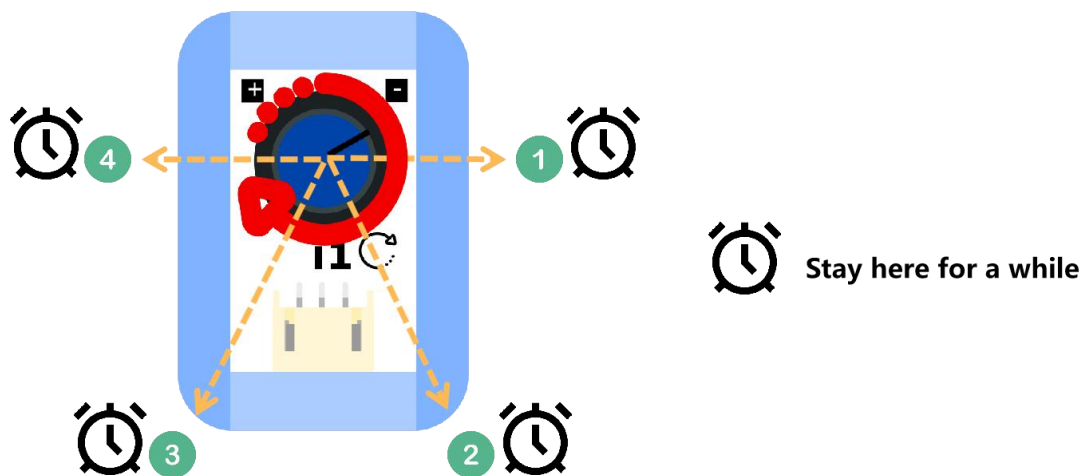
```

when clicked
  go to x: 147 y: 86
  forever
    switch costume to Not ring
    wait until read digital pin P0
    start sound Ring
    repeat 20
      switch costume to Ring 1
      wait 0.1 seconds
      switch costume to Ring 2
      wait 0.1 seconds
  
```

#Change shape to realize telephone vibration effect.

#### 4. Adjustment

*Learning stage:* Rotate the knob to learn according to the sequence shown in the figure below, release the learning button, and the phone will ring on the stage to indicate successful learning.



*Adjustment stage:* According to the rotation speed and sequence of the learning stage, adjust the neurone module according to your needs.

- If Strictly follow the learned actions, and the phone does not ring, indicating that the accuracy is too high.

Adjust the blue precision adjustment knob counterclockwise to lower the matching accuracy of the current input value and the recorded value, also, reduce the requirements. When the arrow of the blue rotary knob points to "-", the accuracy is the lowest.

- If Turn to a random angle, the phone rang, indicating that the accuracy is too low.

Adjust the blue precision adjustment knob clockwise to improve the matching accuracy of the current input value and the recorded value, and the requirement becomes higher. When the



arrow of the blue rotary knob points to "+", it means that the accuracy is the highest, because it is difficult to accurately repeat the rotation speed of the knob when learning, so it is difficult to achieve the project effect with the highest accuracy.

## 5. Hands-on Practice

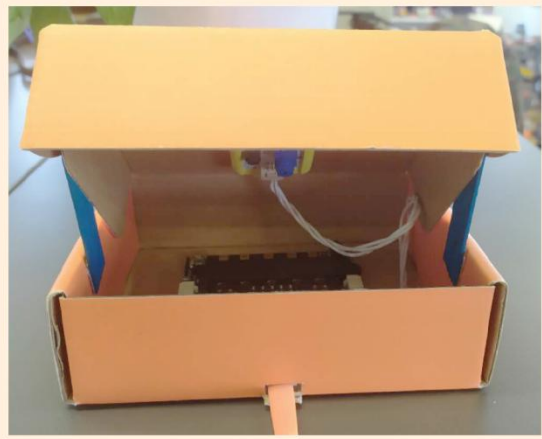
**Material:** paperbox, ice cream stick

**Tools:** scissor, knife, double-side adhesive tape

Front view



Back view



Internal view



Side view



## 6. Debug

### 5. Project Share

**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? Do you encounter any difficulties in making, and how do you overcome them; What do you think about Artificial Intelligence? Let two students share their work and ideas after a given time.

## 6. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Question:** Why can the neurone module recognize the "120" phone number?

**Answer:** Because in the learning process, it remembers the signal characteristics sent by the knob at positions "1", "2" and "0", so it can recognize the 120 phone number.

## Extended

**For reference:** At the end of this lesson, you can assign homework to students as an extension of the course.

**Question:** Can you add a knob password to the project little gatekeeper?

## Resources

### Telephone

The **telephone** is a long-distance communication device that can transmit and receive sound. As early as the 18th century, the term "telephone" has existed, which was used to refer to a microphone stringed with wires (a cup is stringed with a wire). The emergence of the telephone is attributed to Alexander Graham Bell. The principle of the early telephone is: the sound of speech is a compound vibration in the air, which can be transmitted to a solid and transmitted on a conductive metal through electric pulses. Bell applied for a patent for the telephone in March 1876.



### Principles:

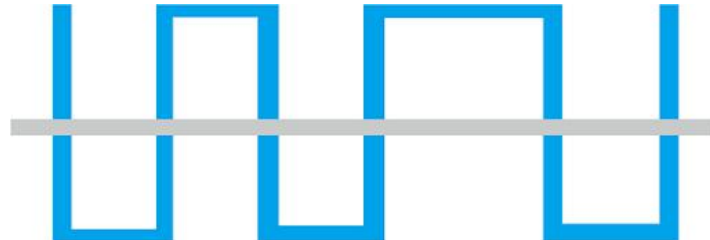
Telephone communication is a communication technology that uses the medium of "electricity" to transmit language through the mutual conversion of sound energy and electric energy. To communicate between two users, the simplest form is to connect two telephones with a pair of lines.

1. When the caller picks up the telephone and speaks to the microphone, the vibration of the vocal cords excites the air to vibrate, forming sound waves.
2. The sound wave acts on the microphone to generate current, which is called voice current.
3. The voice current is transmitted along the line to the receiver of the other phone.

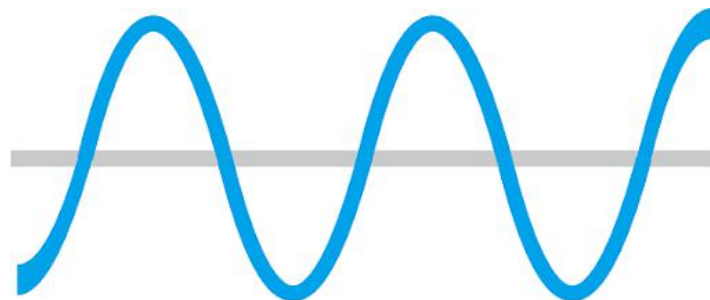
4. The function of the receiver is just the opposite of that of the microphone-it converts the electric current into sound waves and transmits them to the ears through the air.

### Digital Quantity and Analog Quantity

Physical quantities that are discrete in both time and quantity are called **digital quantities**, and the signals that represent digital quantities are called digital signals, such as the signal emitted by a button.



Physical quantities that changes continuously in time and value are called **analog quantities**, and signals that represent analog quantities are called analog signals, such as the signal emitted by a rotary knob.



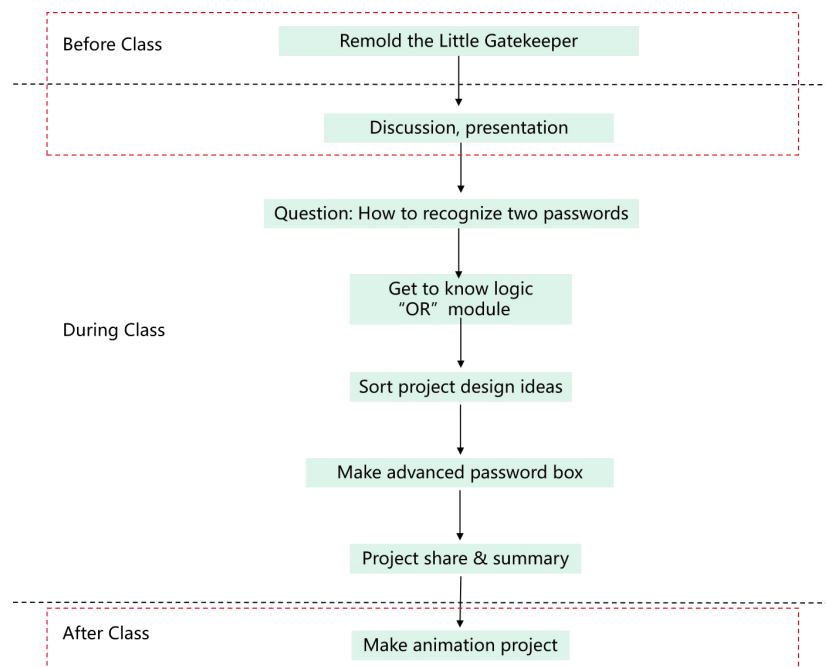
# Project 3 Advanced Password Box

## Objectives

By the end of the lesson, students should be able to:

1. Understand and use Logic OR Module
2. Complete the project under the guidance of teachers
3. Learn the limit of a single Neurone module, and understand the function of neural network

## Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

## Materials Preparation

### Teachers:

BOSON Artificial Intelligence Starter Kit (Power Mainboard\*1, Neurone Module\*2, Rotary Knob\*2, Servo\*1, Servo-controlling Module\*1, Logic OR Module\*1)

### Students:

Textbook, pen, utility scissors, knife, double-side adhesive tape, paper box

\*The tools and consumables required for the project can be freely selected.

## Content

**Preface:** This is the third lesson of *How Does a Machine Learn?* In the previous two lessons, we learned the function of neurons in neural network. In this chapter, we are going to build this simplest “network” with two Neurone modules to initially learn the function of neural network in machine learning. Starting from the password box, we will build an advanced password box with Neurone module and logic OR module based on the previous lesson.

### 1. Lead-in

**For reference:** This part introduces the question that how to protect private rarities to lead in the topic, improving students’ ability to find and analyze problems. The teacher puts forward the problems to trigger students to discuss, and then discover the driving problems of this project, disassemble the functional requirements and general steps, and clarify the logical connection between two passwords.

**Intro Question:** Everyone has their own precious “treasures” , how do you protect yours from being stolen?



**Driving Question:** The password box can store valuables. We can use the knob and Neurone module to make a password lock, but have you found that the Neurone module can only learn one password signal each time? If we let it learn another different password signal at the same time (that is, each of the password signals can open the box), then we will encounter the following troubles after learning the first password signal:

1. When learning the second password signal, the first password signal will be overwritten and deleted;
2. If you want to qualify the second password signal through adjustment, you can only adjust the accuracy to the minimum, then the password box will be useless.

In a final analysis, the reason is that the characteristics of the two password signals are not the same, while a neuron module can only learn one feature at a time, so how can we let the project device learn two password signals?

#### Function Decomposition:

Function 1: Record two passwords;

Function 2: Identify the password;

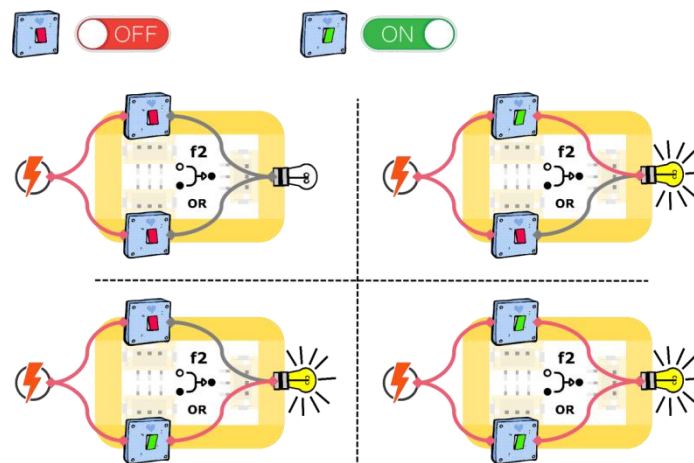
Function 3: Open the password box lock.

## 2. Knowledge & Skills

**For reference:** This part mainly includes the knowledge and skills related to the project, let students learn and use the Logic OR Module.

### Logic OR Module

The relationship between the two inputs of the logic OR module is the same as the relationship between the two conditions of the logic OR in the program. We use two switches to refer to two inputs, "OFF" means no input signal, and "ON" means there is an input signal, the light on or off indicates the presence or absence of output signal.

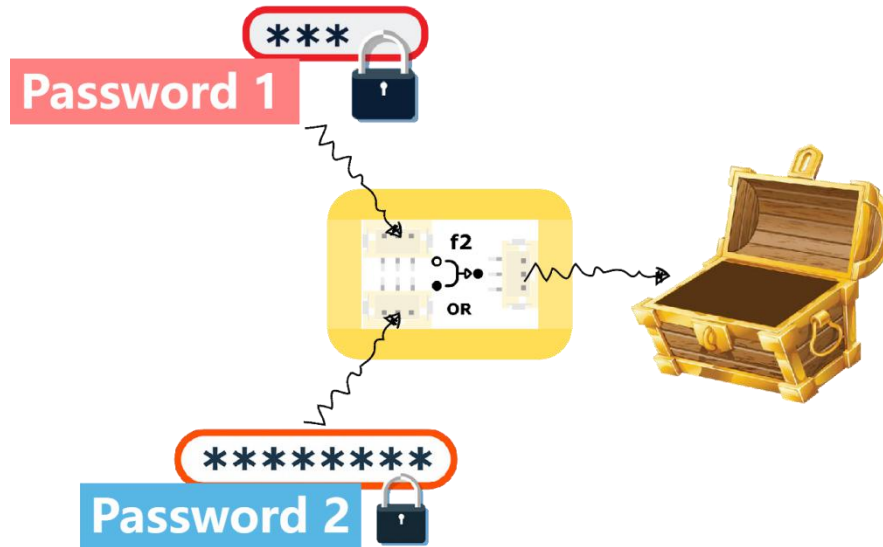


## 3. Design Analysis

**For reference:** This part aims to help students formulate design ideas based on the knowledge and skills learned in the previous part.

### Design Idea

In the learning and adjustment stage, two Neurone modules can be used to learn two passwords at a time, and then use logic OR modules to connect them to achieve the effect that any correct password can open the password box.



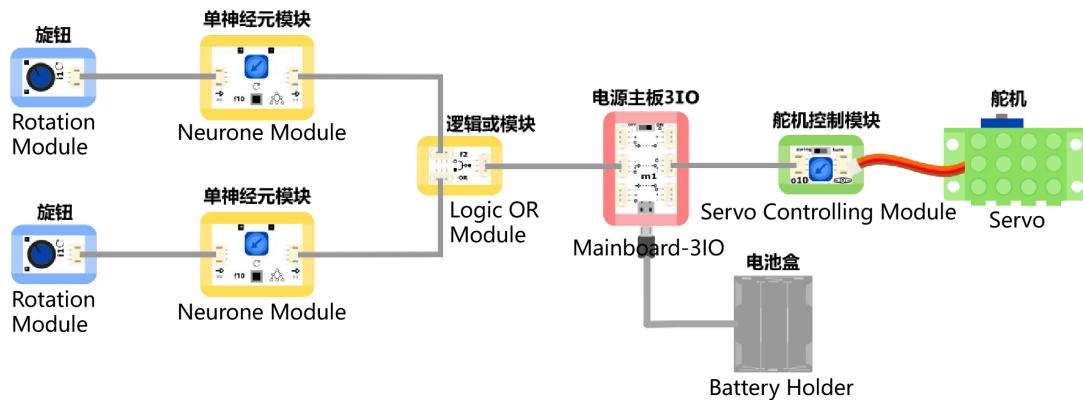
### Structure Design

Function	Design Sketch
Structure Design of password input in function 1	<i>#Combined with the rotary dial telephone of the previous class to guide students to design</i>
Lock structure design in function 3	<i>#Guide students to design from the rotation effect of the servo</i>

## 4. Project Implementation

**For reference:** Implements the project by connecting the hardware and building the structure. Teachers lead students to complete them step by step.

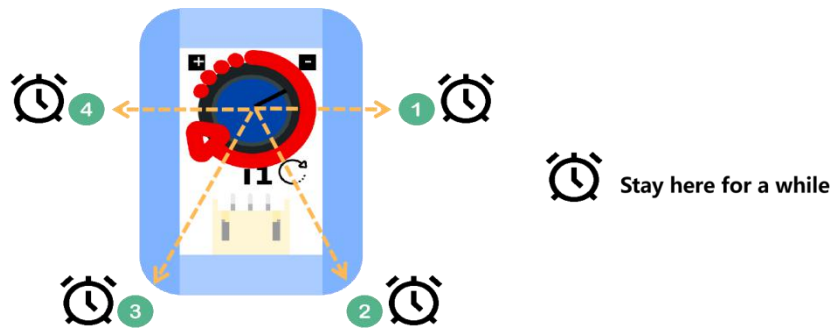
## 1. Hardware Connection



\*Select "turn" mode in servo-controlling module.

## 2. Learning and Adjusting

*Learning stage:* Rotate the knob to learn according to the sequence shown in the figure below, release the learning button, and the servo will rotate on the stage to indicate successful learning.



*Adjustment stage:* According to the rotation speed and sequence of the learning stage, adjust the Neurone module according to your needs.



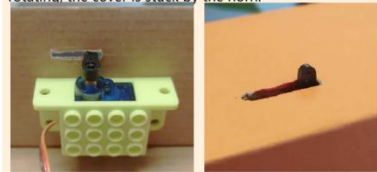
### 3. Hands-on Practice

**Material:** paperbox

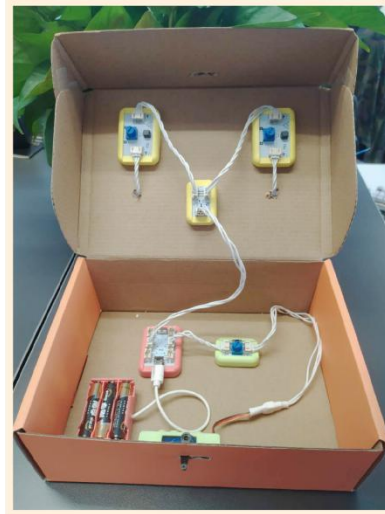
**Tools:** scissors, double-side adhesive tape



Use servo horn as the lock. When the servo is not rotating, the cover is stuck by the horn.



Internal View



### 4. Debug

### 6. Project Share

**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? Do you encounter any difficulties in making, and how do you overcome them; What do you think about Artificial Intelligence? Let two students share their work and ideas after a given time.

### 7. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Question 1:** With the logic and knowledge learned earlier, if the logic OR module in the project is replaced by logic AND module, what function will be achieved, can you create application scenarios for them separately?

**Answer:** The password box can be only opened when two passwords are both correctly rotated, and it is more difficult to open the password box.

**Question 2:** Two neuron modules can "memorize" two password features at the same time, so can multiple neuron modules recognize more complex passwords? Furthermore, can they recognize Chinese characters and play Go with humans?

**Answer:** The more neuron modules there are, the more signal features that can be learned, and that means more logic modules can handle more complex situations.

## Extended

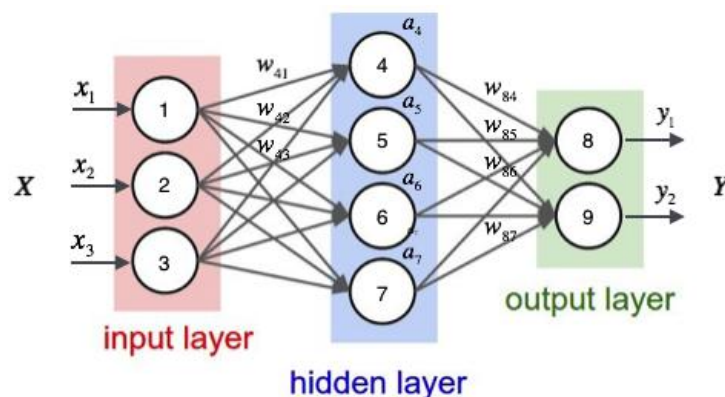
**For reference:** At the end of this lesson, you can assign homework to students as an extension of the course.

**Question:** Take the Mind+ stage display method in the rotary dial telephone project as a reference, try producing the "Ali Baba and the Forty Thieves" animation project.

## Resources

### Artificial Neural Network, ANN

**Artificial Neural Network (ANN)**, referred to as Neural Network (NN), in the field of machine learning and cognitive science, is a mathematical model or calculation model that imitates the structures and functions of biological neural networks (animal's central nervous system, especially the brain), which is used to estimate or approximate the function. The neural network is calculated by connecting a large number of artificial neurons. In most cases, the artificial neural network can change the internal structure on the basis of external information. It is an adaptive system, or we say it has a learning function. The modern neural network is a non-linear statistical data modeling tool. The neural network is usually optimized through a learning method based on mathematical statistics, so it is also a practical application of mathematical statistics. Through standard mathematical methods of statistics, we can obtain a large number of local structural spaces that can be expressed by functions. Meanwhile, in the field of artificial perception of artificial intelligence, we can make decisions about artificial perception through the application of mathematical statistics (That is to say, through statistical methods, artificial neural networks can have simple decision-making and judgment ability similar to humans). This method has more advantages than formal logical reasoning calculations.



Like other machine learning methods, neural networks have been used to solve a variety of problems, such as machine vision and speech recognition. These problems are difficult to solve by traditional rule-based programming.

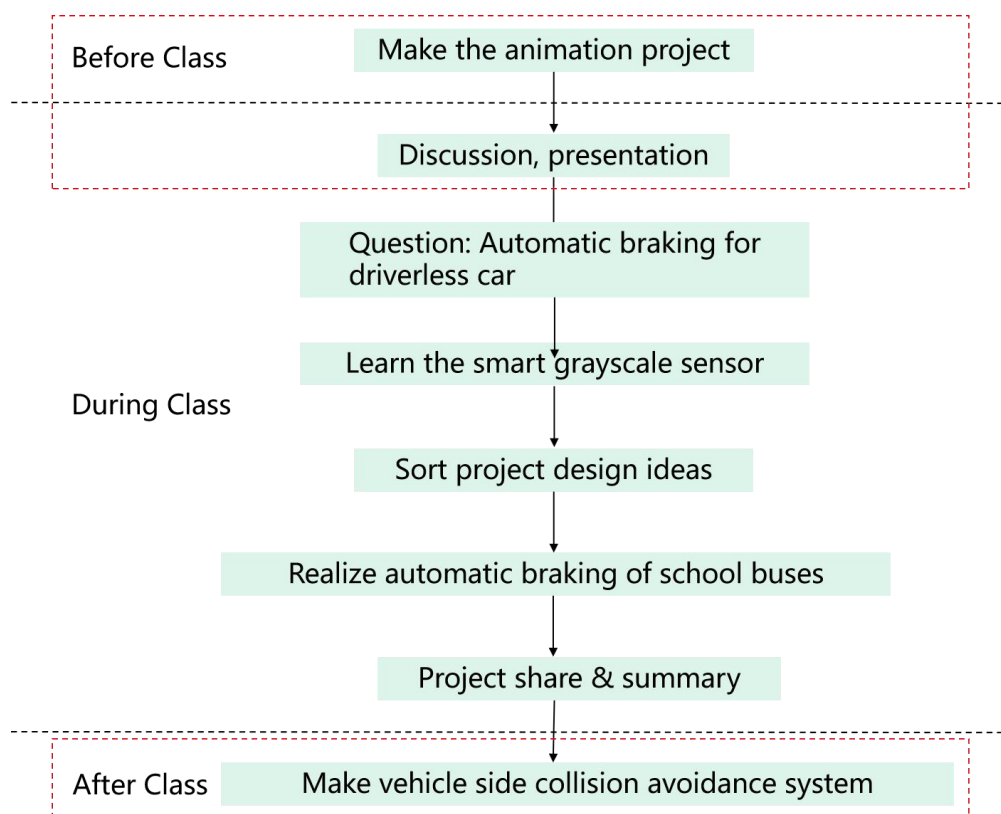
# Project 4 Driverless Car with Automatic Braking

## Objectives

By the end of the lesson, students should be able to:

1. Understand and use Smart Grayscale Sensor and Logic AND Module
2. Complete the project under the guidance of teachers
3. Renovating the project through the transformation of the learned knowledge

## Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

## Materials Preparation

Teachers:

Computer with Mind+ software installed, BOSON Artificial Intelligence Starter Kit (Micro:bit\*1, Expansion Board\*1, Neurone Module\*2, Ultrasonic Sensor\*1, Smart Grayscale Sensor\*1, Logic AND Module\*1, Red LED Module\*1)

## Students:

Textbook, pen, scissor, utility knife, double-side adhesive tape, compass or round object, paper box

\*The tools and consumables required for the project can be freely selected.

## Content

**Preface:** This is the first lesson of *School Bus Transformation*. In the previous lesson, we learned neurone module and the connection method of two neurone modules. In this chapter, we are going to build a neurone module network from simple to complex. In this process, students will witness that the school bus gets more and more “smart” in practice, so that they can have a simple understanding of the principle of the neural network in AI, and better understand the application learned in the first experience of AI module. In this chapter, starting from the automatic parking in driverless vehicles, students will make “eyes” for the magical school bus with neurone module.

### 1. Lead-in

**For reference:** In this part, you can lead students to explain the phenomenon in practice through the knowledge and skills learned in the previous chapter, and then discover the driving problems of this project, disassemble the functional requirements and general steps, so as to initially clarify their own design ideas.

**Intro Question:** The driverless vehicles can “see” the obstacles ahead on the road and determine whether it needs to slow down and stop. Connecting with the single neuron module, can you briefly explain how that works?



**Driving Question:** How to use neurone module to recognize the obstacles ahead and determine whether it needs to slow down and stop.

**Function Decomposition:**

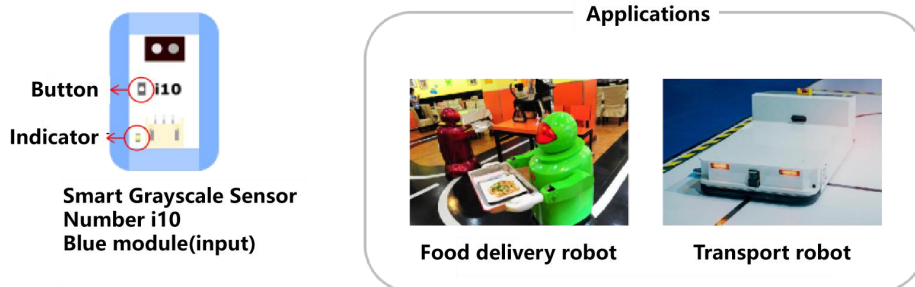
Function 1: detect the obstacles in front of the vehicle

Function 2: determine whether it needs to stop based on the recognition result

## 2. Knowledge & Skills

**For reference:** This part mainly includes the knowledge and skills related to the project, let students learn and use the Smart Grayscale Sensor and Logic AND Module

### Smart Grayscale Sensor



Description:

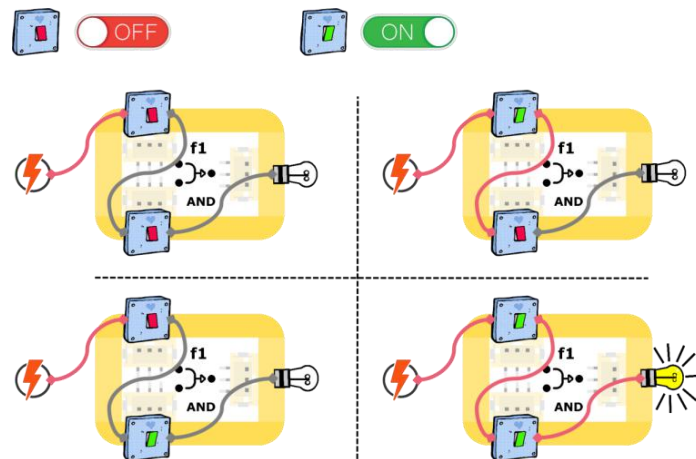
The grayscale sensor has integrated both analog and digital output features. By short clicking the button, it can switch between analog and digital values.

Under analog output mode, the sensor can perceive the corresponding signals generated by different color grayscales on the ground or desktop. The LED keeps on when a color detected. Based on this principle, it can be used to detect the distance between a color and the sensor. The closer the distance, the brighter the LED.

Under digital output mode, the sensor can only sense black and white. White---no signal output, LED off; White---output signal, LED on.

### Logic AND Module

The relation between the two inputs of Logic module And is the same as that of the two conditions in the program. We use two switches to refer to two inputs, "OFF" means there is no input signal, and "ON" means there is input signal. The light on or off indicates the presence or absence of the output signal.



### 3. Design Analysis

**For reference:** This part aims to help students formulate design ideas based on the knowledge and skills learned in the previous part.

#### Design Ideas

*Hardware Design Idea:*

Ultrasonic sensors can detect objects in front of them and measure the distance. However, in a real driving environment, not all objects need the car to stop (for example, other cars in the front that run at the same speed), and only for the objects in front that gradually approach the driverless vehicle, the brake needs to be acted. So, we have to use the neurone module to learn this gradual approaching process.

The smart grayscale sensor can also measure the distance according to its own principle. In order to make the recognition more accurate, ultrasonic and smart grayscale sensors are used at the same time. The detection data is processed by the Logic AND module. Only when signals exist in both ultrasonic and smart grayscale modules at the same time, the braking action will be performed.

*Software Design Idea:*

Use the Mind+ stage to simulate the animation of school bus driving. The school bus is located below the stage, and the lane line and the car move down the stage to simulate the school bus driving upward. If the lane line does not move, it means that the school bus stops.

#### Structure Design

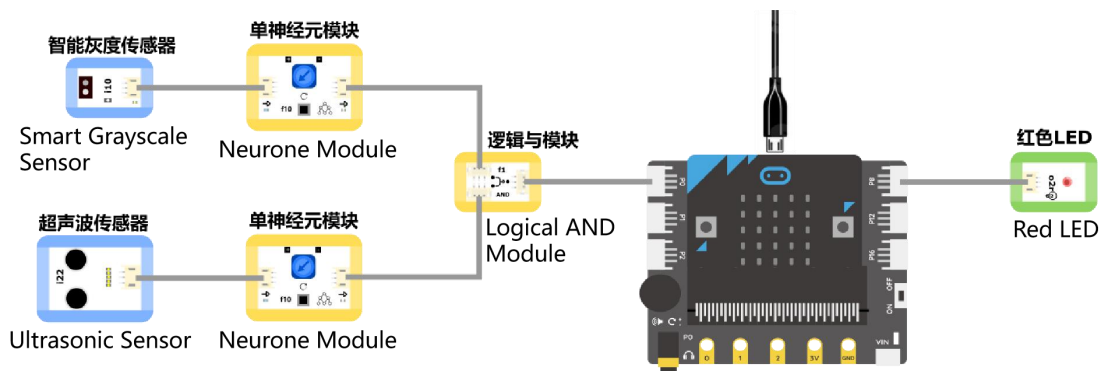
Function	Design Sketch

Appearance, hardware placement	
--------------------------------	--

## 4. Project Implementation

**For reference:** Since the difficulty of the project procedures in this section, teachers are required to lead students to complete them step by step. The programming sequence is recommended as "Background-School Bus-Vehicle-Accident".

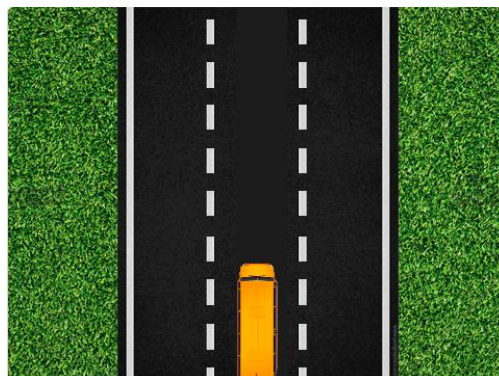
### 1. Hardware Connection



### 2. Set Up the Stage Scenes



**Background:** upload background-"lane 1.png", "lane 2.png"..... "lane 8.png"

**Roles:** upload role-"school bus.png", "car.sprite3", "accident.png"

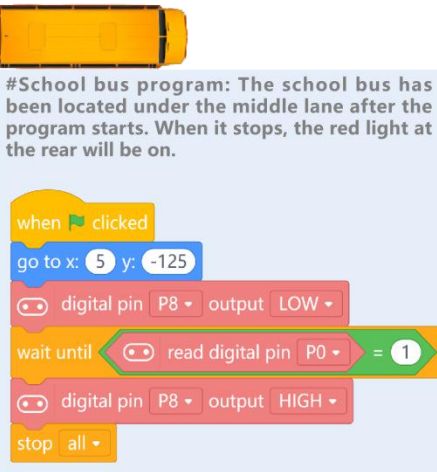



### 3. Write Programs

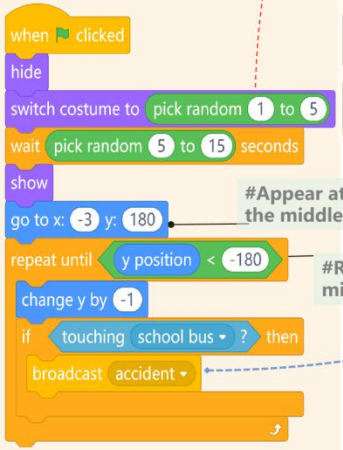
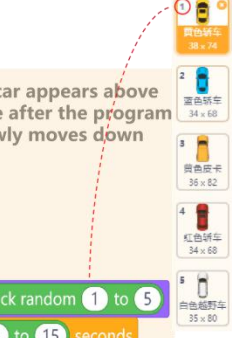
**#Background program:** The cyclic switching of the background creates the animation effect of the lane line moving down

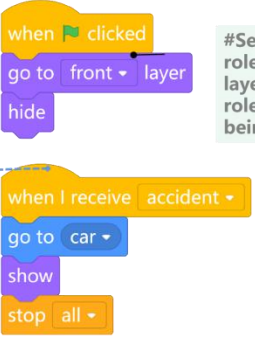

**#School bus program:** The school bus has been located under the middle lane after the program starts. When it stops, the red light at the rear will be on.

**#Car program:** The car appears above the stage for a while after the program starts, and then slowly moves down

**#Accident program:** Appears only when the school bus collides with the car

**#Appear at the top of the middle lane**

**#Run to the bottom of the middle lane**

**#Set the accident role at the top layer, above other roles to prevent being blocked**

### 4. Adjustment

*Learning stage:* Run the program, press the learning buttons of the two neuron modules at the same time, move a book closer to the sensor at a certain speed for learning, release the learning button. If the program on the stage stops, it indicates that the learning successes.





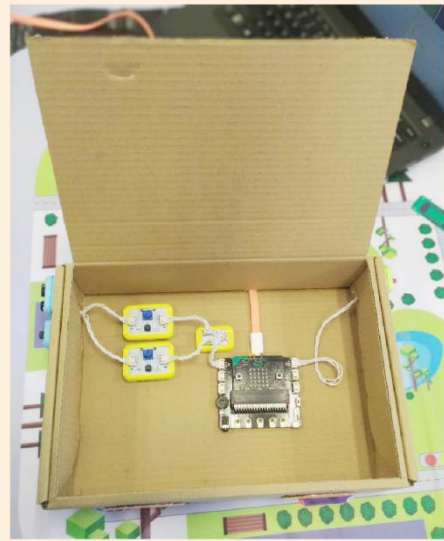
*Adjustment stage:* refer to the approaching speed in the learning stage, adjust the neurone module according to your needs.

## 5. Hands-on Practice(Example)

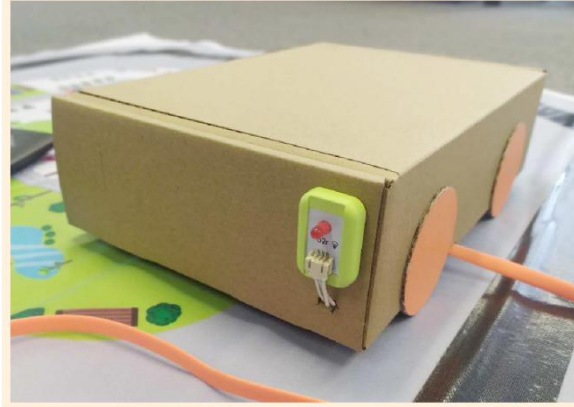
**Materials:** paper box  
**Tools:** scissor, knife, double-side adhesive tape, Compass or round object  
**Front:** Ultrasonic sensor and smart grayscale sensor for simulating ranging radar



Inside: fix the module with double-sided tape



Rear side: Red LED is used to simulate the rear light of the car



## 6. Debug

## 5. Project Share

**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? Do you encounter any difficulties in making, and how do you overcome them; What do you think about artificial intelligence? Let two students share their work and ideas after a given time.

## 6. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Question:** Can you talk about the working principles of automatic braking of driver-less car?

**Answer:** Refer to the design analysis section.

## Extended

**For reference:** At the end of this lesson, you can assign homework to students as an extension of the course.

**Question:** Ask your classmates, being with you (two sets), to use the vehicle model in this lesson to make the side collision avoidance system for the vehicle.

## Resources

### Introduction of Driverless Vehicle Technology

The driverless vehicle is a type of smart car, also called a wheeled mobile robot. It mainly relies on the intelligent driving instrument based on the computer system in the vehicle to achieve the goal of unmanned driving.

Like many other things, unmanned driving actually has a process of gradual technological development. There are three different stages:

Stage 1: Assisted driving stage. Driving assistance functions such as lane tracking and adaptive cruise are all technologies at this stage, but the human driver is still the main operator.

Stage 2: Semi-automatic driving. At this stage, automatic driving under the control of computer can already complete the process of arriving at a destination. It can be used as a backup system to complete the driving. However, due to factors such as laws and regulations, it still cannot exist as the subject of the entire driving.

Stage 3: Fully automatic driving. Factors such as technology, cost, law and regulation are no longer affecting its popularization. Computer-controlled systems have already existed as the main part, and the driver can take over the operating system at any time.

Due to technical and regulatory restrictions, most of the current driverless vehicles are in stage 2. There are two types of current mainstream driverless vehicle technology: liDAR and camera + ranging radar.

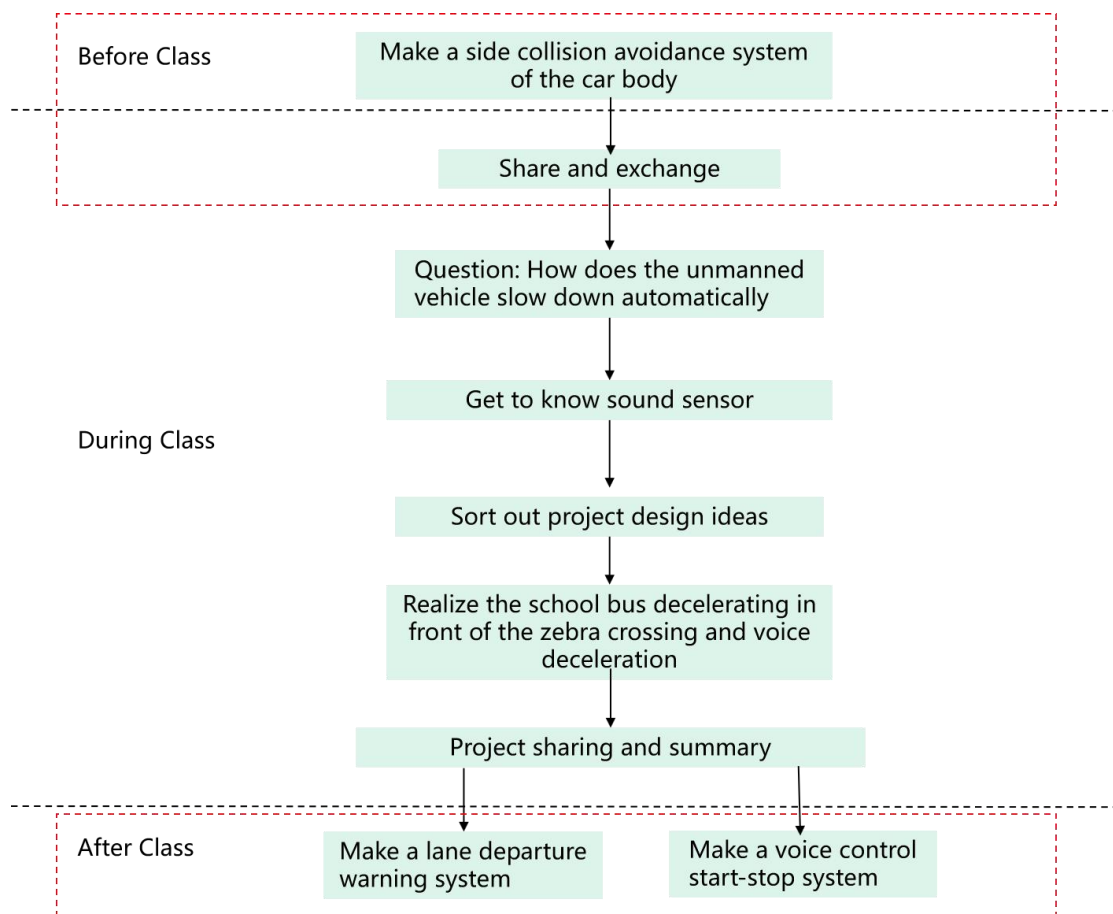
# Project 5 Traffic Safety Needs Mutual Humility

## Objectives

By the end of the lesson, students should be able to:

1. Understand and use smart grayscale sensors and sound sensors
2. Complete the project under the guidance of teachers
3. Transform the project through the application of the learned knowledge

## Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

## Materials Preparation

### Teachers:

Computer with Mind+ software installed, BOSON Artificial Intelligence Starter Kit (Micro:bit \* 1, Expansion Board \* 1, Neurone Module \* 2, Smart Grayscale Sensor \* 1, Sound Sensor \* 1, Logical Disjunction \* 1, Red LED Module \* 1)

### Students:

Textbook, pen, the school bus model from last class, scissors, utility knife, double-sided tape, plastic sheet, ice cream stick

**\*The tools and consumables required for the project can be freely selected**

## Content

**Preface:** This lesson is the second lesson of the unit "*School Bus Transformation*". We will continue to transform our school buses on the basis of the previous lesson. In this lesson, based on the voice function of the driver-less car, students will use neuron module to build the "ears" of the school bus.

### 1. Lead-in

**For reference:** This section explains the actual phenomenon by connecting with the knowledge and skills learned in the previous chapter, then discovers the driving problems of the project, disassembles the functional requirements and general steps, so as to clarify the project design ideas.

**Intro Question:** Driver-less cars can strictly abide by the traffic rules. Take advantage of the neuron module to explain how it does that?



**Driving Question:** How to use a neuron module to identify zebra crossings on the road and achieve deceleration?

### Function Decomposition:

Function 1: Detect the zebra crossing in front of the car;

Function 2: Slow down after successful recognition;

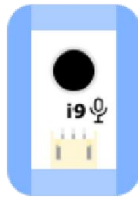
Function 3: Recognize pedestrian's "slow down" voice;

Function 4: Send a deceleration warning to surrounding school buses.

## 2. Knowledge & Skills

**For reference:** This session mainly learns project-related knowledge and skills, and helps students to learn and use sound sensors.

### Sound Sensors



Sound sensor  
number i9 blue  
module ( input)

### Applications



Microphone



Cell phone

Description:

There is a black pickup cartridge on the sound sensor. When you clap or speak loudly in front of the black pickup, the sound sensor can get the vibration of the sound: the louder the sound, the stronger the output signal; the smaller the sound, the weaker the output signal.

## 3. Design Analysis

**For reference:** This section will help students sort out design ideas based on the knowledge and skills of the previous link.

### Design Ideas

*Hardware implementation ideas:*

The zebra crossing is the only "black and white" traffic sign on the road. According to this feature of the zebra crossing, we use the smart grayscale sensor to identify it. Because the smart grayscale sensor can only detect black and white at a certain moment, it needs to use a neuron module to learn and record the changes in black and white.

The sound sensor and neuron module can realize the voice recognition function in the previous course project. The detection of zebra crossing (smart gray sensor) and the pedestrian's "slow down" voice (sound sensor) can both make the driver-less vehicle slow down. Then what logic module do you need to use? The answer is the logical module OR.

There is a wireless communication module on the Micro:bit, which can send a wireless signal to warn nearby school buses when there is a situation that needs to slow down.

*Software implementation ideas:*

Use the Mind+ stage to simulate the animation of school bus driving. The school bus is located at the bottom of the stage. The lane line, other cars, and the zebra crossing move down from the top of the stage to simulate the school bus driving upward. When the lane line starts moving downward slowly, it means the school bus slows down.

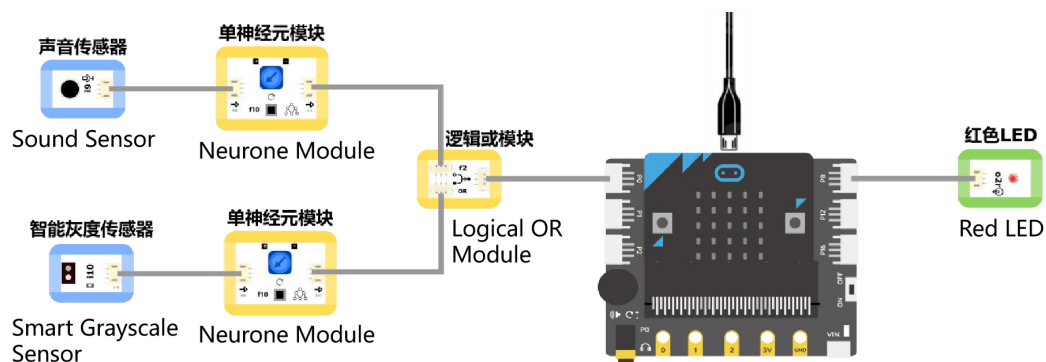
### Structural design

Functional Analysis	Design Sketch
Appearance, hardware placement	
Recognition structure design in function 1	

## 4. Project Implementation

**For reference:** Since the difficulty of the project procedures in this section, teachers are required to lead students to complete them step by step.

### 1. Hardware Connection



## 2. Set Up the Stage Scene

*Background:* Upload the background - "lane 1.png", "lane 2.png"..... "lane 8.png"

*Roles:* upload roles - "school bus.png", "car.sprite3", "zebra crossing.png"

## 3. Programming

**# Zebra Crossing Program: The zebra crossing appears after the program runs for a period of time, and the school bus needs to slow down.**

```

when clicked
  go to back layer
  hide
  wait pick random 5 to 20 seconds
  show
  go to x: 0 y: 180
  repeat until y position < -175
  change y by -1
  if read digital pin P0 = 1 then
    broadcast speed cut
    send string js via wireless
    digital pin P8 output HIGH
  hide
  broadcast speed up
  digital pin P8 output LOW
  
```

**#Background program: The interval between the switching time of the background reflects the speed of the school bus**

```

when clicked
  set waiting time to 0
  forever
    next backdrop
    wait waiting time seconds
  when I receive speed cut
    set waiting time to 0.1
  when I receive speed up
    set waiting time to 0
  
```

**# Car program: After the program starts, the car will clone itself every once a while, and the clone will appear on the road, which is more in line with the reality.**

```

when clicked
  hide
  forever
    switch costume to pick random 1 to 5
    create clone of myself
    wait 2 seconds
  when I start as a clone
    show
    go to x: item pick random 1 to 2 of abscissa y: 180
    repeat until y position < -180
    change y by -2
    delete this clone
  
```

**#School bus program: wireless communication enables the school bus to warn surrounding vehicles to protect their own safety**

```

when clicked
  turn on wireless communication
  set wireless channel to 7
  go to x: 5 y: -125
  digital pin P8 output LOW
  when received wireless data
    if wireless data = js then
      say Traffic is slowing down nearby. Attention, please! for 2 seconds
  
```

**#This code is placed here to make the school bus slow down after the zebra crossing appears**

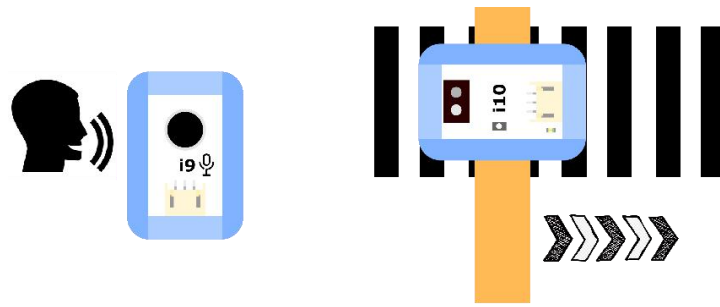
**#Send signal to other school buses, where "js" is the pinyin abbreviation for deceleration, other signal writing methods can also be used, as long as the sender and receiver are the same**

**#Create new lists to make cars appear randomly in the left and right lanes**

## 4. Learning Adjustment

*Learning stage:* according to the normal speaking speed, stabilize the height and speed to move the smart gray sensor to learn, release the learning button, if the output indicator lights up once, it means the learning is successful.





*Adjustment stage:* try replicating the operation of the learning stage, and adjust the neuron module according to your needs.

## 5. Building Structure (Example)

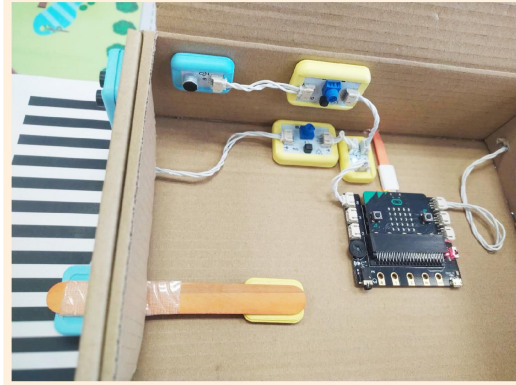
**Material:** paper box, plastic sheet, ice cream stick

**Tools:** scissors, utility knife, double-sided tape

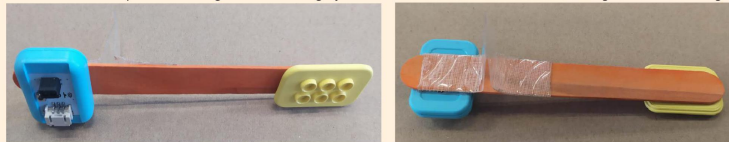
Front side of the car: Ultrasonic sensor is the 13th lesson module, no function



Inside the car: fix the module with double-sided tape

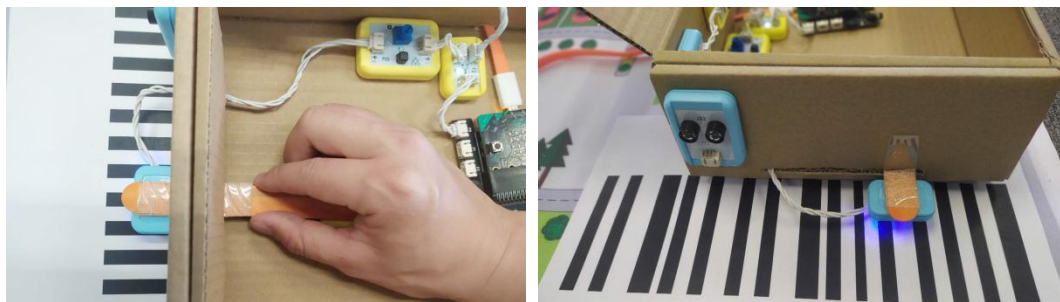


A close-up of the zebra crossing recognition device: two plastic sheets fix the device on the car body, the magnetic sheet has a supporting effect, make sure to keep the same height of the smart grayscale sensor at the other side when scanning the zebra crossing



## 6. Debug

Tips: You can use irregular zebra crossings to set comparison



## 5. Project Share

**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? Do you encounter any difficulties in making, and how do you overcome them; What do you think about Artificial Intelligence? Let two students share their work and ideas after a given time.

## 6. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Question:** Can you talk about the working principle of the "mutual humility" of school buses ?

**Answer:** See the design analysis section.

## Extended

**For reference:** At the end of this lesson, you can assign homework to students as an extension of the course.

**Expansion Project 1:** Use the smart grayscale sensor to install a lane departure warning system for your school bus. (The color change when the car deviates from the lane is "black-white-black")

**Expansion Project 2:** Use sound sensors with your classmates (two sets) to install a voice start-stop system for your school bus.

## Resources

### Introduction to driver-less car technology

Driver-less cars are the direction of future automobile development. It is a kind of intelligent vehicle that integrates various top scientific and technological achievements. Judging from the current development status, there are still several technological breakthroughs that need to be made in the following areas.

#### 1. Sensor technology

The creation of driver-less cars depends largely on the progress of sensors.

There are about 86 billion nerve cells in a human brain, of which 70 billion are cerebellar granule cells. Current driver-less cars use lidar to directly perceive road conditions, it is used on analysis and calculation.

#### 2. Positioning

At present, the GPS in the United States is the most widely used of the main positioning systems, the technology is relatively advanced. However, the current civilian GPS positioning accuracy is far below the demand for driver-less cars. The GPS official civilian positioning accuracy is " $<<10$  m", and the higher accuracy of GPS basically depends on the finite difference. The principle of finite difference is very simple: set up a fixed base station, and fix the calibration position in the base station, then transmit the signal to the vehicle device. The vehicle device obtains the finite difference after receiving the base station signal and the GPS signal. But the effective range of each base station is only 30 km. So there are many technologies that need to be solved based on the problem of insufficient GPS accuracy, such as map matching.

### 3. Obstacle Avoidance

If there is an obstacle in front of the vehicle, is the obstacle moving or stationary? Does the vehicle need to stop or go around? The main difficulty in this part is to identify obstacles from sensors, and determine the movement state of obstacles under the premise of vehicle movement. In other words, need to calculate the relative speed of another object to the static coordinate system under the moving coordinate system, and make a judgment.

### 4. Identify

People can easily recognize the traffic signs on the road, such as speed limit signs, traffic lights, and respond accordingly, but this is a difficult challenge for machines. Current machine vision technology is still difficult to recognize objects such as trees, pedestrians, and animals. The recognition of these objects is all need to be done through the vision system. On driver-less vehicles, not only need to be able to be identified in a limited time, but also to consider possible light changes and object occluding in the road. To solve these problems, we need to wait for technological breakthroughs in the field of machine vision and image recognition.

### 5. Control

In addition to the obstacle avoidance mentioned above, there may be some transformation problems on other peripheral equipment. Such as how to intervene in the bogie, how to intervene in the throttle. This part of the technology is less difficult. The automotive control technology is now relatively advanced, and the driver-less car will basically be a pure electric car in the future, and the control difficulty will be less than the traditional internal combustion engine car.

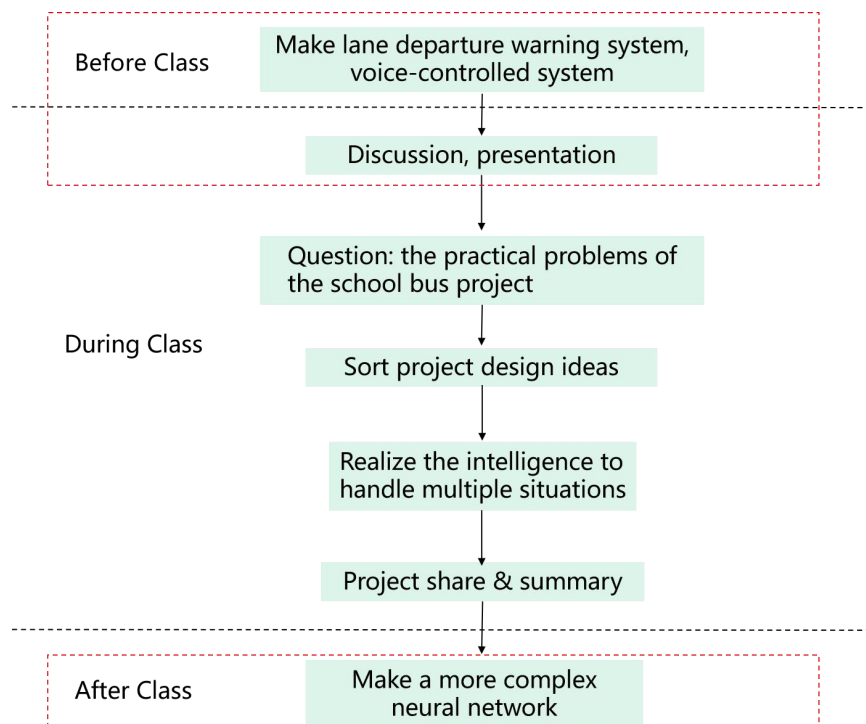
# Project 6 School Buses Benefit Everyone

## Objectives

By the end of the lesson, students should be able to:

1. Understand the function of neural network
2. Complete the project under the guidance of teachers
3. Renovating the project through the transformation of the learned knowledge

## Process



\*The parts in the red dotted box are non-essential, and you can implement the process according to the actual teaching schedule.

## Materials Preparation

Teachers:

Computer with Mind+ software installed, BOSON Artificial Intelligence Starter Kit (Micro:bit\*2, Expansion Board\*1, Neurone Module\*6, Ultrasonic Sensor\*2, Smart Grayscale Sensor\*2, Sound Sensor\*2, Logic AND Module\*2, Logic OR Module\*2, Red LED Module\*1)

\*Students need to be grouped according to the number of BOSON Artificial Intelligence Starter Kits.

## Students:

Textbook, pen, the vehicle module in the previous lesson, scissor, utility knife, double-side adhesive tape

\*The tools and consumables required for the project can be freely selected.

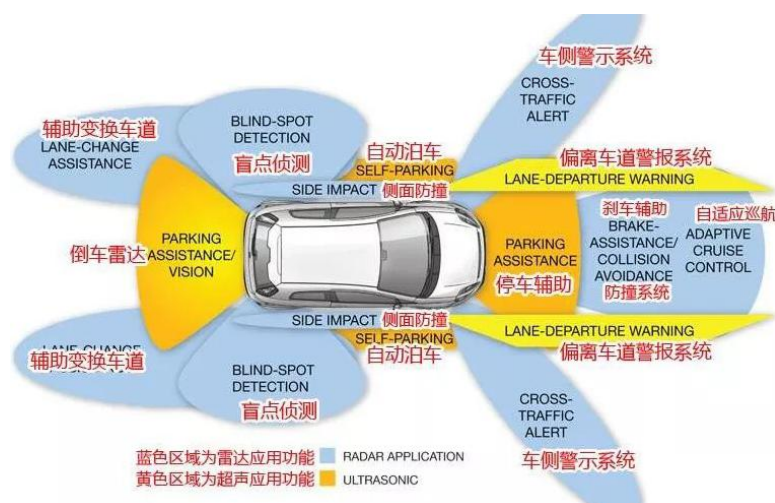
## Content

**Preface:** This is the third lesson of *School Bus Transformation*, also the last lesson of the part "Initial decipherment of Artificial Intelligence". After learning the previous 5 lessons, this lesson will help students reach a new level of understanding of artificial neural networks. Based on the previous two lessons, in this lesson, we are going to build a more complex school bus intelligent network to deal with more practical problems.

### 1. Lead-in

**For reference:** In this part, you can lead students to explain the phenomenon in practice through the knowledge and skills learned in the previous chapter, and then discover the driving problems of this project, disassemble the functional requirements and general steps, so as to initially clarify their own design ideas.

**Intro Question:** In order to drive safely, driverless vehicles have a very complex artificial intelligence control system. Can you choose one of the functions below and connect with the neurone module and artificial neural network to briefly explain how it works?



**Driving Question:** In the previous project, we implemented some functions of driverless driving. However, the practical situation is much more complicated. For example, stop when a gradually-approaching obstacle is recognized. In our project, only one speed situation is

considered, when an obstacle approaches at other speeds, it can't be recognized; when recognizing pedestrian's "slow down" voices, the vehicle will slow down. Voice commands such as "speed down", "slow down", and "stop" all have the effect of reducing the vehicle speed. But we have to consider the difference between dialect and Mandarin. How can we make our driverless car project "smarter"?

**Function Decomposition:**

Function 1: Identify two objects at different approaching speeds and realize the stopping effect;

Function 2: Recognize two different voices and realize the deceleration effect.

## 2. Knowledge & Skills

**For reference:** This session will help students sort out design ideas based on the lead-in session.

### Design Ideas

Since a set of ultrasonic sensors and smart grayscale modules can recognize one approaching speed, and a sound sensor can recognize one decelerating voice, why don't we use more sensors to collect more characteristic data and build a more complex neuron module network, so that it can handle more complicated situations!

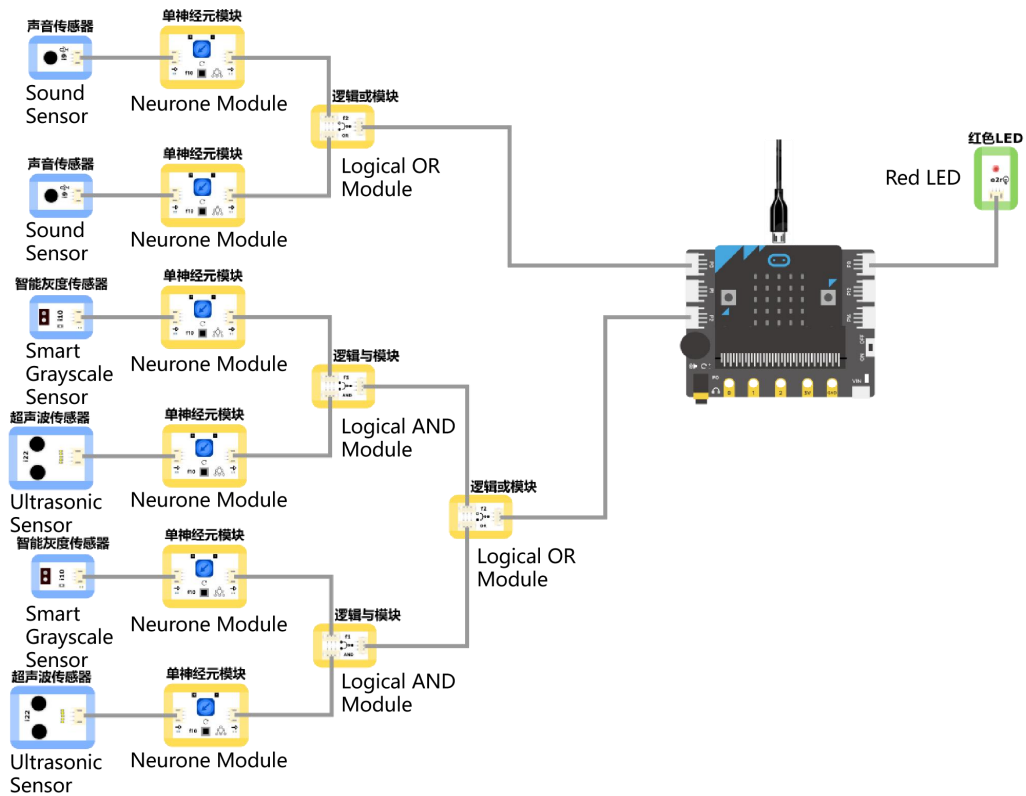
### Structure Design

Function	Design Sketch
Appearance, hardware placement	

## 3. Project Implementation

**For reference:** Since the difficulty of the project procedures in this section, teachers are required to lead students to complete them step by step.

## 1. Hardware Connection



## 2. Arrange Stage Scenes

*Background:* upload background-"lane 1.png", "lane 2.png"..... "lane 8.png"

*Roles:* upload role-"school bus.png", "car.sprite3", "accident.png", "you win.png", "you lose.png", "school.png"

## 3. Write Programs

Open Mind+, select "Online" mode.



**1**

Online mode

**# School bus program: use another Micro:bit board to control the school bus**

```

when clicked
  turn on wireless communication
  set wireless channel to 7
  go to x: 5 y: -126
  repeat until touching color ?
    set speed to -2
    if read digital pin P0 = 1 then
      set speed to -1
      digital pin P8 output HIGH
      broadcast speed cut
      wait 3 seconds
      digital pin P8 output LOW
      broadcast speed up
    broadcast you lose
  
```

**# Driving to the grass will fail**

```

when received wireless data
  if wireless data = 1 then
    change x by -85
  if wireless data = r then
    change x by 85
  
```

**# School program: The school appears in the final stage. If the school bus stops in time, it means that it has arrived safely.**



```

when clicked
  hide
  wait pick random 90 to 120 seconds
  show
  go to x: 0 y: 300
  repeat until touching school bus ?
    change y by -1
    if read digital pin P2 = 1 then
      broadcast you win
    broadcast you lose
  
```

**# Background program**

```

when clicked
  set waiting time to 0
  forever
    next backdrop
    wait waiting time seconds
  
```

**# Accident program**

```

when clicked
  go to front layer
  hide
  when I receive accident
    go to school bus
    show
    stop all
  
```

**# Success program**

```

when clicked
  hide
  go to front layer
  go to x: 0 y: 0
  when I receive you win
    show
    stop all
  
```

**# Failure Program**

```

when clicked
  hide
  go to front layer
  go to x: 0 y: 0
  when I receive you lose
    show
    stop all
  
```

**# Vehicle program**

```

when clicked
  hide
  forever
    switch costume to pick random 1 to 5
    create clone of myself
    wait 3 seconds
  
```

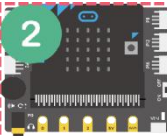
**When I start as a clone**

```

show
  go to x: item pick random 1 to 3 of abscissa y: 180
  repeat until y position < -180
    change y by speed
    if touching school bus ? then
      broadcast accident
    if touching school ? then
      delete this clone
  delete this clone
  
```



Open another Mind+, select offline mode, and upload the program to another Micro:bit.



**2**

Offline mode

**#Controlling program**

```

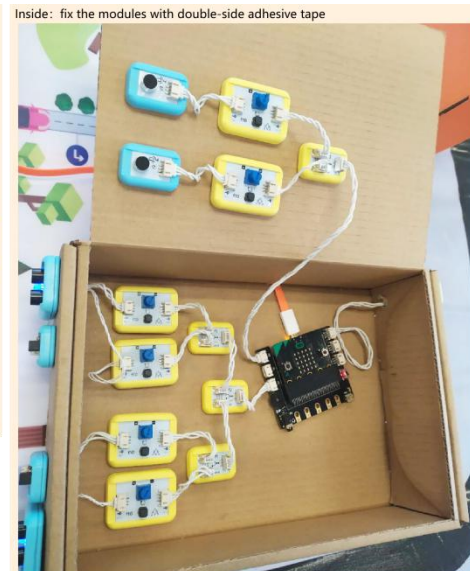
micro:bit starts
turn on wireless communication
set wireless channel to 7

forever
  if A button pressed? then
    send string "|" via wireless
    wait until not A button pressed?
  if B button pressed? then
    send string "r" via wireless
    wait until not B button pressed?
        
```

# Prevent sending multiple signals before releasing the button, and avoid causing the school bus to move to the left for multiple times

#### 4. Adjustment

#### 5. Hands-on Practice (Sample)



#### 6. Debug

## 4. Project Share

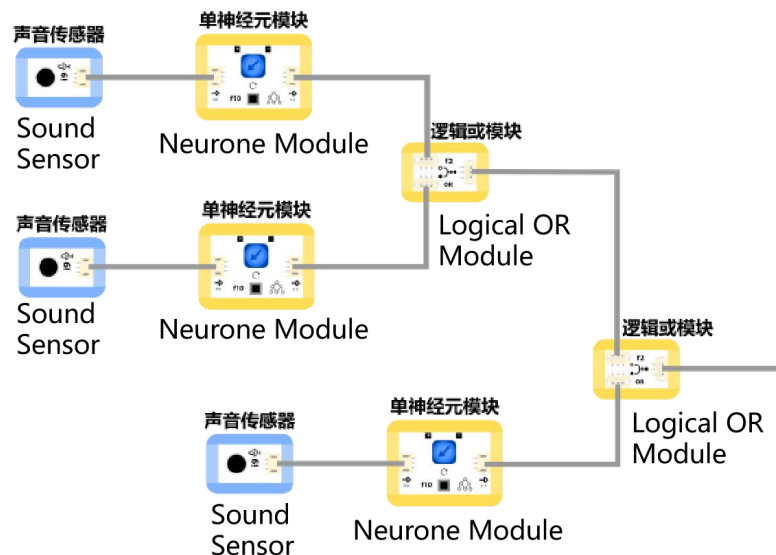
**For reference:** This part will ask students to rethink and share their works. You can remind them to complete this part from these aspects: how do you feel after finishing this project? Do you encounter any difficulties in making, and how do you overcome them; What do you think about artificial intelligence? Let two students share their work and ideas after a given time.

## 5. Summary

**For reference:** In this part, you can summarize the curriculum project by raising questions to let students think and discuss so as to recall the content of this lesson and deepen the understanding of the project.

**Qusetion1:** If three deceleration voices need to be recognized, please design a connection diagram.

**Answer:**



**Qusetion2:** Talk about your understanding of neural networks.

**Answer:** "More people produce greater strength, more logs make a bigger fire.". When multiple neurone modules form a complex network, it becomes "intelligence".

## Extended

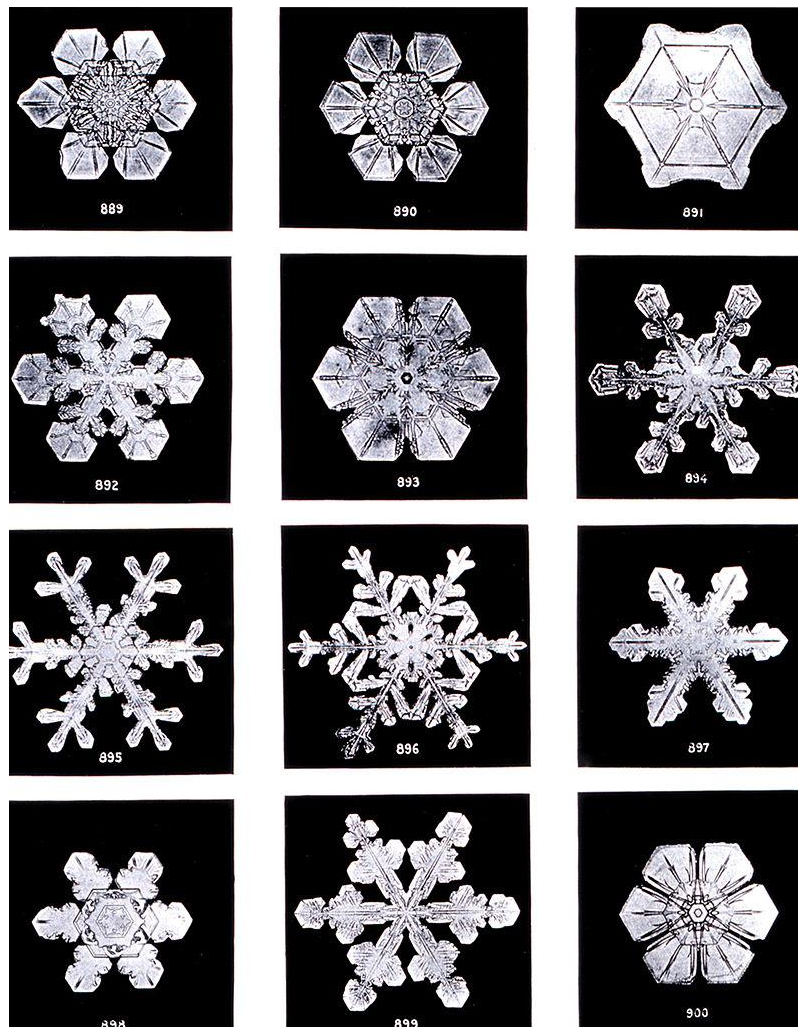
**For reference:** At the end of this lesson, you can assign homework to students as an extension of the course.

**Extension:** Use as many single neuron modules as possible to make your school bus "smarter" !

## Resources

### Emergence

**Emergence** is one of the most fascinating and wonderful phenomena in our universe. In a word, many small individuals interact to produce a large individual, and this large individual exhibits characteristic the small individuals that make it do not have. For example, it is an emergence phenomenon that water molecules gather to form snowflakes with regular shapes.



Although today's scientists have not deciphered "wisdom", we can see a glimpse from the emerging phenomenon. For example, the characteristic of a single ant in nature is with no intelligence. It has no brains, desires, and plans. But when many ants gather, they are smart. A colony of ants can form a complex structure. They show wisdom that a single ant does not possess in multiplying and building nests, foraging for food, launching war, self-defense and other behaviors. If we think of a neuron as one single ant, then the neural network is an ant colony. A large number of neurons are connected according to specific rules to form a neural network, and then wisdom is born.