DFROBOT
DRIVE THE FUTURE

Mike's Maker Journal

A hands-on guide of logic learning with Boson

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Chapter One Mike's first Boson Project

1-1 Crowing rooster

Mike's story

It is during the holiday, Mike visits the countryside with his family. In the morning, he wakes up with the crowing of a rooster. Strange! Clock makes noise based on time, but how does the rooster know the time? Maybe it was the sunlight, the rooster crows when light goes strong. It must be interesting to make an alarm clock that works the same way as the rooster.

Here comes the Boson!

The light sensor in Boson Kit can be used to measure the intensity of light whereas the buzzer makes noise. We can simply use these two modules to build an electronic crowing cock that wakes us up when light goes from dark to bright. To make it more like a real cock, we can use paper cups to make a cock model, put the light sensor at the eyes to sense the change of light, and put the power supply and buzzer inside its belly.

Connection and Theory

To build such a rooster, a light sensor will be used to senses how strong the light is. The light sensor is an analog input module, and it generates a signal within a certain range of voltage (0-5V) corresponding to the intensity of the light. When the light goes strong, the sensor generates a higher voltage, vice versa. We will also need a buzzer as the output module, so the rooster will be able to make some noise. The buzzer is an analog output module, which means that a higher voltage signal leads to a louder noise.

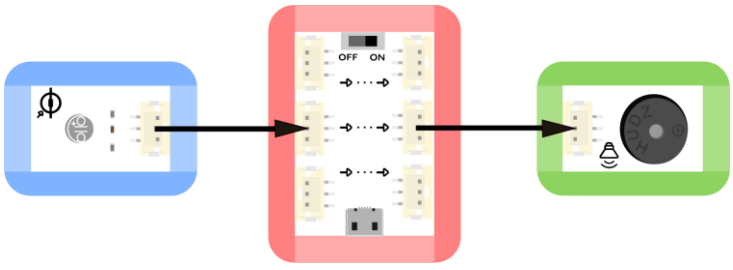
Just as simple as that! Connect the circuit as blow, you will get your own electronic crowing rooster.

Bring it to life!

To realize the function, we will need to get all the following modules and components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Light sensor		1
Output module	Buzzer Module		1

Try to connect all the modules as the shown in the following connection diagram and see if it works out as what we’ ve expected.



Finally, have a try whether the little crowing cock can work exactly or not.

Bonus session

The rooster that we have just built does not work exactly as an alarm clock; it makes noise whenever light goes in. Is it possible that we can set a minimum value so that the rooster will only

crow when the light excesses that value? (Tip: a threshold module may be helpful.)

Draw the scratch here

Mike's further thoughts

Hi Mike, the light sensor we used to build the crowing rooster, is it an analog input module or a digital input module?

For sure it is an analog input module. It senses the intensity of the light and generates different voltages in a range accordingly.
Amazing! It is actually the first time that I know how a device is controlled spontaneously by the environment.

Yes! For such device that senses the change of environment and automatically executes a certain action, we usually call it a "smart device". We will be building a lot of them in our following chapters.

I have another question about the threshold module, is it an input module or an output module?

The threshold module is neither an input nor an output module. It is a function module. A function module is not able to generate an input or output signal, but it is able to modify the signal in a certain pattern. A function module can be used together with an input or output module.

Amazing! Can you explain more about the threshold module?

The threshold module works like a valve, which determines if the voltage of an analog input is high enough to trigger the action. The threshold value is the minimum voltage that the signal is set to pass. When the input voltage reaches this value, the threshold generates a “high” signal, otherwise it will be a “low” signal. The threshold can be set by adjusting the knob on the module. Using the threshold module, an analog signal will be converted to digital signal.

Chapter Two Primary Creation

After several attempts, Mike finally made his new crowing rooster with the threshold module. Now the electric crowing rooster stands on the window-sill to wake Mike up every morning. Does it look like a little housekeeper? Now Mike is so excited that he hopes to make full use of the various types of sensors in the Boson kit to create more interesting works.

In this chapter, Mike will be playing around with more modules, learning their function and mechanism. Based on that, Mike will be able to build projects such as fiery piglet, intelligent fireproof cabin, sound-light lamp and gift boxes that support motion, sound, light interaction. Come on! Join Mike, I believe you can make it better.

2-1 Fiery Piglet

Mike's story

It is during the weekend, Mike visits the farm in town with his family. The farm is full of animals, but there is this piggy that Mike will not forget. The little piggy looks so lovely and outrageous that no one could resist to hold it in the arm. However, the piggy does not seem to be happy about getting touched by people. Every time someone touched him in the ear, the piggy gets angry. He tells mom that he hopes to bring the piglet home, but mom says no. Mike is upset. How can we help Mike?

Here comes the Boson!

“Is it possible to build such a piggy using Boson Kit?” Mike thinks, “So I don't have to annoy the piggy every time I play with him.” Although it sounds a bit complicated, but Boson kit is more than capable of doing that. All what we need is a module that is able to sense the touch and make angry oinks.

Connection and Theory

We need to be clear about the how it works first. The piggy stays quite when no one touches him. But once getting touched, the piggy oinks crazy.

The logic of the connection is quite simple, goes in with an input to the mainboard and ends with an output. But this time, what module should we use to realize Mike’s desire?

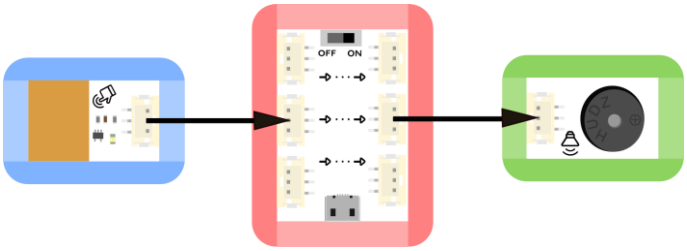
Bring it to life!

We will need the following modules for this project. You may notice that the only thing changed from the last chapter is the touch sensor.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1

Input module	Touch sensor		1
Output module	Buzzer module		1

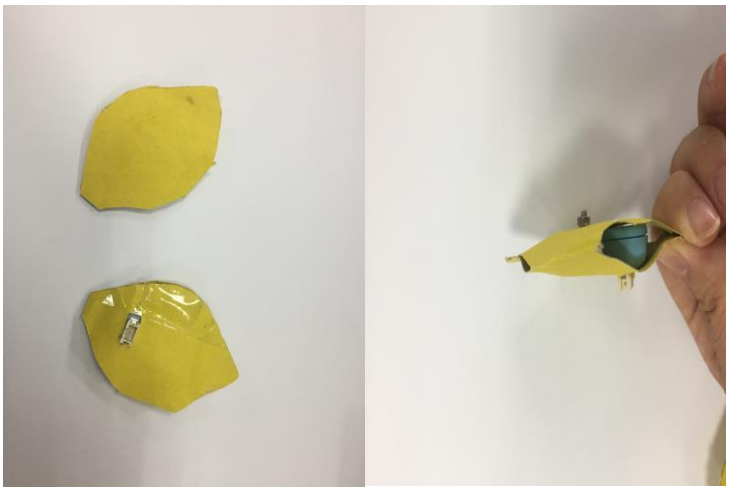
Just as simple as that! Try to connect all the modules as the shown in the following connection diagram and see if it works out as what we've expected.



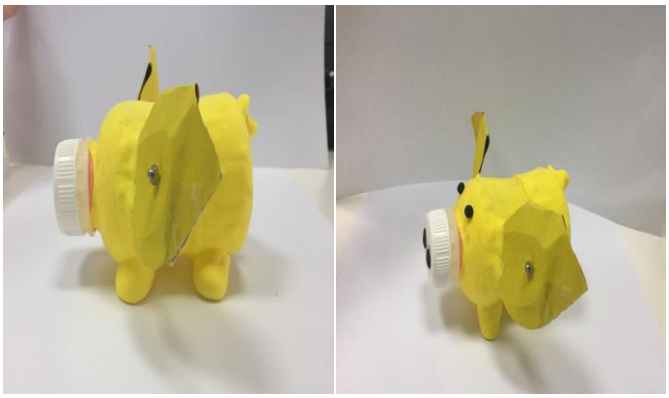
After we have finished the connection, switch on the power and give it a try. If everything goes right, the buzzer will starting beeping once we put the finger on the touch sensor. Now, all what we need to do is to make it looks like a real piggy.

First, cut a plastic battle in half and wrap it with paper. This will be the body of the piggy.

Next, place all the wire inside the body and fix it on a mount. Then use the remaining material to build his ear. Don't forget to add the touch sensor to one of the ears. Also, we will need to warp the ears with paper and install them on the head. To do this, we will need to cut a slot on its body where we can insert the ears into.



At last, add more decorations such as tail, eyes, and feet then we are all done.



Bonus session

Now what we have is a piggy that screams when he gets touched in the ear. However, is it possible to add more reactions, say, make his face turn red when we touch the other ear?

Hint: The Boson main board supports 3-way input and output connection.

Draw the scratch here

Mike's further thoughts

Capacitive and resistive touch sensor

Hi, Mike! The touch sensor that we use in our project is actually quite common around us, can you list few examples of touch sensors being used in our daily life?

The smart phones! Most of the smart phones come with touch screens and they can perform actions so long as my fingers swept over.

That's right, the touch sensor is usually integrated underneath the screen. You may also notice that sometimes such sensor will only be effective when we have directive contact through skin or conductive materials. They are called “competitive touch sensor “and it senses the touch based on the change of the capacitance.

The other kind of touch sensor is based on the change of resistance. The pressure applied to such sensor changes its resistance, so any kind of touch media such as hand, pencil, credit card can be useful with it. We usually call them “resistive touch sensors”.

Aha, I got it. The touch sensors in Boson Kit are capacitance touch sensors.

Do you know what the buzzers can be used in, Mike?

The buzzer only can buzz like a bee, so they could be used in alerter, I guess. Such as fire bell.

You are right about the buzzer. A buzzer is often used as a part of alarm and timing device in virtue of its loud, piercing sound. Sound is essentially a vibration, and a buzzer is no exception. The buzzer can be divided into piezoelectric buzzer, and Electromagnetic Buzzer. The piezoelectric buzzer makes a sound by pushing a piezoelectric buzzer slice, while an electromagnetic buzzer vibrates through a vibrating diaphragm. If the sound is very soft, uncover the paper above and expose the holes will be better.

I get it. Just as the sound of a human being vibration through the vocal cords, there is also a component inside the buzzer that generates the sound.

To move a little bit forward, there is another output module, the voice recorder module, capable of playing of voice. Once we have learned how to set it up, we can even try to record the screaming sound of a pig to make it even more real.

2.2 Temperature-controlled Fan

Mike's story

A new member comes into Mike's family recently, a little Chick. Chick is settled on the balcony of Mike's room, and Mike takes care of her. Recently the weather is so hot. Mike usually turns on his small fan at noon so the little chick can be feeling nice and cool. However, there is one day that Mike forget to open the fan when he leaves home, and Mike got so worried about it. Can we help Mike to solve this problem?

Here comes the Boson!

We just need to make an automatic temperature-controlled fan and put it near the nest. This way, the little chick could enjoy the cool breeze without Mike. Do you remember the shift fan we created in chapter one? Make a little change of it! Replace the input module with a temperature sensor to make the electric fan be switched on or off automatically at given temperature.

Connection and theory

Do you still remember how to set the fan moving at different speed? Yes, a simple input to output connection will do the job. We may use the fan module as the output module, and the rotation sensor as the input module. However, we don't want to manually control the fan this time, we want it run by itself! How should we do that?

A temperature sensor might be helpful. It tells the fan to start running when the temperature goes high. Also, we can use a threshold module to set the minimum value of temperature for the fan to start running. The logic diagram Logic is shown as below:

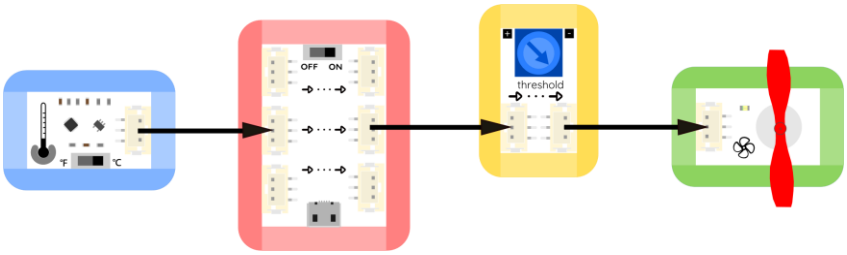
Bring it to life!

To be able to detect the temperature, we will need the temperature sensor as the input module, whereas the fan to be the output module. We may also need other components listed as following:

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1

Input module	Temperature sensor		1
Output module	Fan module		1
Functional module	Threshold module		1

Try to connect all the modules as the shown in the following connection diagram.



After the circuit, we will need to set the knob on the threshold module to an angle. The angle corresponds to a certain temperature that the fan will start running. Need to notice that the threshold module can be either on the input or the output side of the mainboard.

Try to play around with the rotor to find out the target temperature. After all that, we may need to pack everything in to a box to make it more like a household appliance.

Bonus session

Amazing! We have created two electric fans. Guess what? Mike is so earnest that he found the fans sold in the mall, its blades are covered by a cage to prevent people from being injured by the fan blades. Do you find it? Take a close look at your own. Is there something different except the size between your electric fan and the fans in the mall?

Moreover, we could also make a protector for the fan.

Draw the scratch here

Mike's further thoughts

Generally, there are two types of temperature sensors, the contact and the non-contact ones. They are both quite common in our life. The contact temperature sensors are also known as thermometer. During the measurement, it must maintain good contact with the object. Oppositely, the non-contact temperature sensors are also called non-contact thermometer in which the sensor does not touch the tested objects, so they are usually used to measure the surface temperature of moving objects, small targets, or something has lower heat capacity or rapid temperature change (transient), and can also be used to measure the temperature distribution of temperature field.

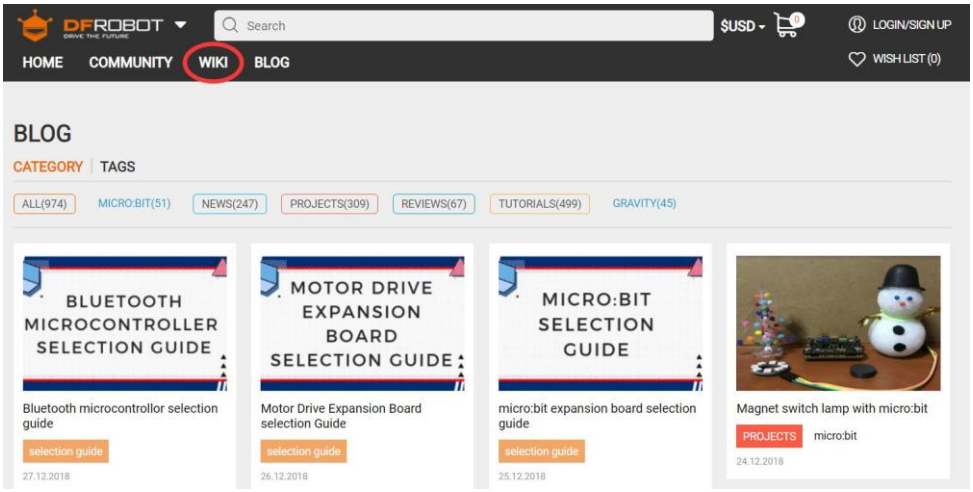
How can you know so many things? I want to be as knowledgeable as you.

Well, here is my trick of learning how each component in Boson kit works.

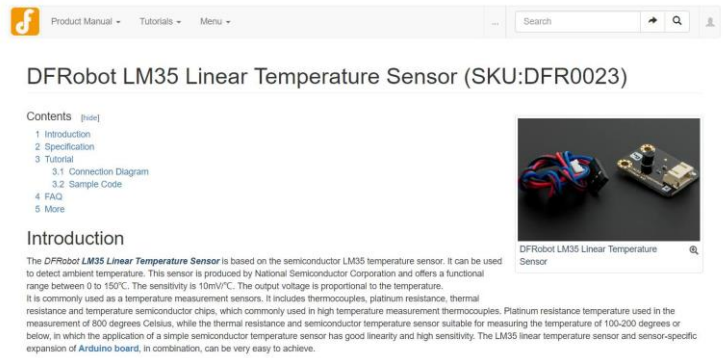
Sounds great! Thanks for sharing with me!

Boson kit is designed by an open source hardware company called DFRobot. The instruction of each component can be found on DFRobot website.

Here is the link: www.dfrobot.com



Enter the DFRobot Product Wiki and you will find the webpage following, in which all their products details including performance, applications, and so on are provided. Or you can find the product you need in their electronic mall first and then click the corresponding production.



Wonderful! In this way I can find out all the further details on it. Thank you. I am going to get started.

2-3 Rain Alarm

Mike's story

In Mike's new house, there is a roomy open-air terrace and his mom always likes insolating clothes or quilt on it. But several days past uncertain weather, rainy and sometimes hot. Mom is too busy with housework to be aware of the rain. The clothes and quilt gets wet a few times. Can we help with Mike's mom be aware of the rain without delay?

Here comes the Boson Kit!

The first thought comes to Mike is that the water drop makes a little bit noise when it hits the ground. However, it is still too small to be detected. Is there a sensor able to detect the rain based on the humidity?

Connection and theory

To make a rain alarm we will need a steam sensor and a buzzer in Boson Kit. As shown in following picture, the steam sensor is placed as an input module for detecting raindrops and then making the circuit connected, so the output module, a buzzer will sound alarm. It needs to be carefully explained that the steam sensor is a sensor can perform the detection of moisture, which is usually applied to the detection of soil moisture, moisture content of wood, etc.

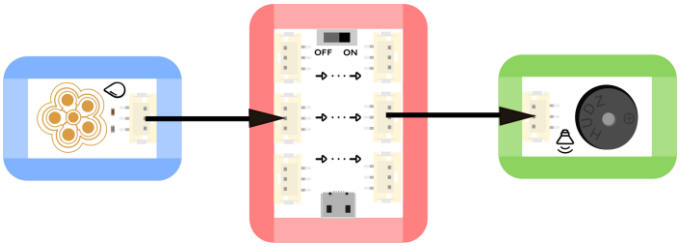
Bring it to life!

In the operation of this module, the moisture sensor is selected as the input module and the buzzer is used as the output module. Get all the modules and components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Steam sensor		1

Output module	Buzzer module		1

Then try to connect these components as below and see if it works out as what we've expected.



Place your own electric rain alarm properly so that mom can hear the alarm. How about it? Mom could feel free to hang out the wash on the air-open balcony

Bonus session

Sometimes the one moisture sensor won’t be enough, the water drop doesn't not always hit the sensor when raining. We may need to add more sensor to make the detection more reliable. But how will the connection look like? Hint: a logic OR module might useful.

Draw your scratch here

Mike's further thoughts

Can you tell me how does the moisture sensor work?

Moisture sensor detects the water based on the change of conductivity. Since the water conducts electricity, when it drops in between the metal parts, the circuit will be connected.

In other words, the more water falls on the moisture sensor, the stronger the output signal. Suppose there is a buzzer connected to the circuit, it beeps louder.

That's absolutely right. You are getting better, Mike.

2-4 Induce-glow igloo

Mike's story

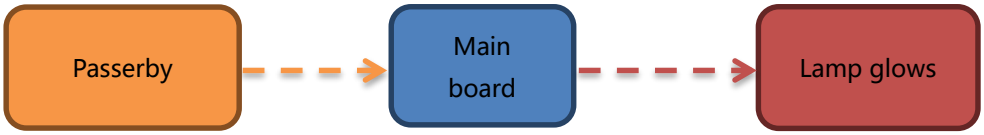
Mike watched a documentary film about a story of the Eskimos yesterday, in which the Eskimos wear animal skins and live happily in the frigid arctic. Mike is shocked by their very different way of life. While what attracts Mike most is their igloo. Due to the loss of stones and woods, and the common house cannot withstand the arctic conditions, the Eskimos build their house with the raw material ice. The igloo is durable and tough enough to against the strong wind. Mike becomes curious and envious to live in an igloo.

Here comes the Boson!

Surely Boson kit won't be able to take Mike to the North pool and build such a house, but what we can still do is to build our little model of the igloo with a small automatic induction LED light inside, which will glow soft blue for greeting hunters when someone passes by.

Connection and theory

First we need to understand the mechanism behind such device. Once someone passes by, the light glows blue. From the point of function, it should be an induce-glow igloo. Specific logic is as follows:



This brings us to another question. How can we know if there is someone passing by? The motion sensor might be helpful. Since every object radiates heat to the surrendering environment, and the frequency of the radiation is depending on the temperature and material. This particular motion sensor in the Boson kit detects the motion based on the heat radiated by human, which stays relatively stable around 37 degree. Because of that, the motion sensor always goes with another name, The PIR (pyroelectric infrared) sensor.

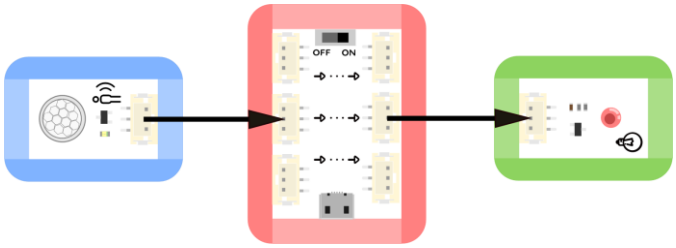
Bring it to life

These are modules and components we need.

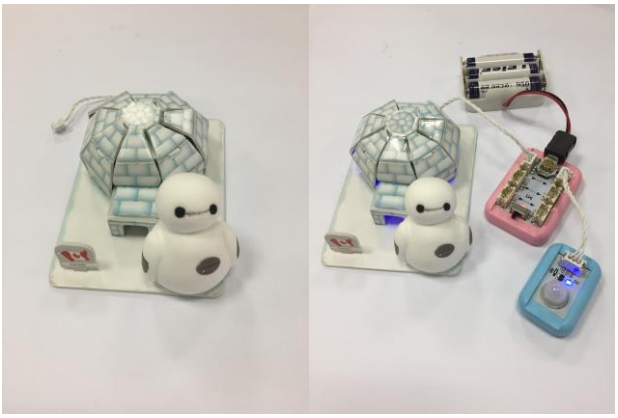
Types	Name	Photo	Quantity
Power supply	Main board-3IO		1

Input module	Motion Sensor		1
Output module	LED Module		1

Again, we will start with the Input to output circuit as what we did in our last chapters:



Its shape may be a little difficult for you. Draw a colorized igloo model on paper first. Cut the module and glue it a tridimensional igloo. For example, Mike makes his igloo below a circle with six blades of paper around it. Be noted that give place for glue, you can find your mom or dad for help. After the shape, put your one in-one put circuit in the igloo, and the pyroelectric infrared sensor out. Try to finish it and see if it works out as what we have expected.



In this way, we get a luminous cabin that automatically senses the body movement. Try it out to see if it can sense you come back!

Bonus session

Did you notice that once stop moving, the light will go off shortly? This is because the sensor senses the change of the sensor. Is there a way that we can make it last longer when we are not moving? A module comes with duration function might helpful.

Draw your scratch here.

Mike's further thoughts

Pyroelectric infrared sensor and duration module

The motion sensor is rather amazing. Can you tell me more about it?

Everything radiates heat to the surrounding environment in the form of electromagnetic (EM) wave. If we go a little deeper into thermo-physics, you will learn that the frequency of the wave always has something to do with its temperature and the type of the material. When it comes to the human body, which usually stays stably around 37 degree, the radiated E&M wave stays in a certain range of wave length. However, does the same story apply to the animals or other objects? This is something for you to find out.

I got it. Could you please explain me about the duration module? I am not very familiar with it.

Sure, we all know that the signal is made up by a certain pattern of voltage. Sometime the signal won't stay at long enough. So we will need a module that is able to extend the duration the signal. What the timeout module does is that we can set the duration extension through the on board knob, once a high voltage comes in, it outputs a signal of length that we set through the knob.

2-5 Intelligent fireproof cabin

Mike's story

Winter arrives, and the weather is getting drier. There are a lot of reports of fire in newspapers and on TV. Mike becomes afraid of the fire will be in their own house. Is there any way to create an intelligent fireproof device to reduce the risk of fire?

Here comes the Boson!

Fire detector can be found in various places to keep the house safe. Is there a way that we can use Boson module to build our own fire detector, which triggers alert when fire is detected?

Connection and theory

To make your house a smart fireproof house, you definitely need to have an alarm flame detector. Such detector in our Boson kit is called the flame sensor. The flame sensor in the Boson kit can detect the presence of a fire source and is the perfect choice for making a flame alarm.

Common flame alarm

Connect the circuit as below and you will get your own electric fire alarm.

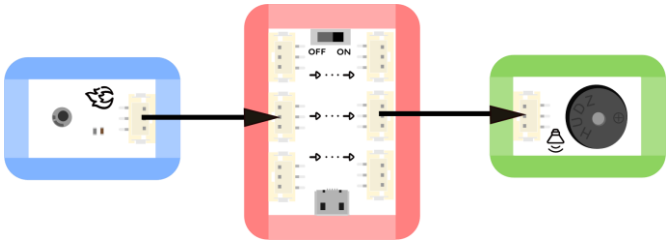
Bring it to life!

We will be using the flame sensor as the input module, whereas the buzzer as the output module.

Types	Name	Photo	Quantity

Power supply	Main board-3IO		1
Input module	Flame sensor		1
Output module	Buzzer		1

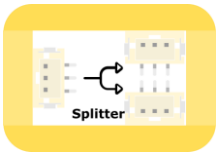
Try to connect the components and see if it works out as what we expected. A match or a lighter can be fire source.



Try to light a match, or a lighter, to see if it can give an alarm.

Bonus session

The intelligent fireproof cabin we created can only sound the alarm when there is a fire, it cannot put the fire off. Can you integrate it to make it able to automatically extinguish the fire? (Tip: a fan module and a splitter module may be helpful.)



Draw your scratch here

Mike's further thoughts

The flame senor looks cool, but base on what fact that the sensor knows there is fire? Is it the heat or the light?

Actually, the flame emits a specific wavelength range of microwave (E&M wave), and that is what the flame sensor detects. The probe in flame senor is particularly sensitive to that range of wave. The probe transforms the intensity of the wave into electric signal as output. In this way, the flame sensor is also an analog input module.

Wow, that is brilliant. How does the splitter module start the fan and alarm?

The circuit will become a parallel circuit with a splitter module added, as the following picture shows. Once the main path is connected, the two branches of fan module and buzzer are connected simultaneously. The main feature of the parallel circuit is that the two branches do not interfere with each other, which means that even if the fan is broken, the buzzer works as well.

2-6 Sound-light lamp

Mike's story

Mom's birthday is fast approaching and Mike wants to make a birthday present for her. Having learned how the sound-control light works, Mike wants to make a birthday cake with it. He hopes the candles flicker with the music and go out when the music stops. Mom makes a wish with the music. Though this cake is not edible, he knows his mom will be happy to see the gift. Let's work together.

Here comes the Boson Kit!

Sound sensor can feel the music. As for music, students can sing, or use a music player whose loudness makes the sound sensor feel it. The candle can be replaced with a small lamp module. If you want more small light bulbs, you only need to add the branch module on it. As a gift, the basic function of the acousto-optic interactive lamp has been implemented. Then you make a beautiful appearance and a good package, and the birthday gift is completed.

To make it more beautiful, the devices can be put inside the cake with the bulbs outside. And if you sing together rather than a music player, well you need to place the sound sensor outside. If it is a music player, just place it inside. The device starts when the happy birthday songs begin.

Connection and theory

Sound sensor is an analog input module that can feel the sound of different loudness outside. The sound sensor can identify a high or low volume in a song. Our small lamp module is the analog output with different brightness. Sound sensor makes the light bulb show different brightness to achieve rhythm effect according to the different volumes of music. So when happy birthday song is playing, you can see the changeable lightness of light bulb, in which the effect is very interesting. The connection diagram can refer to the bottom.

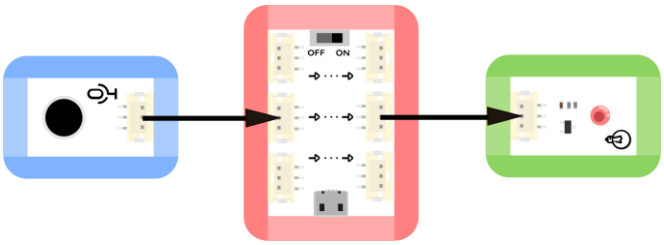
Bring it to life!

Select the sound sensor as the switch, namely, the input module, using the small light module

as the output module. Here are components we need.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Sound sensor		1
Output module	LED module		1

Try to connect the components and see if it works well. Remember to put the components inside and make it more beautiful.



The "acousto-optic interactive" gift is done. The equipment should be hidden in the cake because it looks not good to show.

Bonus session

Our "sound-light" lamp could be more artistic with a spout. We can put a spout outside of a transparent water tank and set the bulbs at the bottom of it. Then we can enjoy the sparkling light with music. It must be beautiful. Give it a try and show your talents.

Write down the difficulties and solutions in the process of operation and practice please:

Mike's further thoughts

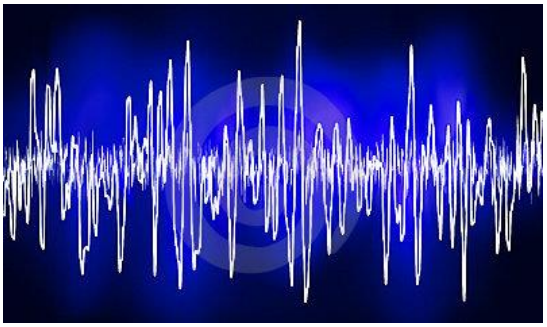
I think the birthday gift amazing. I must learn more and practice what I learnt.

Do you know how the sound is generated?

Yes. I learnt that it comes from the vibration of an object.

Correct. Touch the object that is making a sound and you will verify your answer. For example, touch the location of your vocal cords — that is our throat position, or touch the music wire or drum head that is making a sound, you will find they have something in common — it causes some numbness in your hands. That is because sound is the vibration of an object, and those are making sound.

You can also touch an audio; Open it and play the music. Change its volume. You will find that your hands feel a harder vibration when the music gets louder -- in science, the amplitude of vibration is increased, and the sound gets louder. Sound travels in the form of sound waves and louder the sound is, greater the rise and fall of the sound waves are, which is also known as the vibration amplitude. Here are the sound waves recorded by computer.



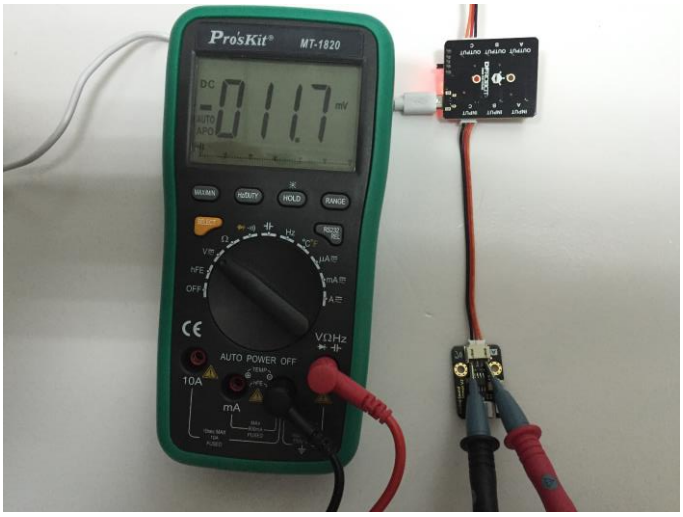
A section of sound waves recorded in the computer

So how the sound sensor works?

The sound sensor is an analog sensor. It acts as a microphone to receive sound waves. The vibration of sound waves causes tiny voltage in "microphone". In this way, transform the sound waves into electric signal. The value of voltage changes based on the vibration amplitude.

We can see the analog input and analog output changes synchronously. Can I know the changes of the other analog input?

Yes. A multi-meter will be perfect. Turn the knob to voltage measurement. Connect the red marker to the metal point corresponding to the yellow line. Connect the black marker to the metal point corresponding to the black line, as the following picture shows. Make sounds to sound sensor. Then you will find that the value of voltage gets higher with your louder voice, and the analog input gets higher accordingly. In other words, the louder the sound, the brighter the light.



The connection of multimeter and sound sensor

2-7 Gift boxes

Mike's story

The birthday of Mike’s cousin is coming next week. Mike has already prepared a gift for him, but how to wrap it gives Mike difficulty. Ordinary packaging is to wrap paper with silk flowers, however, the best package also can’t escape the torn destiny by cousin, and it has no surprise and is environmentally unfriendly. What can Mike do to differentiate the gift package to impress his cousin?

Here comes the Boson!

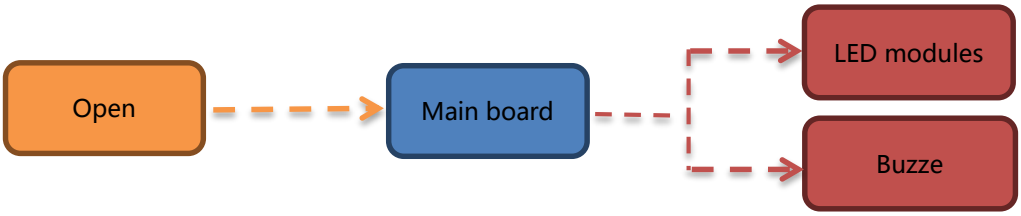
Well it is the most thoughtful thing and you need to take more efforts for surprise. Now we just focus on the gift boxes in view of the prepared gift. In Boson Kit, there is a lot of light modules which we can choose to make a different gift boxes.

Connection and theory

When it comes to a gift box for surprise, we usually have trick toys as below in mind. Once you open the box, there will be little gadgets jumping out of it. Inside these trick toys, there is a spring to pop up gadgets.

Trick toys

For our Boson Kit, there is no spring, but the gift boxes we want to create must be automatic. The logic circuit has shown below.



To be able to open the box to start a small light and make the buzzer sound, what module do you need to do it? Think about it, what's the difference between a closed box and an open box? The most obvious difference is lights in the box. When the box is open, it is bright; and when the box is closed, it is dark. As long as there is a module judging the brightness and darkness of lights, automatic control of the box can be achieved.

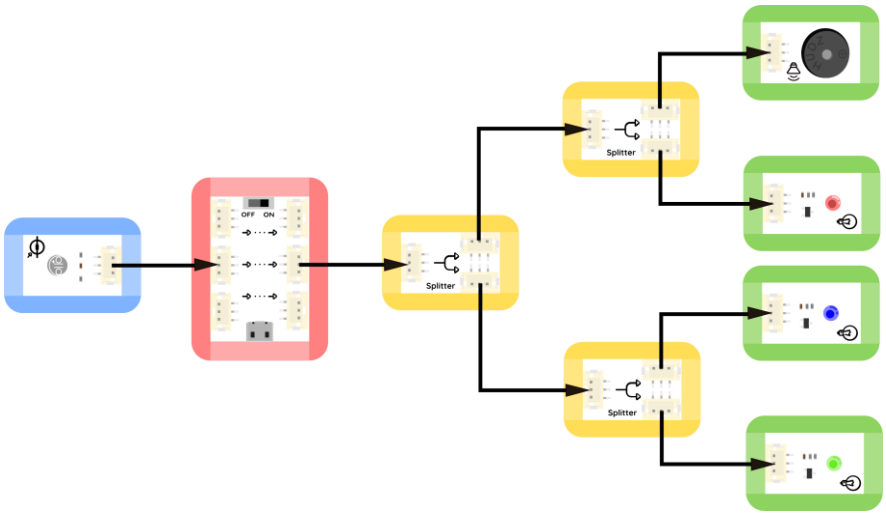
Bring it to life

Can you describe the theory and functions? Well, we want the lamps light and buzzer sounds at the same time when open the box. Therefore, an ambient light sensor will be good. Use the

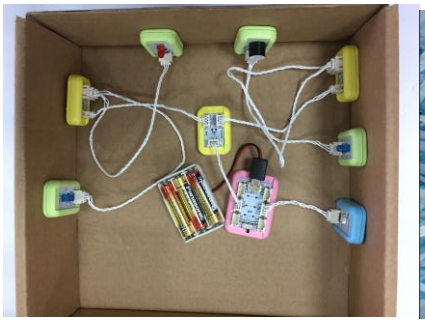
ambient light sensor for detecting the brightness of surroundings. Open the box, the ambient light sensor will detect a light and produce an input signal, then the circuit is connected and the lamps light and buzzer sounds at the same time. These are the components we need.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Ambient light sensor		1
Output module	LED module		3
Output module	Buzzer module		1

There is a little bit more branches there. Connect these components according to the logic circuit. Put it in the gift box and see if it works well.



Fix the lamps and ambient light sensor properly on the top of inner side. Cover the components exposed with paper slip. Then we finish the gift box.



The exposed components in the box are covered with a piece of paper as shown above, so the surprise gift box is done.

Bonus session

Does your box light up beautifully when you open it? Does it light up only outdoor under the strong sunlight or indoor with a strong flashlight? Do not forget to use the threshold module.

Mike is so excited that he wants to make a little doll and let it turn under the electric fan. Do you have any idea?

Draw your scratch here

Mike's further thoughts

What is an ambient light sensor?

The ambient light sensor can detect the light surroundings. They are usually used in digital electronic products. In mobile applications such as mobile phones and laptops, the ambient light sensor senses the surrounding pipelines, and produces input signal to the processing chips to adjust the brightness of the displayer automatically, reducing the power consumption of the product.

Changing the brightness of monitor can reduce the power consumption of the product, why is that?

In general, the monitor consumes as much as 30% of the total battery power and the ambient light sensor maximizes the battery's operating time. Ambient light sensors, on the other hand, help the monitor provide a soft look. When the ambient light is bright, the LCD monitor using ambient light sensor is automatically adjusted to high brightness. When the external environment is dark, the monitor will be transferred into a low brightness state, which achieves automatic brightness adjustment.

Infrared light sensor, ultraviolet light transducer, sunlight sensor are also light sensor. You can find more sensors by yourself.

Thank you. I am going to search for more.

Chapter Three Intermediate creation

Mike has been a better creator with the Boson Kit. Many interesting ideas hit his mind. His creations of increasing difficulty show all his talents and become more and more fascinating that his little friends are deeply impressed, especially the gift boxes he gives. Now, Mike wants to make more practical, beautiful works and share with his friends.

In this chapter, Mike will learn more about the application of logic modules, and make works that are both practical and playful, such as security booth, smart streetlight, retro candlestick, and friend machine. Mike is so sincere, and he hopes to find more like-minded partners by friend machine, so that his friends will know the Boson Kit and realize their ideas with it.

Do you want to be his like-minded friend? Show your skills.

3-1 Security booth

Mike's story

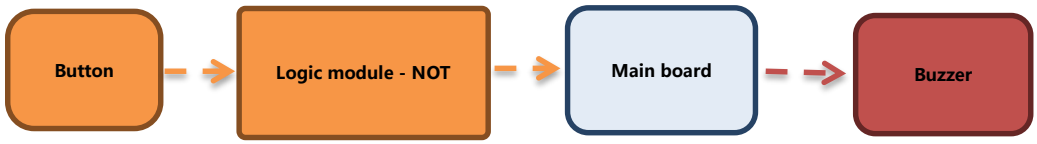
Mike was shocked by news this morning. The most precious treasure of a local museum was stolen. The thieves dressed up broke into the museum in the dark and took it away from the booth in spite of the monitoring in museum. Can we create a security booth? The booth sounds alarm when the treasure is stolen. The workers can get there in time.

Here comes the Boson!

The theft was not discovered immediately because the anti-theft system in museum was too weak. Boson Kit can help to create an intelligent security booth with alarm. Once you pick up the items on the booth, the booth sounds alarm automatically so that the guards will get to it as soon as possible.

Connection and theory

The security booth must sound alarm once the exhibits were taken away. We may need a buzzer or even with a light indicator. Pressing the button will produce high potential and the buzzer sounds. We need a "logic module - NOT" to transform the high potential into low potential. Put the exhibits on the button. That is to say, the button sprang up when you take the exhibits away, and the buzzer sounds. The logic circuit is shown below.



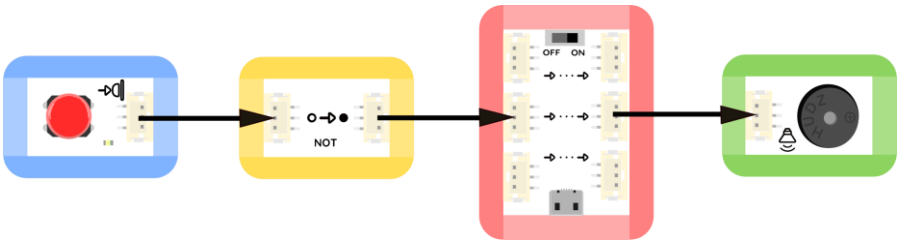
Bring it to life!

The logic module - NOT is used to transform the signals from sensors in reverse. We need to get the components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Button module		1

Output module	Buzzer module		1
Function module	Logic module - NOT		1

Just put the logic module - NOT behind the sensor. Connect the components as follows and see if your security booth works out as what we have excepted.



After completing the construction of the circuit, you can test it to check whether it can achieve the expected function. It should operate as follows: when the item is put on the button sensor, the buzzer is silent, but it will sound when the item is taken away. Since the booth plays its role in the museum, it is necessary to make it look beautiful. The booth is shown in the following figure.

Bonus session

If you have made an anti-theft booth successfully for the museum, congratulations! There are still challenges, come on and join us! About this challenge, I can give you some tips. Please listen carefully. “Is there any other sensor that can achieve the anti-theft function?” I asked. Please try to use other sensors in the Boson Kit to make an anti-theft device.

(Tip: touch sensor may be helpful)

Draw your scratch here

Mike's further thoughts

The exhibits in museum are invaluable. Their alarm device s must be more advanced, and the function should be more powerful. So, what are the high-tech alarm devices in the museum?

To enter the museum, first you need to produce identification. Some museums use biometric identification, such as fingerprint identification, vein recognition, facial recognition and iris identification. In addition, the acoustic system can identify abnormal sounds to sound an alarm. The latest is light detection system, such as video monitoring system and infrared thermal radiation protection equipment. Moreover, there are some other advanced security materials. For example, the security glass sounds alarm once it is cut up. All these advanced security devices protect the national property every moment.

Wow, that is wonderful. The museum must be safe with these security devices.

Yes. For all this, the workers in museum should not be careless. And we should update the anti-theft technologies and works harder.

3-2 Smart streetlight

Mike's story

Mike is on his way home. All of a sudden, he finds that there are smart streetlights around their own neighborhood. All the smart streetlights are on only in the evening if someone comes. Not only has it saved the power resources, but also is humanization. Mike wants to create a smart lamp with similar function.

Here comes the Boson!

Use a sound sensor to detect the sounds. Use a light sensor to determine if it is at night. And to make the two sensors control the same lamp, we also need a logic module - AND. Finally, make a shape of streetlight with hardboard.

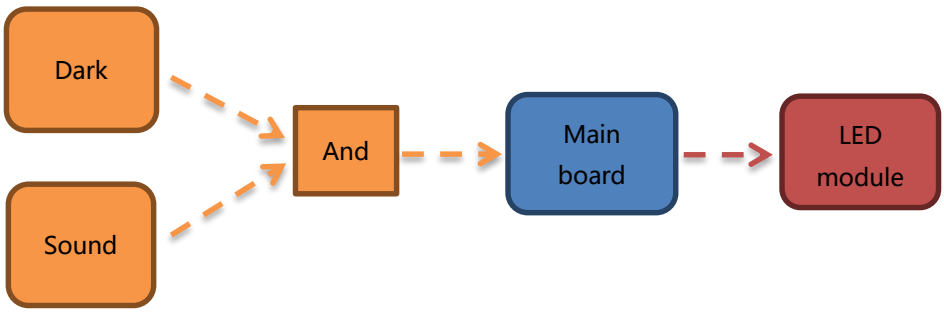
Put the main board, battery and other components under the base. Put the sensors out to detect sound and light. Place the light bulb as above picture shows.

Connection and theory

Two conditions need to be met to lighten the lamp. First, the light sensor "thinks" it is in the evening; second, the sound sensor detects a sound. The logic module - AND produces high potential when it receives two signal at the same time. You can add a threshold module to set specific value for detecting sounds just in case the sound sensor cannot identify soft sound sources.

The light sensor only produces voltage when it senses a light. Our streetlamp must light at night. So a logic module - NOT will be helpful. The logic circuit is shown as below. Both the light sensor and the sound senor are input module. The LED module is an output module.

This work’s operation principle is shown as follows:

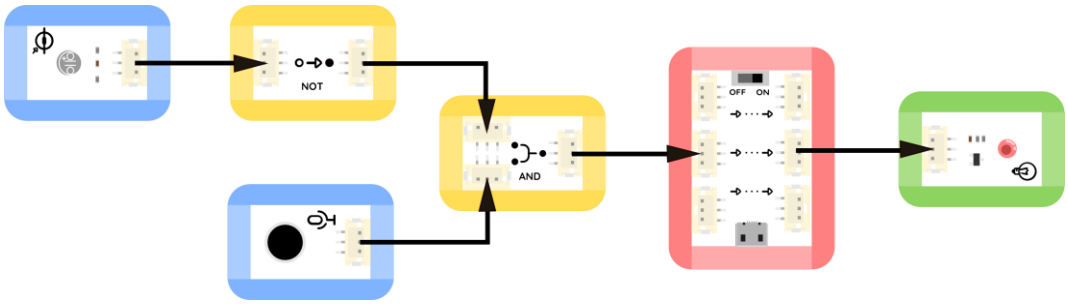


Bring it to life!

We choose sound sensors and photosensitive sensors in the input module, which is connected to the "logic And" module. Then we use the small lamps module as the output module. Get the components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Output module	Sound sensor		1
	Light sensor		1
Function module	Logic module - AND		1
	Logic module - NOT		1
Output module	LED module		1

Try to connect these components and put it in its beautiful "body" and see if it works well.



We add a shell for them, then a smart streetlight is completed.

Bonus session

Through the previous operation, we have made a beautiful smart streetlight and the light can be on when it hears the sound. It only flashes for a moment, but the streetlights in our life are on for a few minutes. Can you make smart lights more powerful? Can you make a smart-light on for a few minutes?

Draw your design here

Mike's further thoughts

We have created a streetlight with the logic module - AND. Do you understand how it works? Besides, the logic module - OR is similar to it, give it a try and think about how the logic module - OR works.

I found that there are two modules similar to logic module - AND.

The splitter module can produce multiple outputs by dividing the input signals into two. But what exactly is logic module - OR?

The three logic modules are similar in appearance. The Mike s on them are different. Marker splitter is a splitter module. OR means logic module - OR, and the AND means the logic module - AND.

The logic module - AND only produces high potential when there are two input signals. So I think the logic module - OR produces high potential as long as one of input modules is met. Am I right?

Completely correct. A or B means that anyone can work. After learning, I hope that you can use these two modules to make something and pay attention to the text description to the module. If the modules are not used correctly, you can't achieve the expected effects.

You are so careful, Mike.

Oh, right. I found that the streetlamps give off different colors of light. Can we choose the colors when we make it?

3-3 Retro candlestick

Mike's story

Mike is shopping with mom. He takes a fancy to a retro candlestick and wants to buy it home. But mom says it is dangerous for him. Mike becomes depressed and decides to make a candlestick himself. You can lighten up the candlestick by "fire". It sounds interesting. Let's do it.

Here comes the Boson！

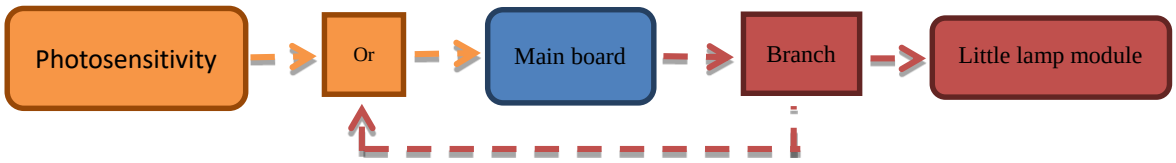
The candlestick can be lit by glare. Here, the small lamp module stands for the fire in the candlestick. There is a sensor in the Boson Kit that can feel the light intensity. It is named as photosensitive sensor. Small lamps can be lit by the flashlight's glare. In order to achieve this effect, we need to use the splitter module and "logic or" module.

Candlestick creation: Use soft clay or paperboard to make a candlestick.

Connection and theory

The "fire" means light. The light sensor senses the high-light and produce input signal, then the circuit is connected and the lamp lights up. Once there is no high-light, the lamp goes out. But a candle should keep its "fire". To solve this problem, we need the splitter module and logic module - OR. Splitter module is used to get the circuit back to logic module - OR. In this way, the bulb continues to light.

As the following logic circuit shows, one of the branches lightens up the lamp by high-light. For the other, splitter module gets the circuit of high level back to logic module - OR and keep the lights. Is it amazing?

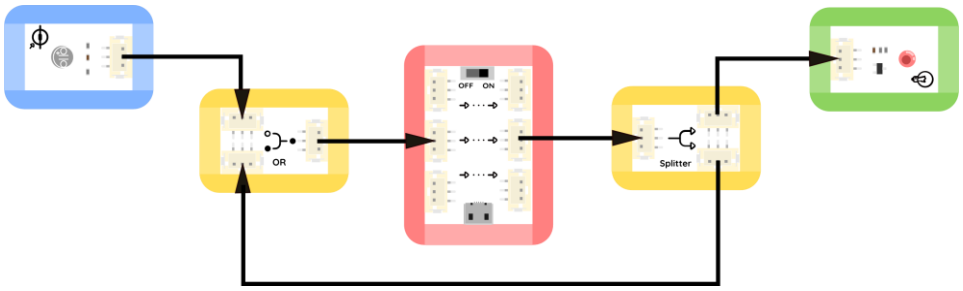


Bring it to life!

We choose the photosensitive sensors as the input module, small lamp module as the output module, and combine the splitter module and the “logic or” module to make lamps on continuously. Get the components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Light sensor		1
Output module	LED module		1
Function module	Logic module - OR		1
	Splitter module		1

Try to connect the components and see if it works well.



The circuits in this case are different from that used previously, which are more complex. When the photosensitive feels glare, “logic or” condition is satisfied, then the system will output high potential. High potential passes through the splitter module, and one part of it directly lights the small lamps, the other returns to the “logic or” module. The whole system operates

repeatedly like this. Owing to the circulatory system, these small lamps are on all the time.

Bonus session

Theoretically, our experiments can be successful. But in the actual experiment, we may meet such a condition that small lamps may be on before glare is provided. Why?

The bulb is on sometimes even there is no high-light. That is because the light indoor is high enough to make the light sensor produce a high potential. We need to test it at somewhere is dark or far away from light source. Or use a threshold module and set a specific size of light.

Draw your scratch here

Mike's further thoughts

I have an even simpler way for keeping the light, Elf

Let me hear about it.

Put the light sensor and lamp closer. For the first time, lighten up the bulb with high-light. Then the bulb light is also a light source for sensor. It is a circle and the bulb can never go out.

Good idea! This shows that you have learned to think. Your words remind me that there is a kind of ouroboros (Its head and tail bite). Ouroboros pattern is used as an ancient alchemy tag. It bites its tail, constantly creating a new life, forming a ring. In our case, we achieve the circulation through the circuits. The system works all the time, forming an endless loop.

Elf, although this is a practical way, it has limitations. For example, how to turn off the small lamps?

Well that is the limitation of the circuit. For our candlestick, the bulb light can only goes out when you be turn off the power or cut off the branch circuit from splitter to logic module - OR. Generally, we should avoid this closed-loop system. We will learn to add judging condition in cycling circuit later, and end the cycle by the judgment.

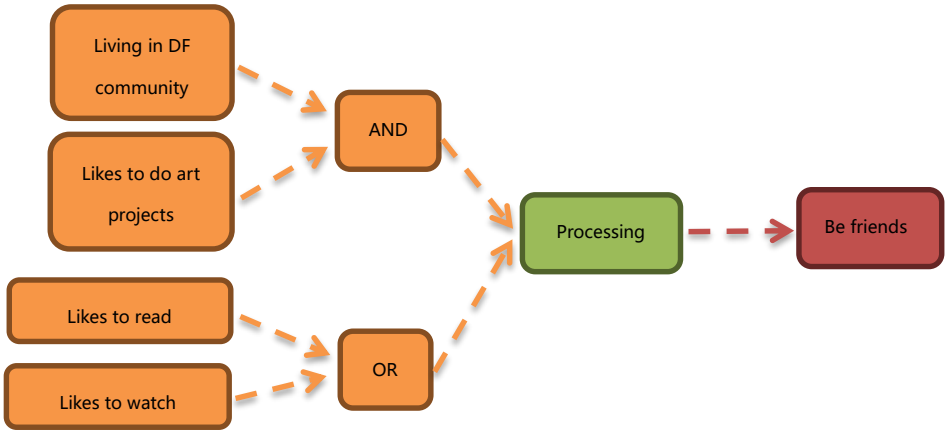
3-4 Friend machine

Mike's story

Mike likes to create little things with Boson Kit and wants to share it with little friends, but he does not know who is like-minded with him. Is there any way to help Mike find like-minded friends quickly? How about a friend machine?

Here comes the Boson!

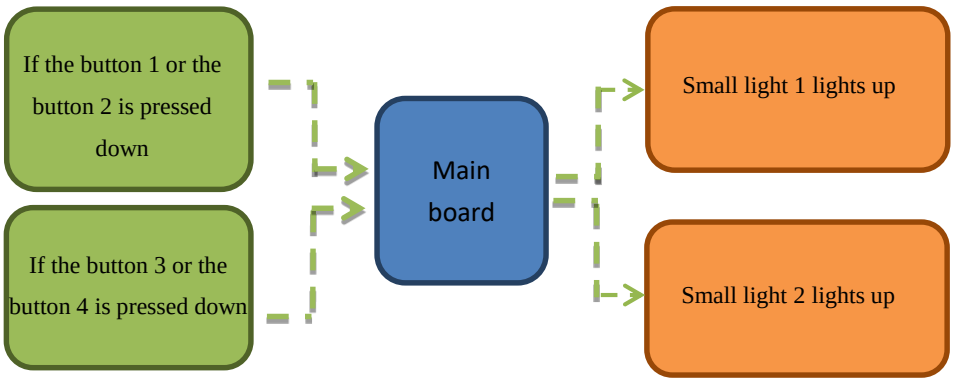
Our target is to help Mike find like-minded friends. We can ask Boson Kit to help. We plan to make a friends finding machine and use it to help Mike find friends. Please press the "next" button or several buttons, then we can evaluate whether you can be a friend of Mike according to the analysis of your options.



Connection and theory

According to the hobbies and characteristics, Mike gives out some options. Mike is a child that likes hand making, loves watching “Happy Goat” and “Journey to the West”, and lives in the DF community. So, he gave out these options: (A) like hand making; (B) live in the DF community; (C) love watching “Happy Goat”; (D) love watching “Journey to the West”. There is a logical relationship between these options. They can be friends if the partner chooses (A) and (B) at the same time. The conditions of (A) and (B) must be met simultaneously. And the options of (C) and (D) are as the same. The schematic diagram of friend machine is as follows. The buttons are used as options. The LED lamp lights shows that they have the same hobbies and will be friends. Otherwise, they cannot be.

The following simple diagram is used to show the principles of the friends finding machine.



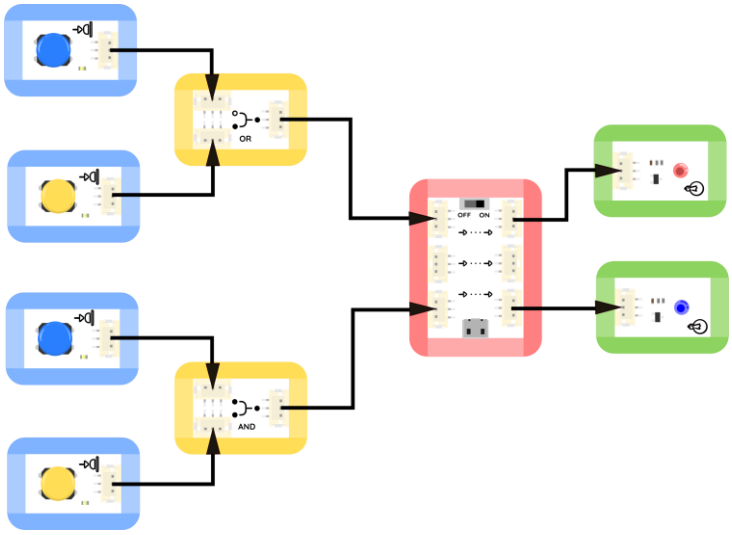
Bring it to life!

Here buttons stand for the options. After pressing the buttons, if the small lamps are on, it means that you can be a friend of Mike. We need to get the components ready first.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Button module		4
Output module	LED module		2
Functions modules	Logic module - AND		1

	Logic module - OR		1

Try to connect these components and decorate it. Then find like-minded friends with it.



Next, we use a beautiful box to package it. Now, we can find friends by the friends finding machine.

Bonus session

(1) The LED lamps are used to show whether you can be friends. One or both of them are on, the partner will be your friends. Try to make friends with your friend machine.

(2) The logic module - NOT has never been used. For the logic module - NOT, the circuit is connected when the buttons are pressed down; while press the button and the circuit is disconnected. You can use this logic module - NOT in your friend machine. For example, if you don't like coriander, you can give out an option (love eating coriander). Those who choose this option can't be friends with you.

Draw your scratch here

Mike's further thoughts

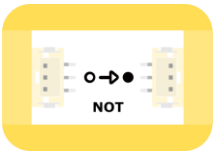
Do you know how to distinguish signal input and signal output in the circuit, Elf?

For computer science, the number “0” and "1" stands for the value of output and value. “0” means false, such as the buttons are not pressed or the lamps are not on. “1” means true, such as the buttons are pressed down, or the lamps are on.

I read that the logic module “AND’, “OR” and “NOT” are operational symbols similar to the “plus", "minus", "multiply" and “division”. How do the symbols woks?

Well, the “AND”, “OR” and “NOT” are three basic operators in logic operation. List all the possible values of logic event input (A) and output (Y) in a table, and that is what we called the truth table. You can understand logic operation better with it. Let me show you the truth tables.

“Logic NOT” means the opposite of the original value.

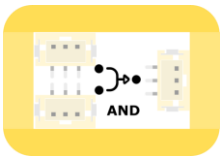


The truth table value form is shown as follows:

A	Y
1	0
0	1

Remarks: If the input value is 1, then the output value is 0; if the input value is 0, then the output value is 1.

“Logic AND” is equal to “and”. It means the output value is true when both conditions are true.

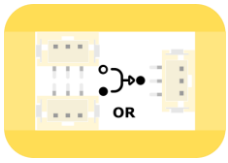


The truth table value form is shown as follows:

A	B	Y
1	1	1
x	0	0
0	x	0

Remarks: X can be replaced with 0 or 1. When A=1, B=1, the output value is 1. If A=0 or B=0, the output value is 0 under any circumstances. You can refer to the experiment 3tomake your own test, and observe the small lamp module’s output condition after pressing the keys A and B.

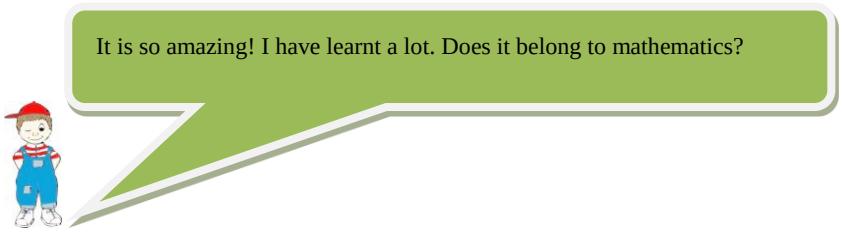
There is no difference between “logic OR” and “or” in life, which means that any of two conditions is satisfied, the final operation result is true.



The truth table value form is shown as follows:

A	B	Y
1	x	1
x	1	1
0	0	0

Remarks: "X" can be 0 or 1. The output value is 1 as long as any of the value of A and B is 1. And the output is 0 when both values of A and B are 0.



Logic operation is also called Boolean operation. Boolean used mathematical methods for logic problems and established the logic calculus successfully. This case is related to the programming math. If you are interested in computer programming, you should learn more about logic operation.

Chapter Four High-level creation

Mike made a lot of friends with his friend machine. They work together and share ideas in mind with each other. Elf told Mike to make more interesting works with the Boson Kit when he is going to leave. Think of there, Mike becomes excited. He wants the Elf be proud of him. After a period of efforts, Mike learned a lot and can create more devices expertly with the Boson Kit. On the eve of Halloween, Mike made a very interesting pumpkin lamp, and his friends like it very much.

In this chapter, Mike will make more complex and interesting works with us, such as pumpkin lamps, coded locks, responders, etc. Boys and girls, let's do it with Mike!

4-1 A Jack-o-lantern for Halloween

Mike's story

Halloween is coming! It is time to make pumpkin lamps. Mike plans to use the same methods of candlestick we created last time to make pumpkin lamps. But the candlestick we created cannot go out. Is there any way to glow the pumpkin lamp out like a candle?

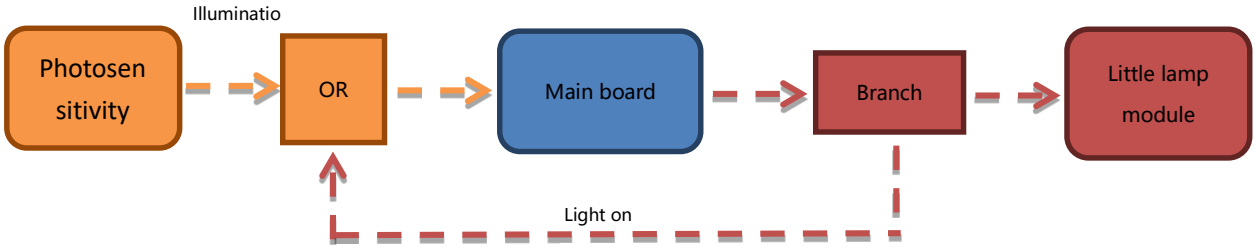
Here comes the Boson!

We need a sound sensor. Blow at the sound sensor, and the sound sensor will detect it. Then the circuit is connected and the lamp could go out. We also need the logic module - AND and splitter module. For making the sound sensor more sensitive, it is required to use the threshold module.

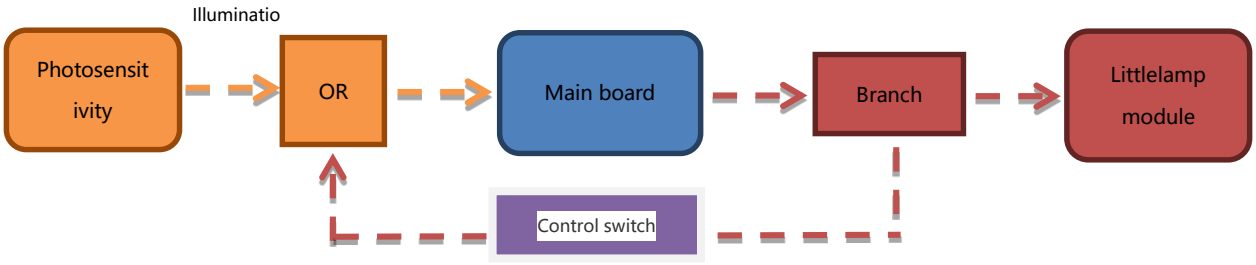
Use light clay or card boards to make a shape you favorite. It does not have to be a pumpkin shape.

Connection and theory

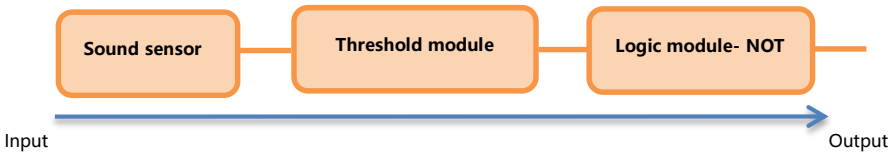
In the creation of the vintage candlestick, we use the following loop structure. The connection structure is shown as follows:



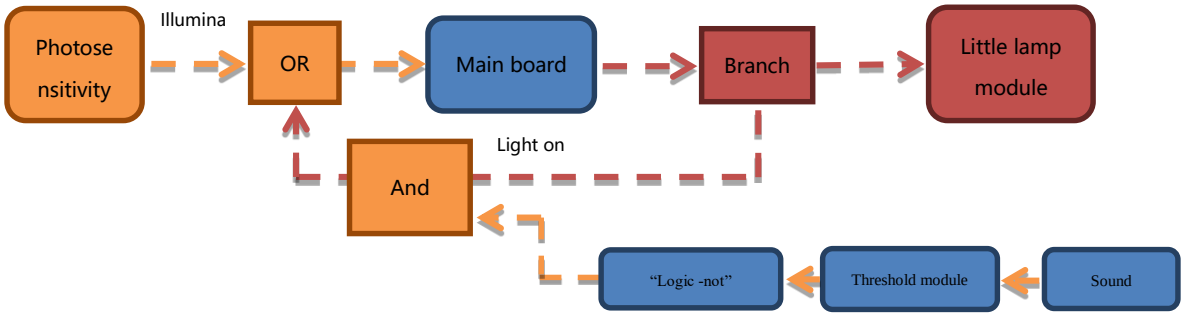
How to blow out the pumpkin lamps? We need to add a control condition in the loop from the branch to the “logic or” module, so that the sound sensor, as a switch, can control this loop. Switch installation position is shown as follows.



Add a sound sensor to the control switch to sense the blowing. In order to make the sound sensor more sensitive to the sound, a threshold module may be helpful. When blowing, the sound sensor is under control of high potential. If we want to make the small lamps go out, it is required to provide a low potential. Therefore, we need to use a logic module - NOT to transform the high potential to low potential. The logic connection is shown in the following figure.



If we want the sound a condition of controlling, it is required to use the logic module - AND. By default, the logic module - NOT combined with the sound sensor, the output is "true", and the circuit is connected. Once the sound sensor senses a blowing, one condition of logic module - AND is not met, and the output is "false". The circuit is disconnected. Connect the circuit as follows and you will get your pumpkin lamp.



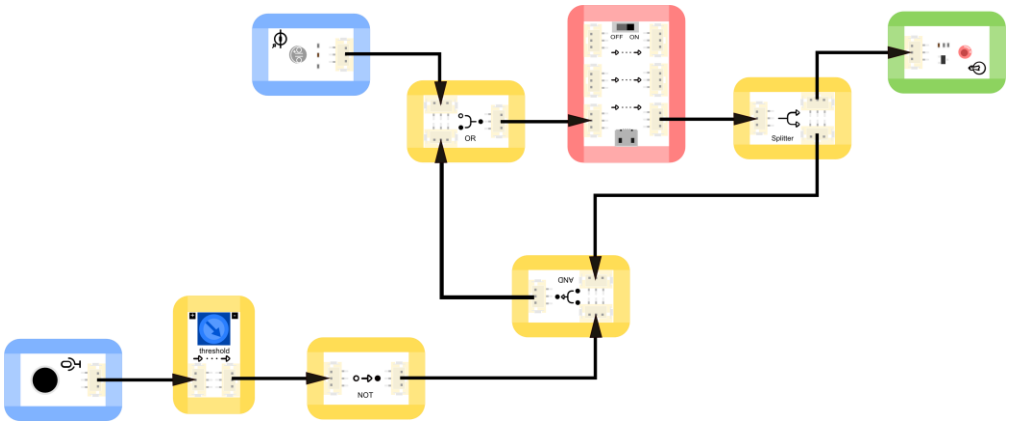
After correctly connecting the circuits, we complete the creation of the pumpkin lamp, achieving its functions. Next, let’s do it.

Bring it to life!

Based on the last lesson, we know that it is necessary to use the "logic negation" module, “logic and” module, the threshold module and the sound sensor, in addition to the equipment and materials required.

Types	Name	Picture	Number
Input Module	Sound sensor		1
Function modules	Logic module - AND		1
	Logic module - NOT		1
	Threshold module		1

Connect these elements according to the logic connection.



Set the value of threshold module properly. Please take the central position of knobs as the base for left or right adjustment.

Bonus session

In addition to the modification of the loop structure, it is also very important to be skilled with input and output. Please follow the principles and the circuit diagram to connect your circuit. The

physical connection diagram is not good enough for practice. Can you design a doorbell structure with what we have learnt now? When visitors press the doorbell, the doorbell sounds alarm. Only when the host answers that it stops.

Draw your scratch here

Mike's further thoughts

Have you ever seen any special bulbs, Mike?

Yes, I have seen all kinds of pumpkin lamps, fluorescent lamps, desk lamps, etc.

Hum! With the development of history, science and technology and the improvement of aesthetic standards, the lamps in our life are no longer limited to lighting. People created all kinds of lamps with multi-functions. Let me show some of them to you.

1. DIY unplugged noctilucent bulb

It can be used for basic lighting without electricity at night. So it is convenient for emergency, such as looking for candles and flashlights when there is a power failure.

2. Huge Irradiative pencil

This HB lamp is designed by Michael and George of England. It looks like a huge pencil in a corner whose head eraser lights up the room. It’s worth mentioning that the wires from the pen point look like a child is scribbling when they are placed randomly on the floor.

3. Squeezable light bulb can "assimilate " color

Colorup is a wireless lamp designed by PEGA Design & Engineering. It changes its color according to the surrounding environment when it is squeezed. Make the tip of the colorup face forward to the top of the object, and squeeze the bulb; it will show the same color as the object. It is a good choice to use it to show your emotions considering that it can 'sense" hundreds of different colors.

Wow, I never know a lamp can be so cool.

4. Romantic Ceiling lamp

It is an adventurous and romantic design. I feel it cool when I have my first sight. It brings the clouds indoor and that is amazing. Besides, it can do more incredible things. Its shape can be varied with music, and the lamp can even imitate the various things such as lightning and thunder.

4-2 Password lock

Mike's story

Recently, many thieves appear near the DF community which Mike lives in. The ordinary security door cannot prevent the clever thieves. For the security of house, Mike wants to add a password lock to their security door. Only the right password is offered can the door be open. So do you have any idea about this password lock?

Here comes the Boson!

The direct modification of security door at home is troublesome. We can make a password lock with the Boson Kit, and it is much easier. First, we need three buttons. Only when the three buttons is pressed the lock is open. And then the LED lamp lights, the buzzer sound alarm. In this way, we can be aware of the conditions of lock.

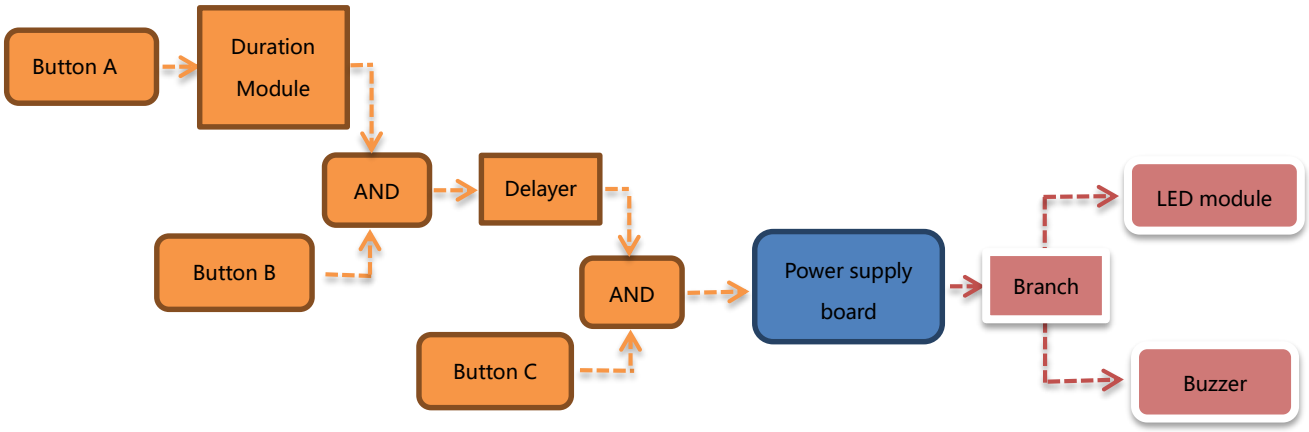
Pay attention to the logical sequence of password. For example, the password includes three letters represented by buttons. The output is 1 when the password A, B and C are offered successively. And that is the only way to lighten lamp up and make the buzzer alarms. This will improve the performance of security doors. Of course, it would be better if you could have more conditional settings, such as typing correct password within the specified time; otherwise, the buzzer will alarm.

Connection and theory

You need three different buttons, a small lamp module, a buzzer and a number of functional modules to set a switch. First, know the order of the buttons very well, and assume the order is A, B, C. According to the order of the buttons, the small lamp module will be bright. If not, the small lamp module will not be bright.

The button A produces an input a signal when it is pressed down. The signal lasts 1~6 seconds under the control of continuous modules. In the specified time, you need to press down the button B. Use the same method to connect a continuous module, which can keep the received signal unchanged for a certain period of time and transmit the signal to the second module. During the time, press the button C. The transmission of the signal will be implemented. Finally, the small lamp module and the buzzer receive the signal and begin to work. Pay attention to the signal input, and the logical relation between buttons and modules.

Its structure is as follows:



In the process of production, pay attention to the signal input, and the logical relation between buttons and modules.

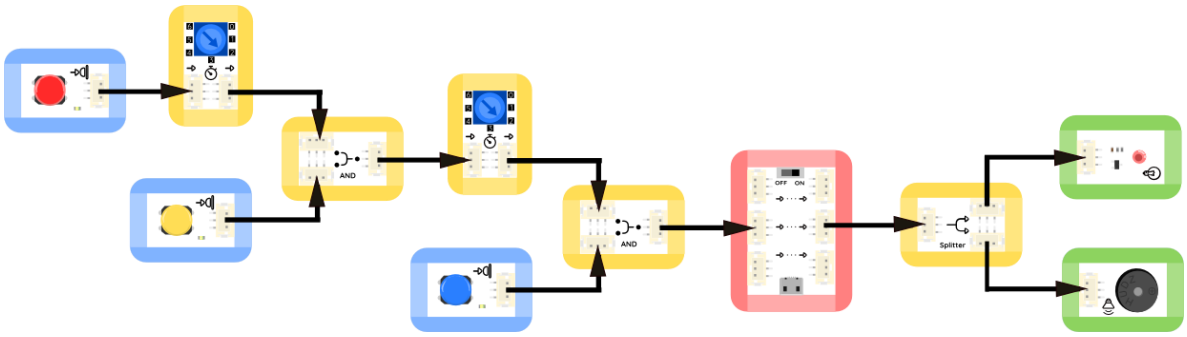
Bring it to life!

This route is not complicated. As long as the signal of each module is transmitted, the transmission of each level signal can be realized. The continuous module and the “logic and” module have been in contact before, and I'm sure there will be no problems for you. The components we need are ready.

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input modules	Button modules		3
Functional modules	Logic module - AND		2

	Continuous modules		2
Output module	Red LED module		1
Output module	Buzzer module		1

The reference of components connection is as follows:



Connect the circuit and see if it works well. You can check it and set a reasonable time for the continuous module to improve the accuracy of the switch. What should be paid attention to is that you could operate after the continuous time is over and all the settings return to 0. It’s a process of resetting.

Bonus session

You could press down the buttons in wrong sequence and see if the lamp lights. You could find the small lamp module will not be light. It indicates that every module of the branches is dependent.

However, Mike thinks it not secure enough. If pressing down all the buttons, the lock would open. Could you help him? Try to add logical module to improve the security of the safe switch.

Please draw your scratch here.

Mike's further thoughts

Do you know how many kinds of passwords are there with your three buttons?

There are six. Arrange these buttons one by one.

Okay, if there are ten buttons. So how many kinds of passwords are there?

I don’t know. It’s troublesome to arrange them one by one.

Yeah, it would be troublesome and you might make something wrong, if we arrange them one by one. In our life, we often use this kind of password. The number 0~9 can make up 10! =10*9*8*7*6*5*4*3*2*1. So that's a huge number.

It sounds difficult. How do you understand it?

You will learn this in the future. You can understand in this way. If the passwords are ten different numbers and the first number we have 10 choices of 0-9. And the second time, you can choose a number from the last 9 numbers. Thirdly, you only have 8 choices, and so on.

4-3 Responder

Mike's story

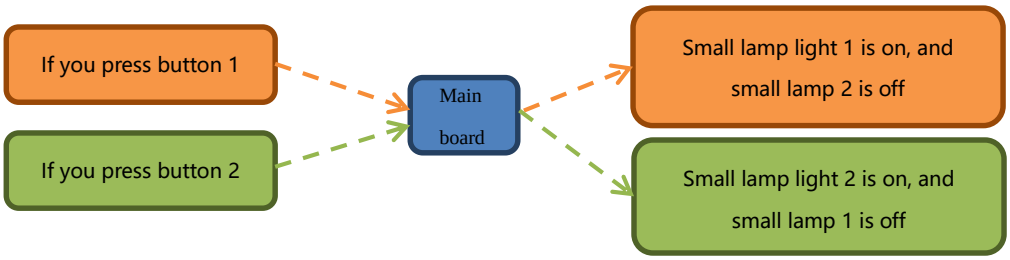
Recently, there is a knowledge contest in school. It comes the final stage after a month of selection. The final of the contest will produce champion and runner-up through racing to be the first to answer the question. In the past, both sides shall answer by raising their hands. However, it is often confused because their hands change too fast. The teachers and students are very puzzled. Is there any way to solve this problem?

Here comes the Boson!

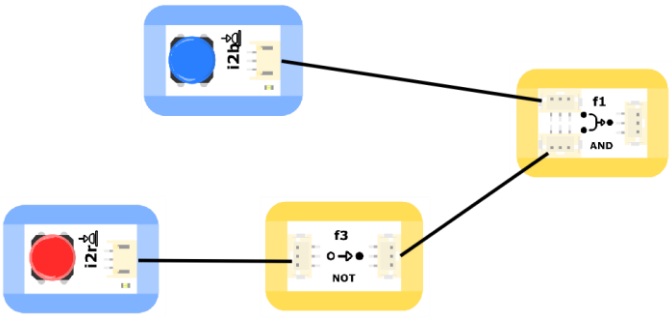
Actually, this problem is easy to solve. They use the buzzer on TV. The system will show which player press the button first. This buzzer looks so complicated. But Boson Kit can make it easily.

Connection and theory

In addition to lighting the corresponding lamp which the player presses down the button first, it needs to prevent another lamp from lighting up. The logic connection is as follows:



How to prevent the other lights from lighting? In fact, you need to satisfy two conditions. First the corresponding button is pressed down, and another button is not. Use logic module- NOT and AND to transmit the input of button to another button. As shown in the picture, if the red button is pressed down, the output will not be "true" even if the blue button is pressed.



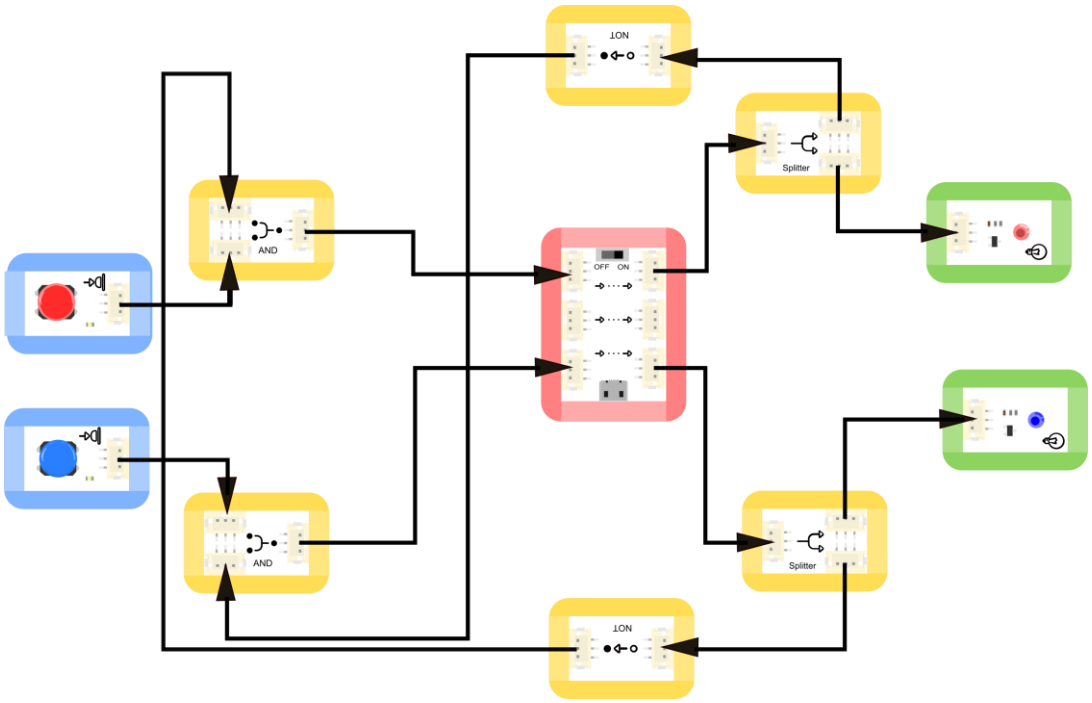
Bring it to life!

You should better choose the color of the button corresponding to the small lamp, so that it is more convenient to use. The components are:

Types	Name	Photo	Quantity
Power supply	Main board-3IO		1
Input module	Button modules		2
Output module	LED lamp module		2
Functional module	Logic module -AND		2
	Logic module -NOT		2

	Splitter module		2

Connect these components according to the logic, as shown below:

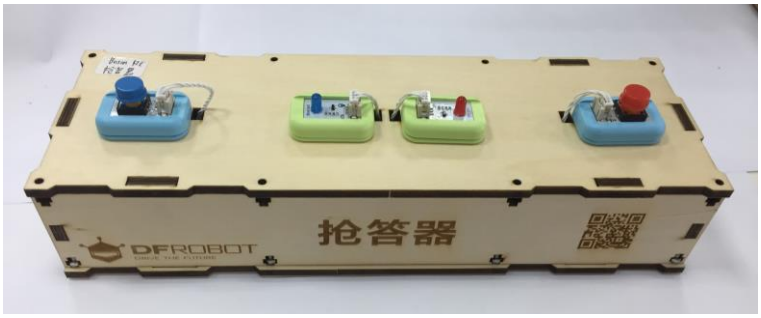


Do you feel complicated when you see this circuit diagram? Actually, the circuit of the two groups is the same. The signal from the branch connects to another group logic and module through "logic not module".

For example, when the blue button is pressed down, the blue button sends signal A to the logic and module, and the input value is the true. If the red button is not pressed down at this time, the red button will send signal B with value false through circuit 2 arriving branches module, and then transform the value of signal B from false to true. Last, input the value into the blue button that is connected to the logic and module. At this point, logic and module received two signal value is true. Two conditions - "blue button is pressed down" and "red button is not pressed down" are all established. After the power supply board receives the signal, it output state 1, and the blue lamp lights up.

Follow this logic. When the blue buttons or the red buttons light up their own little lights, they stop the other person's light from lighting up so that the fantastic buzzer is completed.

Finally, make a nice box with a laser cutting machine. Doesn't it look cool?



Bonus session

The buzzer is for two players to answer the question, so it is called the two-input buzzer. In the process of production, we only make use of two ports on the motherboard. Could you make use of three ports to make a three-input buzzer? Only the one who press the button first can light up the lamp, and neither of the two lights will be on. However, it should be noted that a set of creation particle suite is not enough. You can find the partners with the creation particle suite, so the two sets could be used together.

Please draw your sketch here.

Mike's further thoughts

Do you know the common points between responder and the retro candlestick?

Yes, they all form a loop on the circuit. Only we build a circulation on the Boson Kit's circuit, it can bring the signal from the output end to input end again. So the circulation forms.

Elf, does computer have this structure?

In computer programming, there is a structure called loop structure, which is similar to our "input-output - input" cycle. In computer programming, the loop is more intelligent. The loop not only can repeat execution but also can enter and out of the loop condition. It can realize more complicated functions.

Appendix

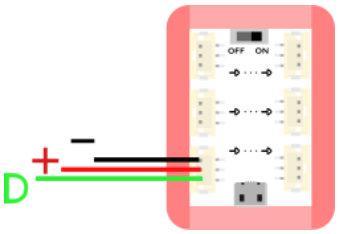
Turn signal of the bicycle

Mike's story

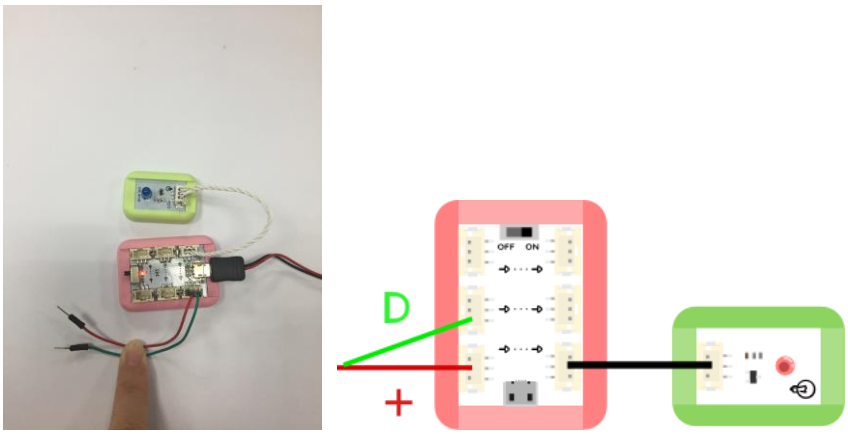
On the way to mall, Mike finds that mom turns on the light at every turn. Mike asks that why you still need to turn on light at daytime. Mom says: “we need to tell other drivers to go left or right. This could avoid risks.” Mike thinks that his bike does not have turn signals. Can we install an intelligent turn signal for the bike? He even hops to make a turn signal which is more intelligent than the cars’. Just turn left or right and the turn signal lights up automatically.

Here comes the Boson!

Before making the intelligent turn signals, you need to know some knowledge. Firstly, observe the motherboard carefully, and you will find the symbol **D + -** (as shown in the red circle)

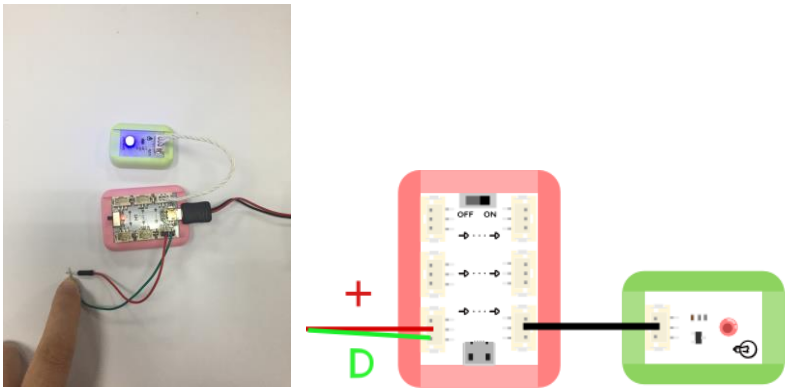


Follow the connection and let's do a test.

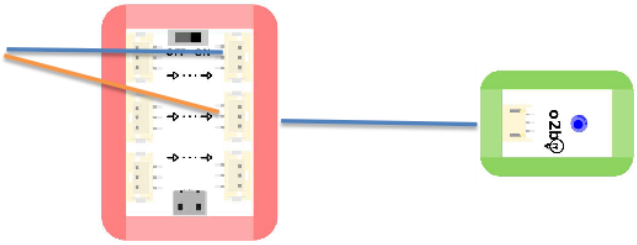


As shown in the above picture. Connect the bulb to the input end, and connect the D on the motherboard input end to + with hermaphrodite connector wire. (Hermaphrodite connector is a wire with a stitch on one side and a pin on the other side, as shown in the below picture)

When the two stitches are connected to each other, the light bulb will light up. This function just likes a button. The lamp lights up when you touch it. The light goes out when you leave it.



You will find that every + is universal. Just need the D at the input end to connect wire, and then pick + out the wire, so you can light up the small lights that are corresponding to D.

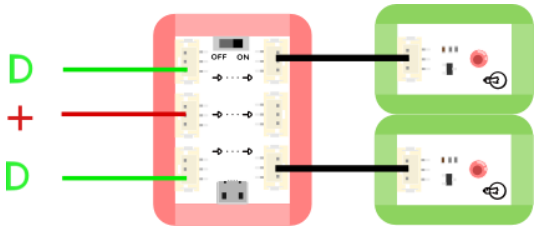


Mike found that Boson Kit can do more things such as the intelligent turn-bike. Let the bike turn left to touch the control line that controls the left small lamp, or turn right to touch the control line that controls the right small lamp. If the bike goes straight, there is no line and neither of the lights is on.

Bring it to life!

There are three pairs of input and output interfaces on the power supply board, and the intelligent turn lamp requires two input and output interfaces. The turn lamp includes left lamp and right lamp. So you must have two small lamp modules, 3 pieces of wire or hermaphrodite connector.

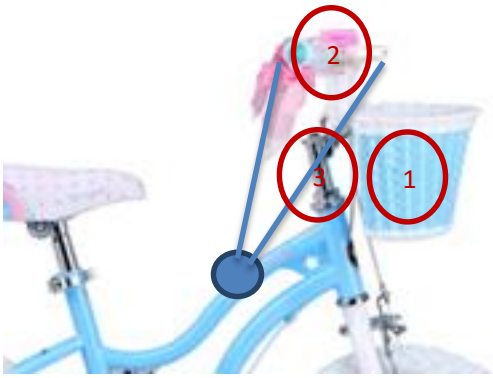
Connect the small lamp module to the output end, and then use the wire to draw the D of the input end corresponding to the output end, as shown in the red line. Select a "+" to connect the wire randomly, as shown in the yellow line.

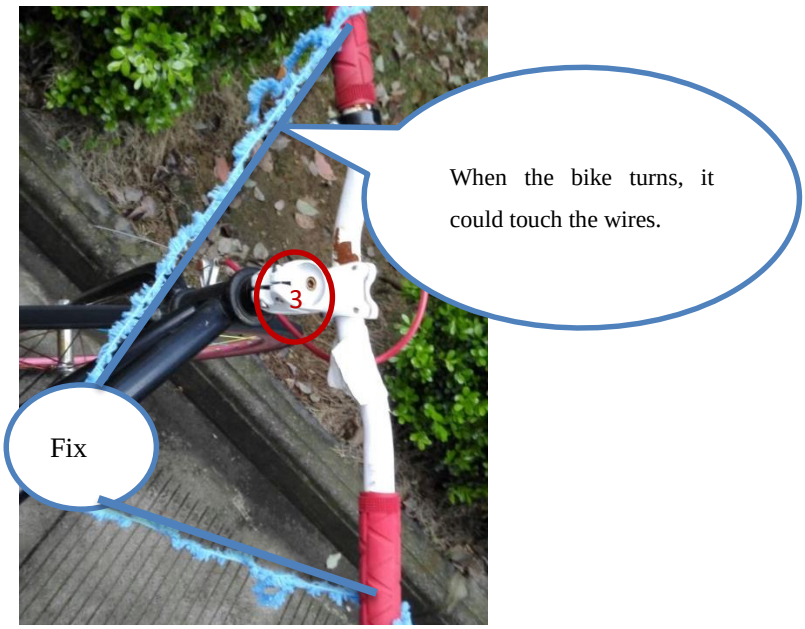


As long as the red line touches the yellow line, the corresponding light will light up. After the basic structure has been set up, the device will be installed on the bicycle to realize the turn lights.

Next change the bike, as shown in the picture:

Hide the motherboard inside the basket (1) Put the left and right turn signal on the handlebars (2). Connect the + wire to bicycle front posts (3). Hang the one side of thetwo wire connected to D on the handlebars, and fix the other side in the middle of the bike. Turn left to contact the left wires (3). Turn right to contact the right wires (3).





So that’s completed.

Bonus session

We can make the trigger switch on. As long as you try to make the + and D connect, you can output the "high level" signal, which is equivalent to pressing the button.

Can you make a device to check whether the door is open? When the door is closed, the light goes out, and when the door is open, the light lights up.

Please draw your sketch here.

The main board has been given:

Mechanical design of Goldberg

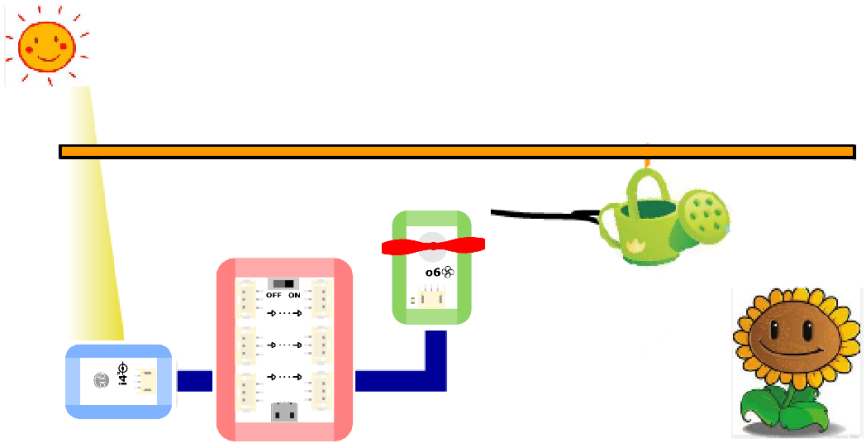
Mike's story

Mike saw an interesting device online. As shown in the picture: touch the rugby on the left corner, and the cage with a bird will be open. The bird flies out. The module of the statue of liberty falls beside, which leads to black ball drops into the barrel. Drive pulley block, and raise the flag of the United States. Meanwhile, promote the iron, and the iron lit fireworks. The final screen is stars and rain... Mike found this chain reaction was really interesting. He searched on the Internet. He found that one device could drive a series of devices called "Goldberg mechanical device".

A new thought hit his mind: why not make a small Goldberg device by Boson Kit with friends?

Bring it to life!

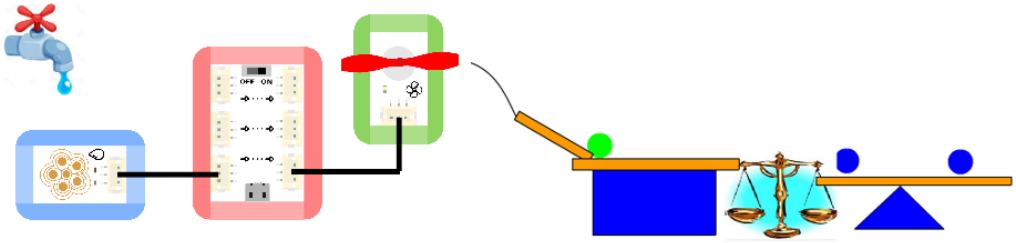
Mike designed a module. When the sun is shining, the water can be pumped to the plants by the rotation of the electric fan.



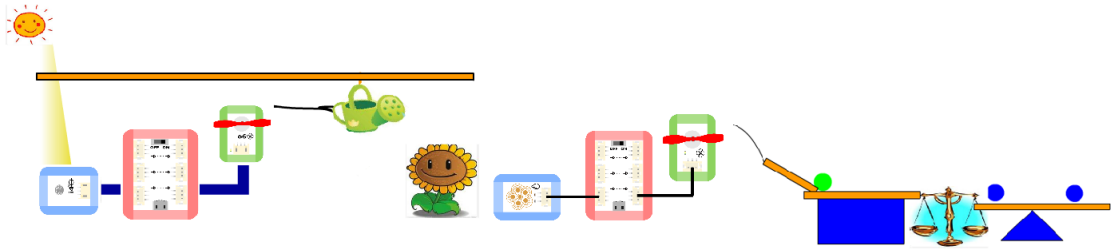
In addition to blocks and toys, here are the devices that Mike uses in Boson Kit:

		
Power supply	Light sensor	Fan module

Mike’s friend Addie is interested in the design. He joined Mike later. When the tap is turned on, all the balls fell to the ground.



After communication, they found that their designs could be combined with to form a larger Goldberg device.



They told this to more friends. After this, they all attempted to have a try. Some tried new designs, and the others took out previous work. The Goldberg device became more interesting and larger.

Xuanxuan, who is the desk mate of Addie, adds a button that we have learned before. When the ball fell down, it hit the button, and the button made the lamp light up.

Lele added a retro candlestick after Xuanxuan’s button. Let the lamp light to the photosensitive sensor on the retro candlestick. Finally let the photosensitive sensor light the lamp and used branch module to alarm the buzzer.

Jack and Mingming connected more devices through Lele’s lamp and buzzer.

So all the students had fun and finally formed a great work. Everyone was proud of this work because there involved their effort. Finally they named this work "creation particle reunion".

Bring it to life!

Now invite the whole class together to complete a work. Design an interesting example, and communicate with friends. Discuss a small device in small groups. Finally integrate and complete a large Goldberg device.

Step 1: You need to tell what your initial input and final output are, so that everyone can connect devices better.

Input (such as: light sensor)	Output (small lamp, buzzer, fan and so on)

Step 2: Perfect your work. You can modify your previous work, or you can create new work.

Please draw your sketch here.

Step 3: after the integration of Group and class, the new "creation particle reunion" is

Epilogue

Mike leaned over the window and looked out the window at the bright starry sky and thought, "when the Boson Kit elf will be back? I wish he could see my results." As he sighed and looked up, he suddenly noticed a streak of light across the dark sky. Before Mike recovered, and he heard a familiar voice: "Hi, dear Mike, I finally see you again. Have you had a good time recently? Do you like the gift I gave you? "Said Boson Kit, waving his wings as he excitedly said. Mike felt flash at the moment, and saw the lovely elf. He was very excited. This actually is not in dream, but really sees the Boson Kit. This is really incredible!

Then, Mike showed Boson Kit the results. The Boson Kit was excited and said happily, "dear Mike, you are so smart. The things you create are really interesting. I love them." Then Boson Kit said "Mike, I brought some friends to you this time. I told them that you are a creative child and they are curious about you!"After the words had, the room was filled with colorful lights, and after the light was gone, the cute little elf appeared in front of Mike.

"Mike, Mike, I am Arduino, nice to meet you! "

"Hello, Mike, I am Scratch, I really love your works! "

"Mike, I am 3D printing Elf. "

Every cute little elf introduced himself to Mike and showed his skill. Mike was surprised when the magic music water lamp, the cute 3D printed huba, and all kinds of funny games showed up in front of Mike. They had a wonderful evening...

Early the next morning, Mike got up early and faced his mother's confused eyes. Mike smiled mysteriously. Because at last night, he got a group of lovely friends, and he wanted to go to school hurriedly, so he can introduce his mysterious good friends to classmates, to share this wonderful experience together.

Appendix

In addition to the modules in book, Boson Kit also has more modules. As the table shows.

Name	Photo	Introduction
Infrared proximity sensor		The grayscale sensor is an analog sensor that can sense different colors of the ground or the desktop. And then produces corresponding signals.
Tilt Switch		Use of the characteristics of the steel ball based on the digital module of steel ball switch, to make steel ball roll downward by gravity. So it can also be used as a simple dip sensor.
Touch Sensor		The touch switch is based on capacitance sensing. The direct contact of the human body or metal on the sensor's metal surface will be detected. And the contact of a certain thickness of plastic, glass and other materials can also be detected.
Soil moisture sensor.		This is a simple moisture sensor that can be used to detect moisture in the soil. When the soil is short of water, the sensor output will decrease.
Self-locking key module		It’s a switch module. Press the button to continuously output high level electricity.

Colorful lamp band module		Directly use switch or potentiometer module to control brightness. You can replace other color lights.
Servo Controller Module		Two patterns. The rotation Angle can be controlled directly by using the digital module, which also can be controlled by the analog sensor.
Conductivity Switch		With a certain resistance, it can be connected.