EXPERIMENT MANUAL

KAI

The Artificial Intelligence Robot

Teach my AI to follow your sounds or movements!

THAMES & KOSMOS

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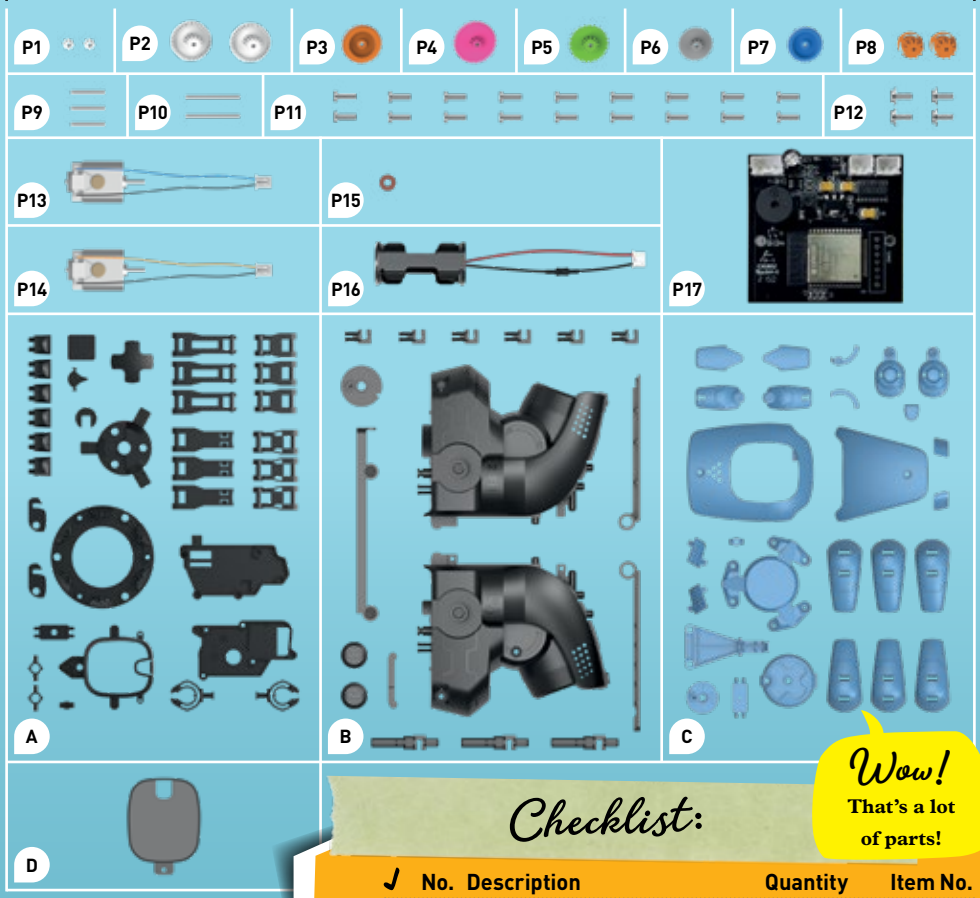
Thames & Kosmos UK LP, Cranbrook, Kent, TN17 3HE, United Kingdom | 01580 713000 | thamesandkosmos.co.uk

KIT CONTENTS

Good to know!

Do you have any questions or are you missing any parts? Our tech support team will be happy to help you!
support@thamesandkosmos.com
or 1-800-587-2872

What's in your experiment kit:



Wow! That's a lot of parts!

Checklist:

✓	No.	Description	Quantity	Item No.
○	P1	Small sprocket, white	2	725938
○	P2	Gear 36/14T, white	2	725939
○	P3	Gear 36T, orange	1	725938
○	P4	Gear 40/10T, pink	1	725938
○	P5	Gear 36/14T, geen	1	725939
○	P6	Gear 32/10T, gray	1	725939
○	P7	Gear 32T, blue	1	725939
○	P8	Sprocket 10T, orange	2	725938
○	P9	Metal rod, short	3	725939
○	P10	Metal rod, long	2	725938
○	P11	Screw	18	725939

YOU WILL ALSO NEED:

Diagonal cutters (or a pair of scissors and nail file), 4 AAA batteries (1.5-volt, type LR03), a small Phillips-head screwdriver, a smartphone or tablet. See the app store for details.

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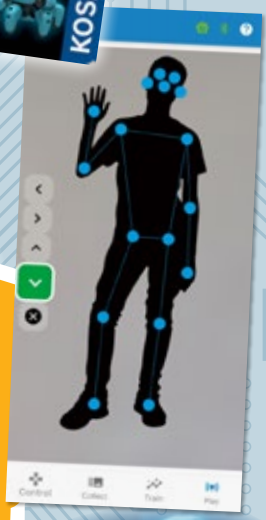
TIP

ADDITIONAL INFO CAN BE FOUND IN THE CHECK IT OUT SECTIONS ON PAGES 24–25, 36–37, AND 56–64.



✓	No.	Description	Quantity	Item No.
○	P12	Wide-headed screw	4	725938
○	P13	Motor with blue and black connection wire	1	725941
○	P14	Motor with orange and black connection wire	1	725940
○	P15	Washer	1	726597
○	P16	Battery compartment with connection wire	1	725942
○	P17	AI circuit board	1	725943
○	A	Frame A with parts A1 - A19	1	725933
○	B	Frame B with parts B1 - B10	1	725934
○	C	Frame C with parts C1 - C17	1	725935
○	D	Faceplate	1	725936

SAFETY INFORMATION

WARNING. This toy is only intended for use by children over the age of 10 years, due to accessible electronic components. Instructions for parents or caregivers are included and shall be followed. Keep packaging and instructions as they contain important information.

WARNING. Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Store the experiment material and assembled models out of the reach of small children.

Safety for Experiments with Batteries

- To operate the models, you will need 4 AAA batteries (1.5-volt, type AAA/LR03) which could not be included in the kit due to their limited shelf life.
- The supply terminals are not to be short-circuited. A short circuit can cause the wires to overheat and the batteries to explode.
- Different types of batteries or new and used batteries are not to be mixed.
- Do not mix old and new batteries.
- Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.
- Batteries are to be inserted with the correct polarity (+ and –). Press them gently into the battery compartment. See page 35.
- Always close battery compartments with the lid.
- Non-rechargeable batteries are not to be recharged. They could explode!
- Rechargeable batteries are only to be charged under adult supervision.
- Rechargeable batteries are to be removed from the toy before being charged.
- Exhausted batteries are to be removed from the toy.
- Dispose of used batteries in accordance with environmental provisions, not in the household trash.
- Be sure not to bring batteries into contact with coins, keys, or other metal objects.
- Avoid deforming the batteries.
- The wires are not to be inserted into socket outlets.
- Warning! Do not manipulate the protective device in the battery compartment (PTC).
- The toy is not to be connected to more than the recommended number of power supplies.

As all of the experiments use batteries, have an adult check the experiments or models before use to make sure they are assembled properly. Always operate the motorized models under adult supervision.

After you are done experimenting, remove the batteries from the battery compartments. Note the safety information accompanying the individual experiments or models!

Notes on Disposal of Electronic Components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the following symbol:

Please contact your local authorities for the appropriate disposal location.

EU Declaration of Conformity

Simplified EU Declaration of Conformity
Thames & Kosmos hereby declares that the radio communication unit "KAI: The Artificial Intelligence Robot ", model number 620392, conforms to Directive 2014/53/EU. The complete text of the EU conformity declaration is available at the following Internet address:
http://thamesandkosmos.com/kairobotics/declaration.pdf

Bluetooth Information

Bluetooth Low Energy, frequency band: 2.400 - 2.4835 GHz
Maximum transmit power: ≤ 0dBm for BT-LE

FCC Part 15 Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause
undesired operation.

Warning: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, maybe cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different form that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC RF Exposure Statement

To comply with the FCC RF exposure compliance requirements, this device and its antenna must not be
co-located or operating in conjunction with any other antenna or transmitter.
For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with an accessory that contains no metal and that positions the device a minimum of 5 mm from the body. Use of other accessories may not ensure compliance with
FCC RF exposure guidelines.

CAN ICES-3 (B)/NMB-3(B) IC Statement

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme NMB-003.

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

RF Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 5 mm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 5 mm de distance entre la source de rayonnement et votre corps.

IMPORTANT INFORMATION

Dear Parents and Supervising Adults,

Children want to be amazed, understand, and create new things. They want to try everything out and do it for themselves. They want to know! They can do all this with Thames & Kosmos experiment kits. We hope you and your child have a lot of fun experimenting with KAI: The Artificial Intelligence Robot!

Before building and experimenting, read the instructions together with your child and discuss the safety precautions.

Support your child by providing them with advice and a helping hand, especially during tricky assembly steps and experiments.

To prevent damage to the work surface on which your child is building and experimenting, provide them with a mat or other surface protection.

Your AI Robot cannot be controlled without a smart device. Please provide your child with a smartphone or tablet and install the free KAI Robotics app on it for them (additional information about the app can be found on pages 42 through 55).

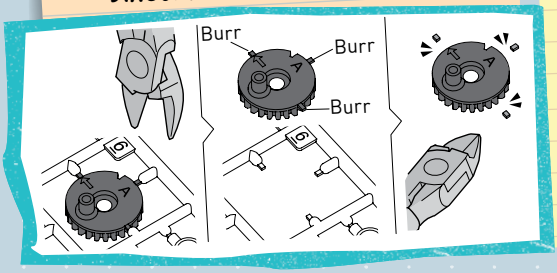
When cutting the plastic parts out of the frames with the diagonal cutter or scissors, special care must be taken, not just because of the sharp edges on the tools, but also because the plastic parts can yield sharp edges or burrs. These can be removed with the help of the diagonal cutter or a nail file. Supervise your child when they are using the sharp tools until you trust that they can handle them independently.

We hope you and your child have lots of fun building and playing with your AI Robot!

TIP

IMPORTANT:

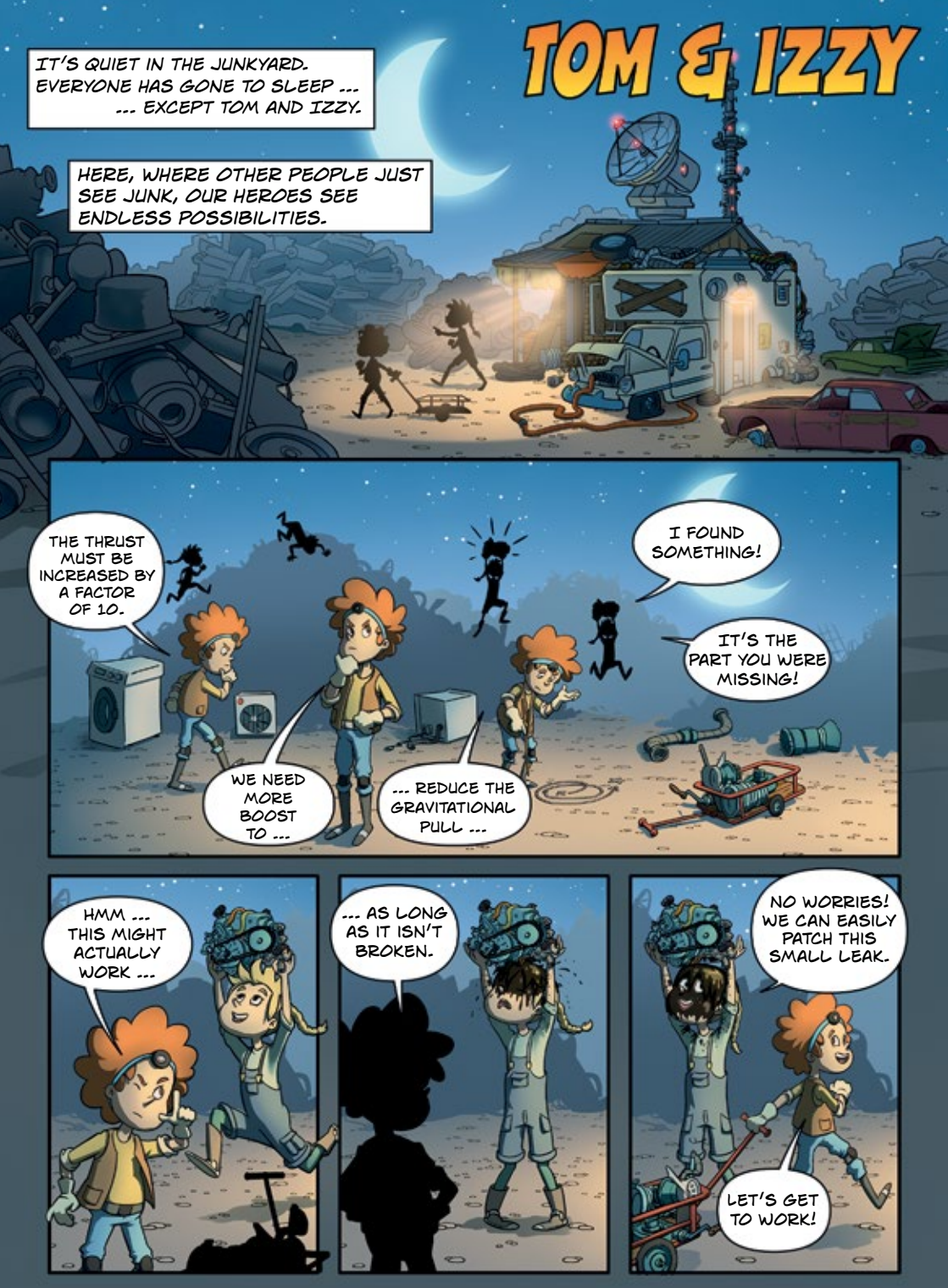
REMOVE THE PARTS FROM THE FRAMES ONLY WHEN THEY ARE NEEDED. REMOVE EXCESS MATERIAL (BURRS) BEFORE ASSEMBLY USING A DIAGONAL CUTTER OR A NAIL FILE.



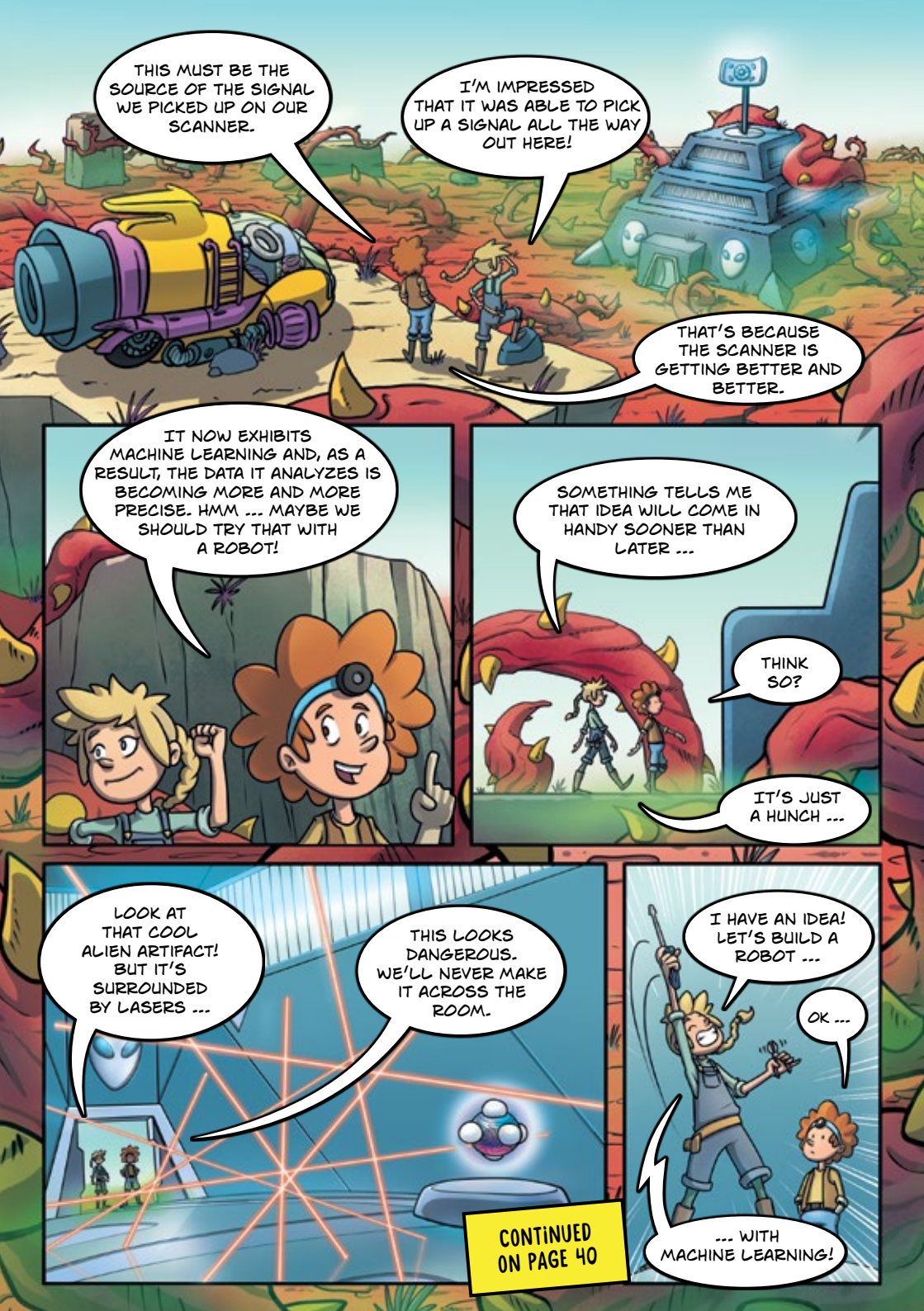
THE RIGHT TOOL

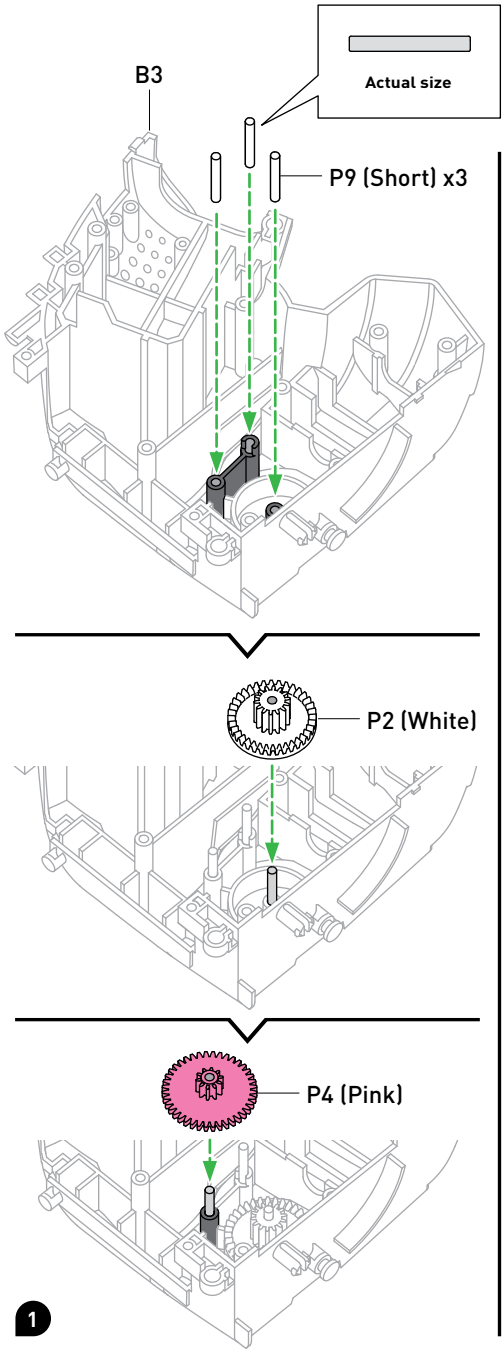
The right tool can make assembling your model much easier and it can also make your model work better in the end. It is best to cut the plastic parts out of their frames with a small diagonal cutter (such as those used for electronics work) or model pliers. Using these tools, the parts can be precisely cut so that no burrs remain on the parts and there is no need to file them down. If you don't have these pliers at home, you can use scissors and a nail file. Normal scissors do not cut as precisely as a diagonal cutter, so you may have to file some of the rough edges down with the nail file.

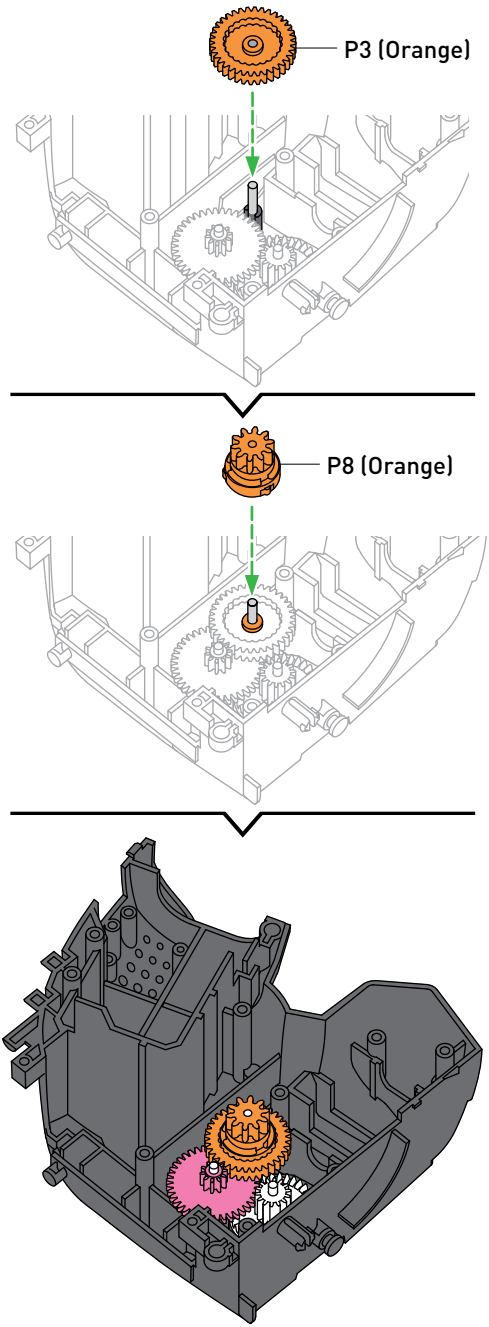
KAI
THE LEARNING MACHINE!

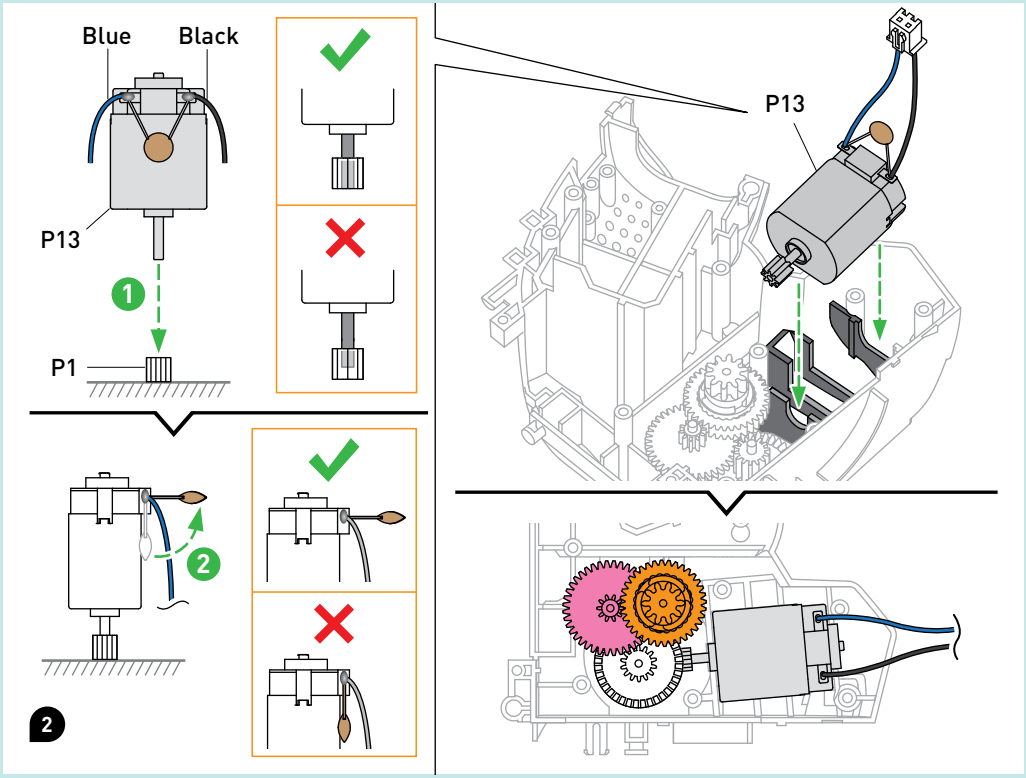

TOM & IZZY
IT'S QUIET IN THE JUNKYARD. EVERYONE HAS GONE TO SLEEP ...
... EXCEPT TOM AND IZZY.
HERE, WHERE OTHER PEOPLE JUST SEE JUNK, OUR HEROES SEE ENDLESS POSSIBILITIES.
THE THRUST MUST BE INCREASED BY A FACTOR OF 10.
WE NEED MORE BOOST TO ...
... REDUCE THE GRAVITATIONAL PULL ...
I FOUND SOMETHING!
IT'S THE PART YOU WERE MISSING!
HMM ... THIS MIGHT ACTUALLY WORK ...
... AS LONG AS IT ISN'T BROKEN.
NO WORRIES! WE CAN EASILY PATCH THIS SMALL LEAK.
LET'S GET TO WORK!

IZZY CAN REPAIR ANYTHING. SHE IS A GENIUS WHEN IT COMES TO MECHANICS.
TOM, ON THE OTHER HAND, IS A SCIENTIST THROUGH AND THROUGH.
HE'S ALWAYS GAME TO TRY OUT AN EXPERIMENT!
TOGETHER, THESE TWO CAN BUILD ANYTHING!
I THINK IT'S READY!
YES! WE DID IT!
NOTHING CAN STOP US NOW!
WHERE SHOULD WE FLY TO FIRST?
WHEREVER WE WANT!
WE CAN GO ANYWHERE!

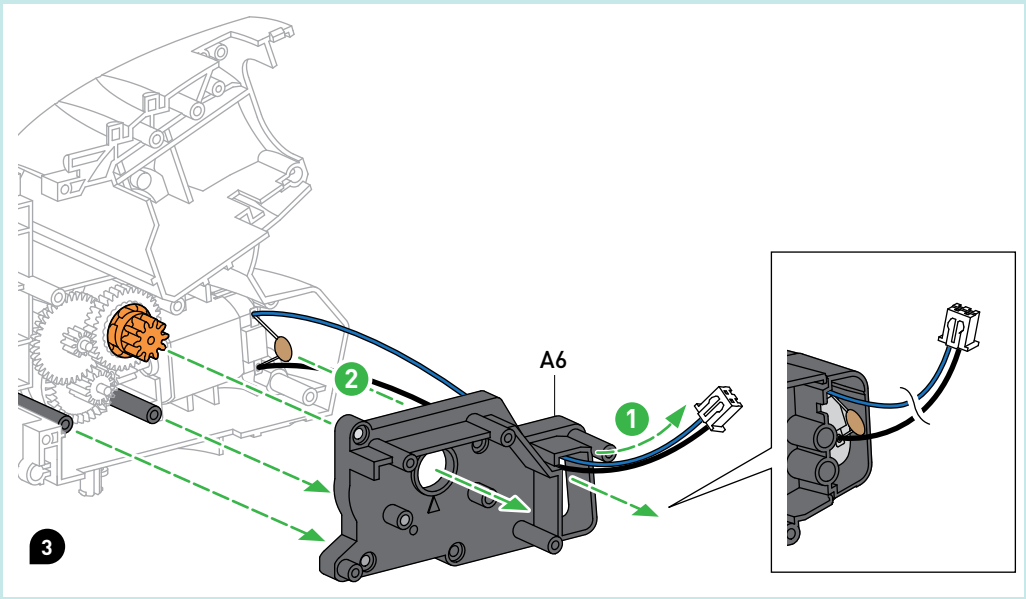

THIS MUST BE THE SOURCE OF THE SIGNAL WE PICKED UP ON OUR SCANNER.
I'M IMPRESSED THAT IT WAS ABLE TO PICK UP A SIGNAL ALL THE WAY OUT HERE!
THAT'S BECAUSE THE SCANNER IS GETTING BETTER AND BETTER.
IT NOW EXHIBITS MACHINE LEARNING AND, AS A RESULT, THE DATA IT ANALYZES IS BECOMING MORE AND MORE PRECISE. HMM ... MAYBE WE SHOULD TRY THAT WITH A ROBOT!
SOMETHING TELLS ME THAT IDEA WILL COME IN HANDY SOONER THAN LATER ...
THINK SO?
IT'S JUST A HUNCH ...
LOOK AT THAT COOL ALIEN ARTIFACT! BUT IT'S SURROUNDED BY LASERS ...
THIS LOOKS DANGEROUS. WE'LL NEVER MAKE IT ACROSS THE ROOM.
I HAVE AN IDEA! LET'S BUILD A ROBOT ...
OK ...
... WITH MACHINE LEARNING!
CONTINUED ON PAGE 40


B3
Actual size
P9 (Short) x3
P2 (White)
P4 (Pink)
1

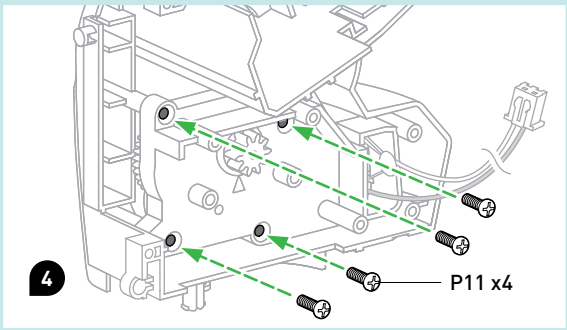

P3 (Orange)
P8 (Orange)

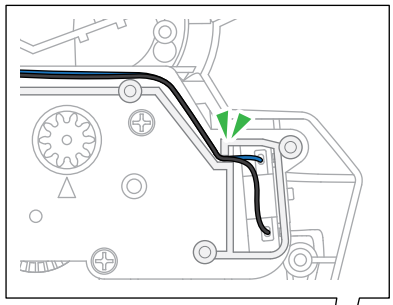


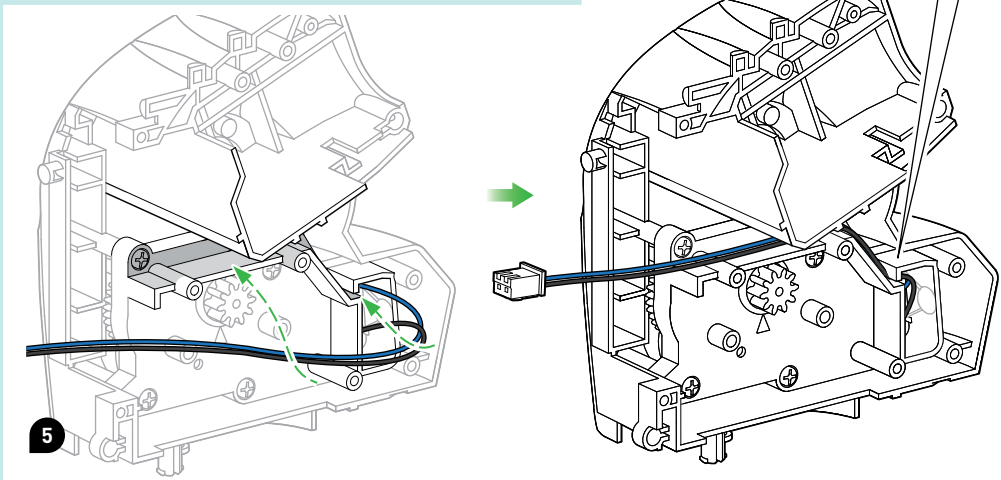
2



3


4
P11 x4

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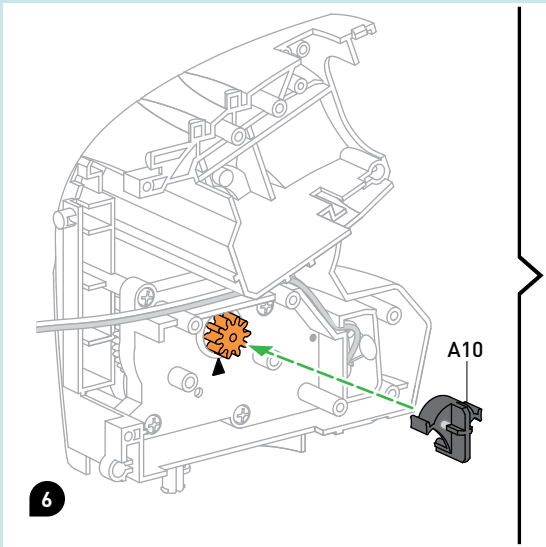
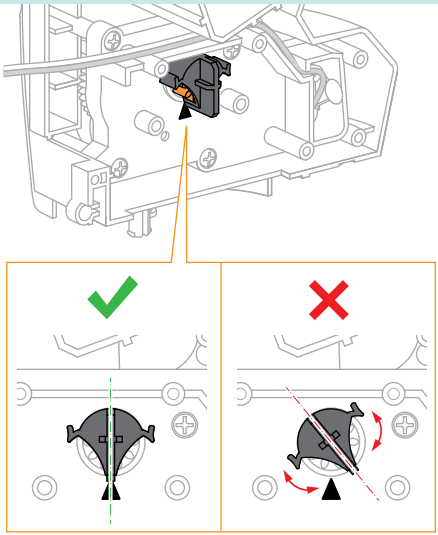
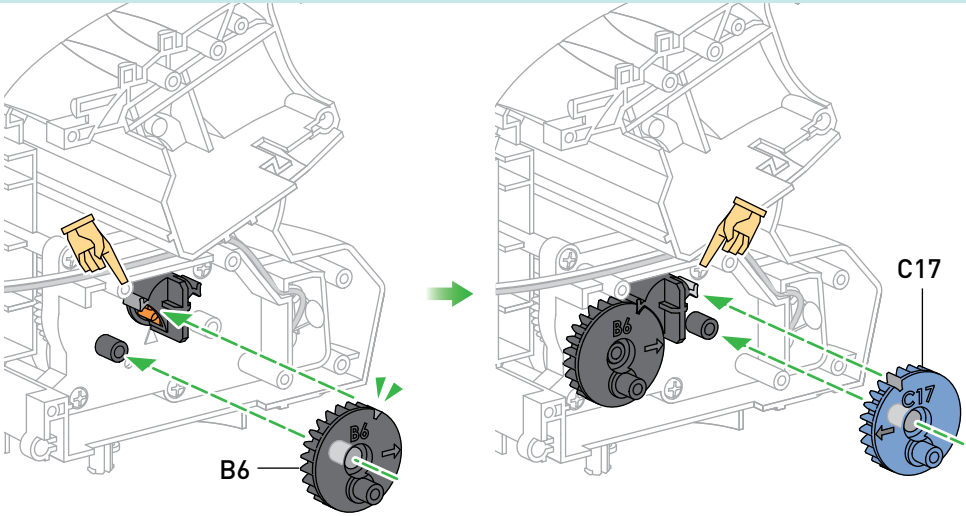
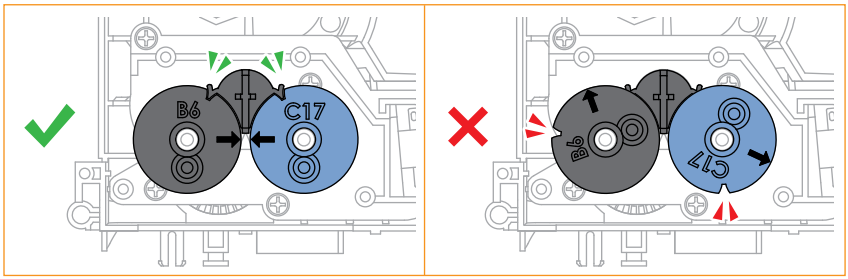
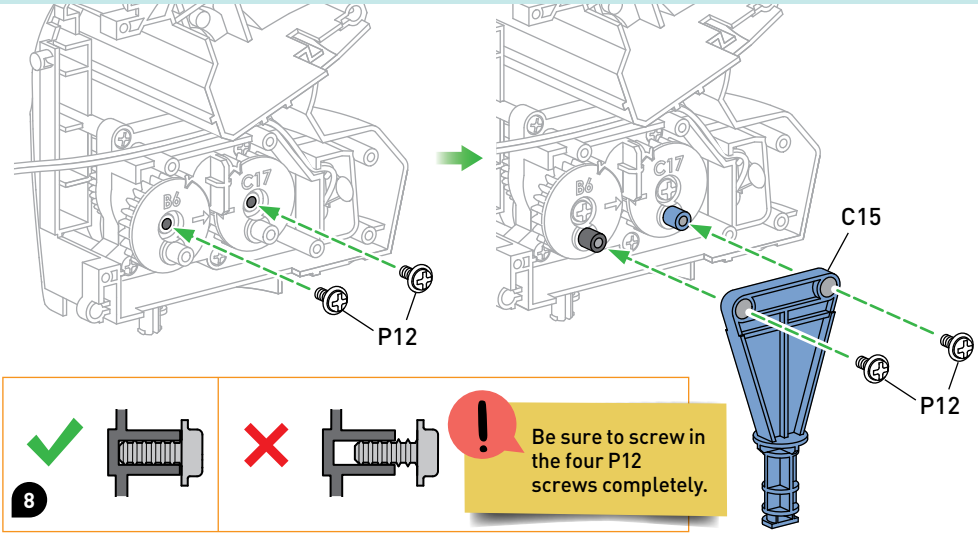

A10
6



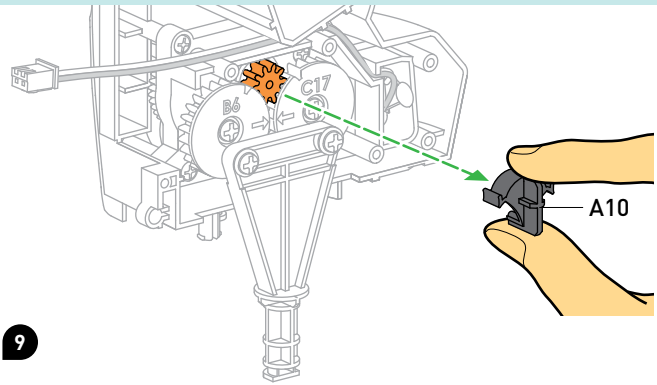

B6
C17
B6
C17


B6
C17
B6
C17

7

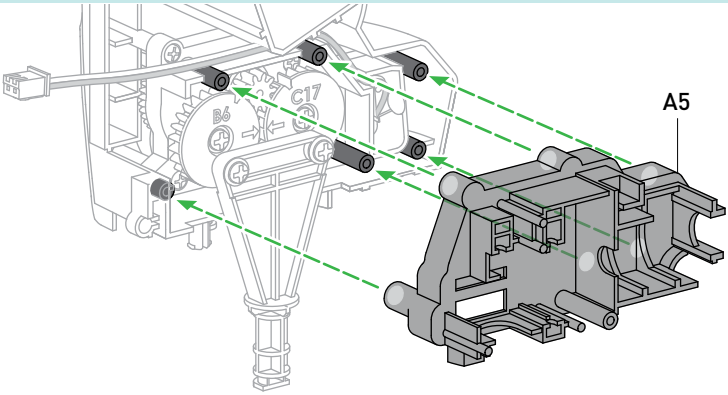

C17
B6
P12
C15
P12
Be sure to screw in the four P12 screws completely.

8



Do not remove A10 until all of the preceding steps have been completed.

9



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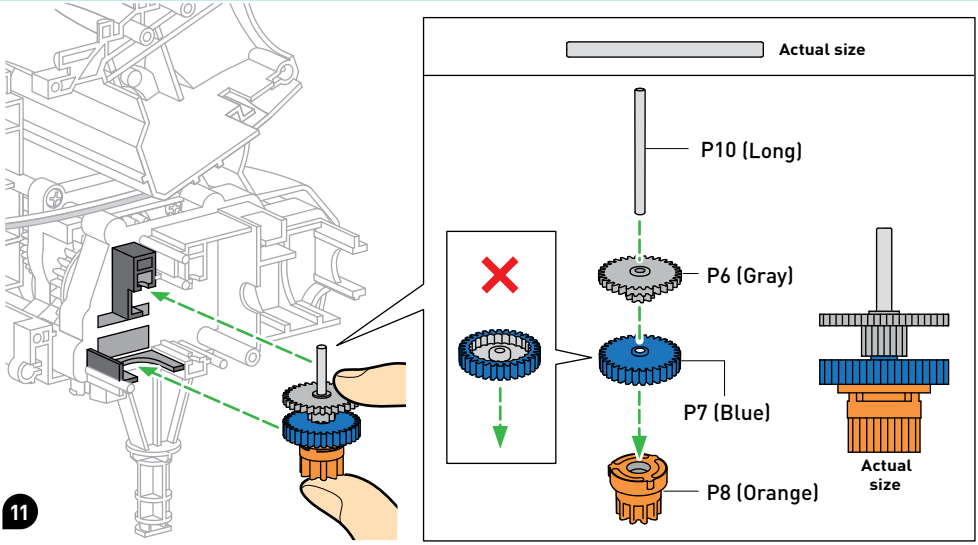

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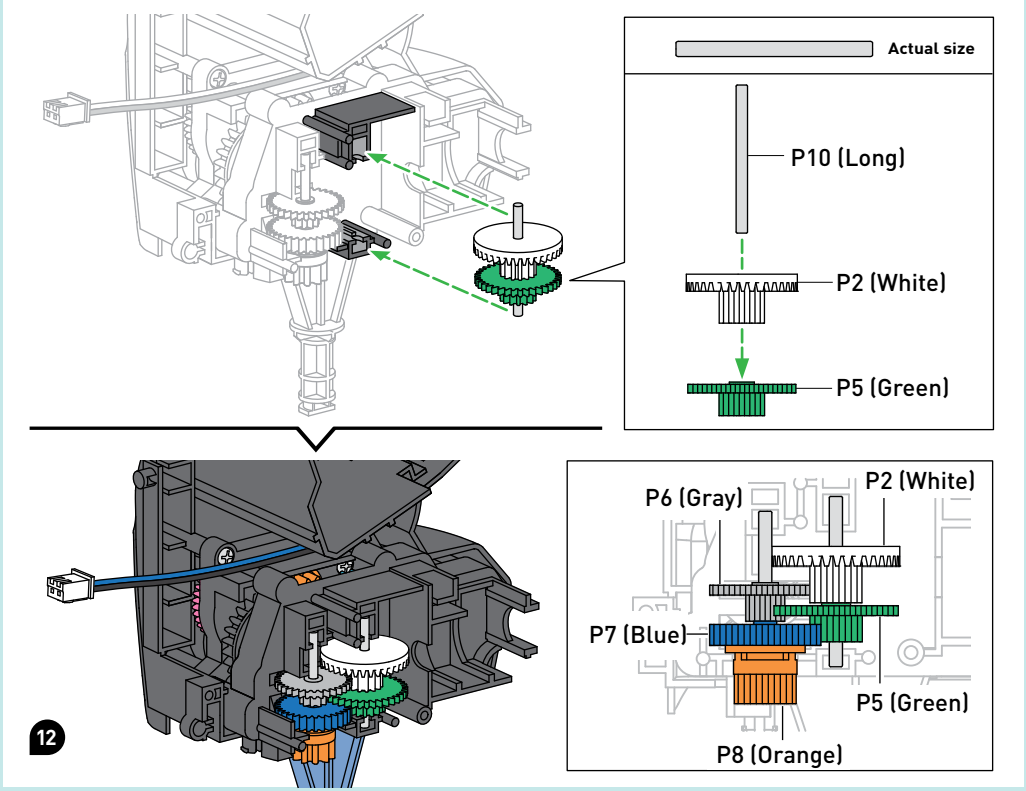
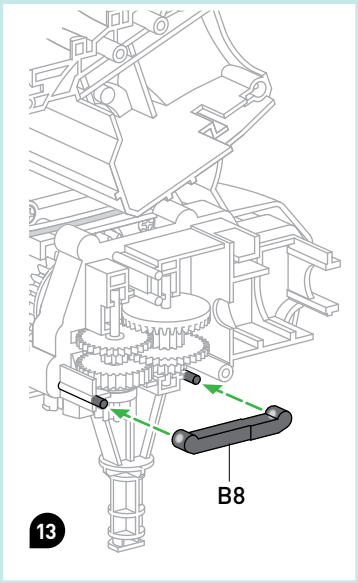
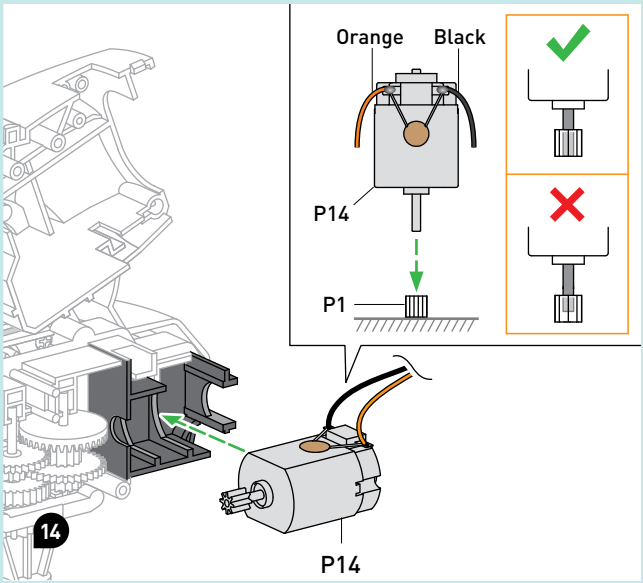
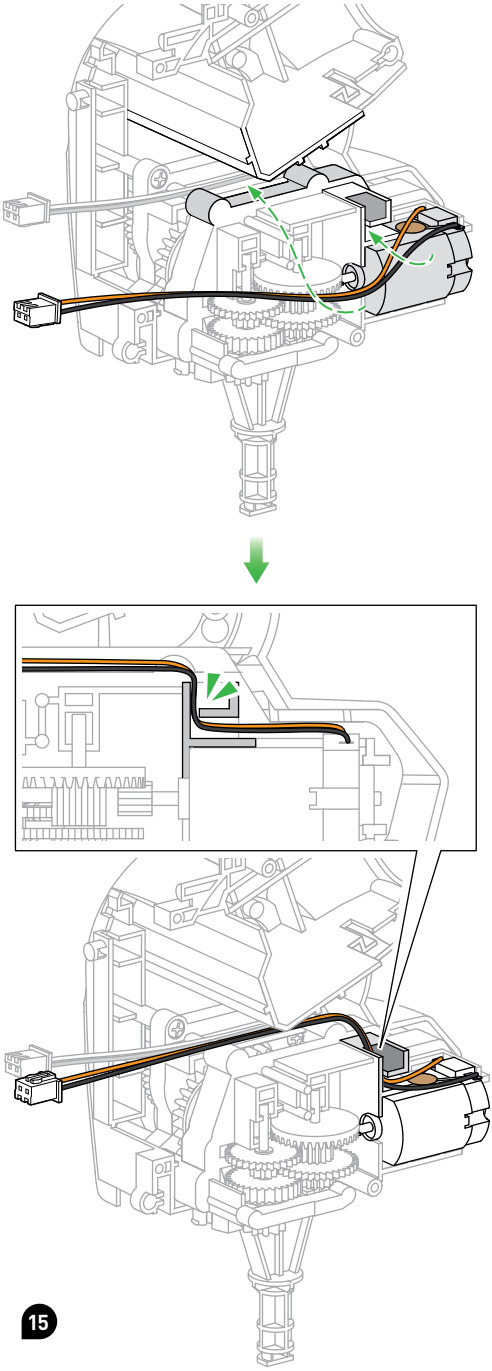

Actual size
P10 (Long)
P2 (White)
P5 (Green)
12
P6 (Gray)
P2 (White)
P7 (Blue)
P5 (Green)
P8 (Orange)


B8
13


Orange
Black
P14
P1
14
P14



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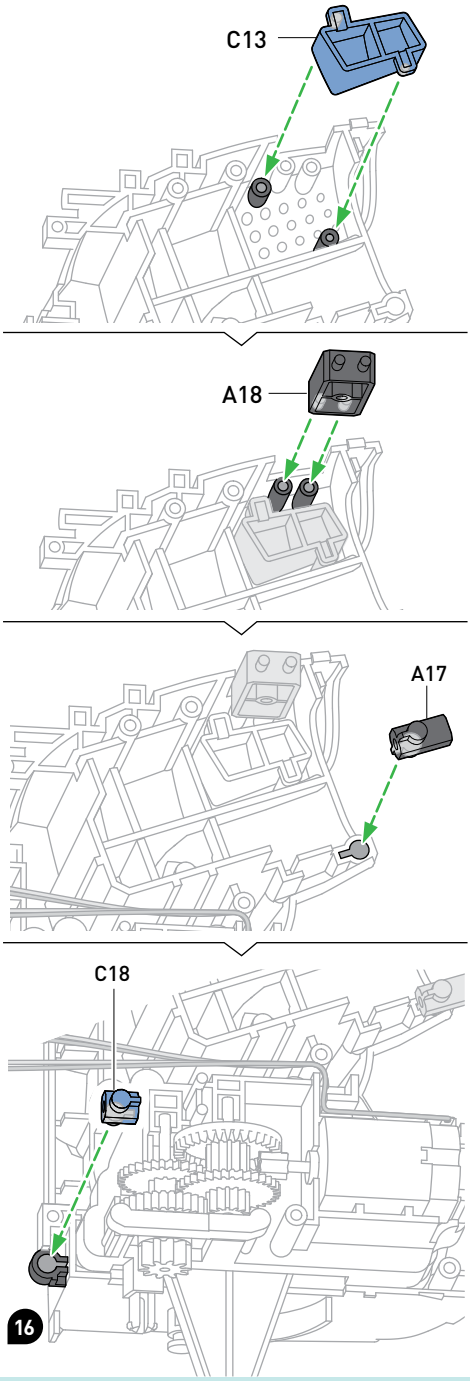

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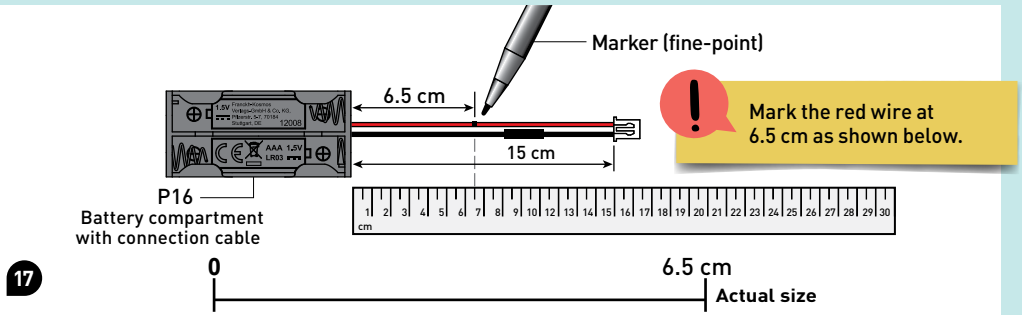
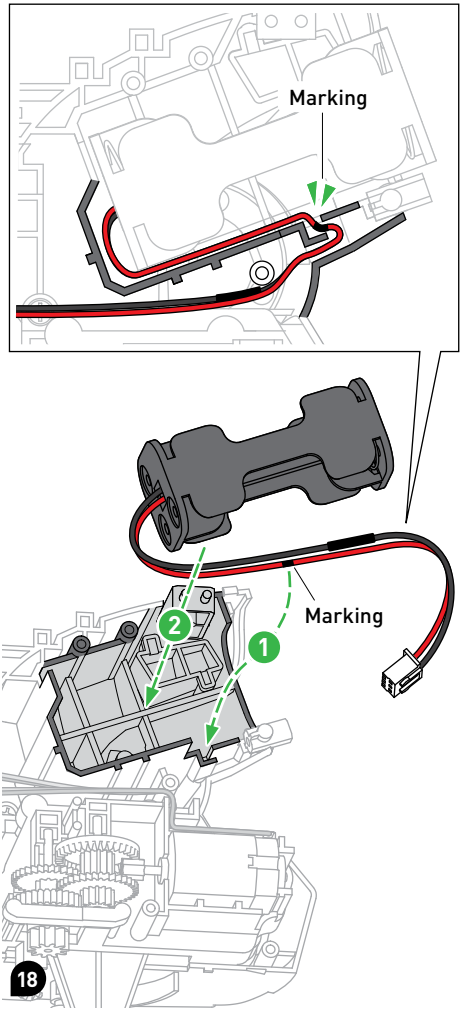
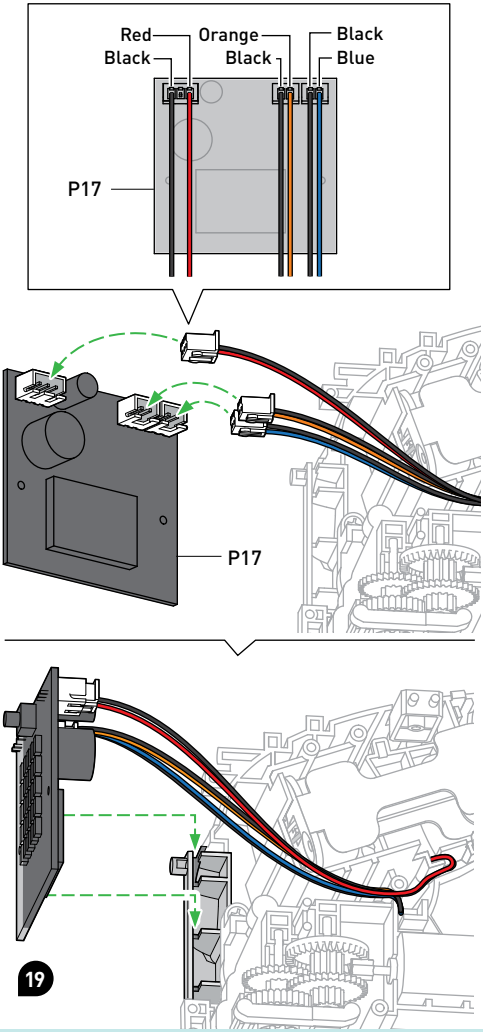

Marker (fine-point)
6.5 cm
15 cm
Mark the red wire at 6.5 cm as shown below.
P16
Battery compartment with connection cable
0
6.5 cm
Actual size

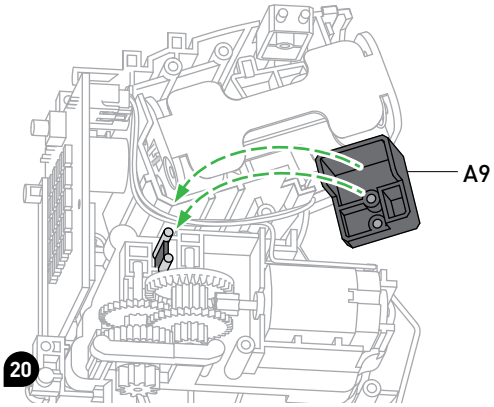
17

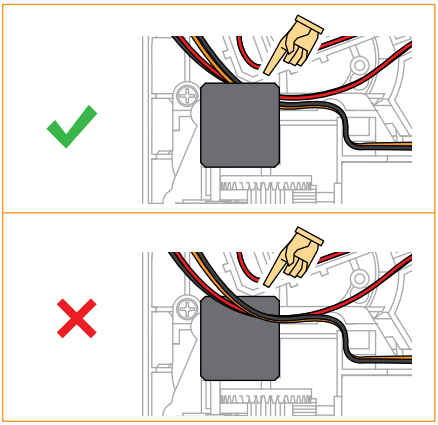

Marking
Marking
2
1

18

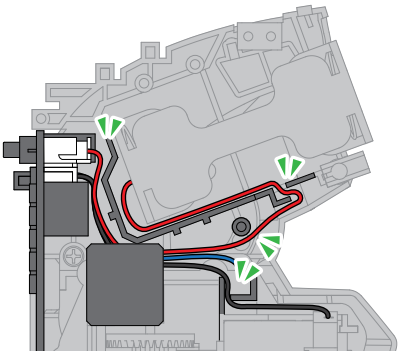

Red
Black
Orange
Black
Black
Blue
P17
P17

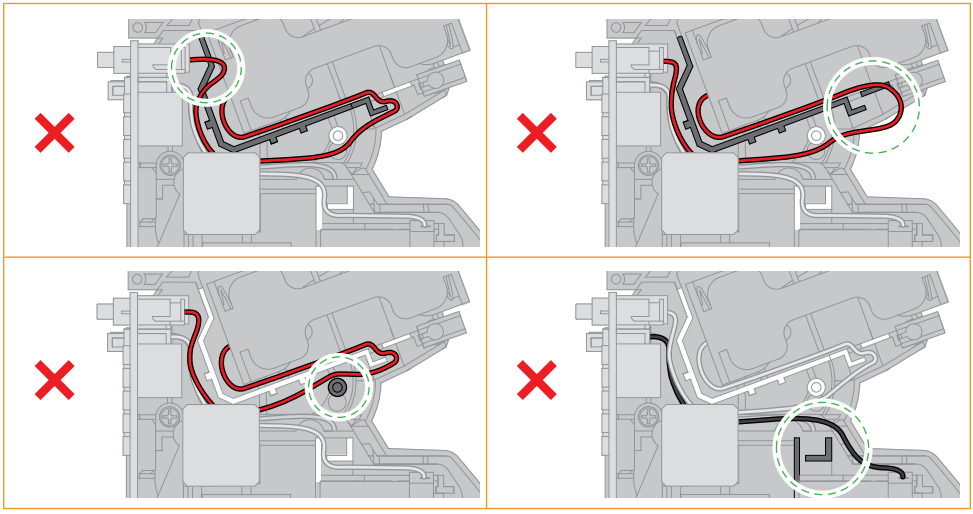
19

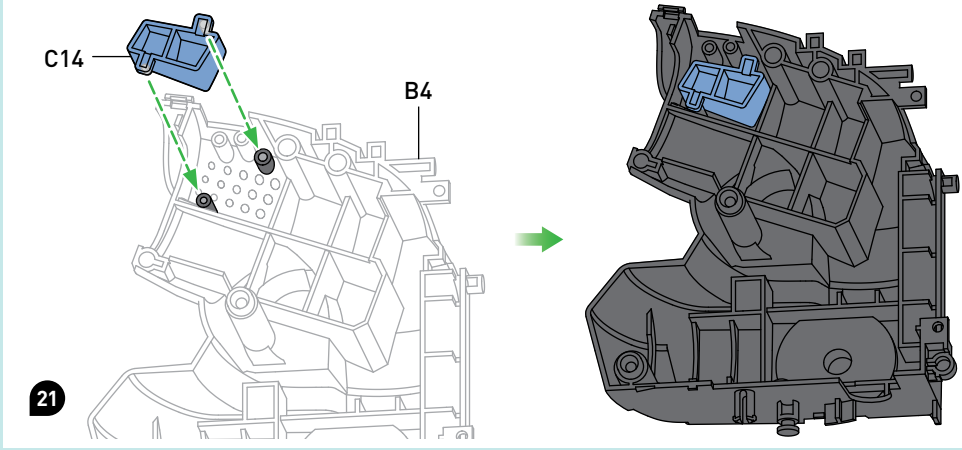




Tuck all of the wires into the case as shown before proceeding to the next steps.

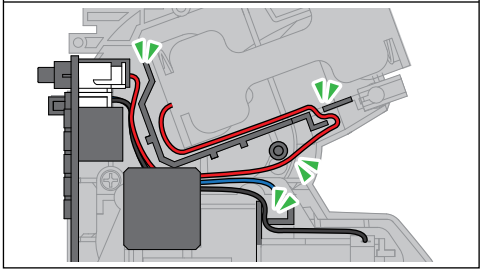


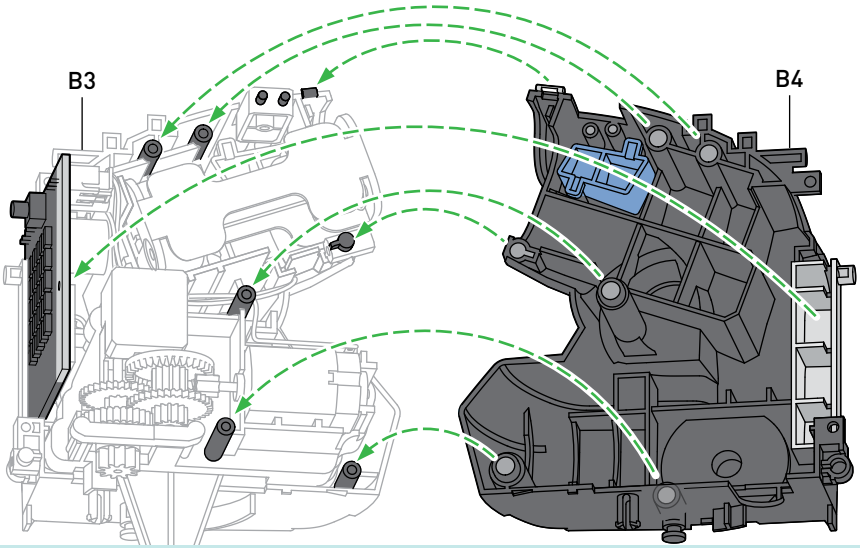




21

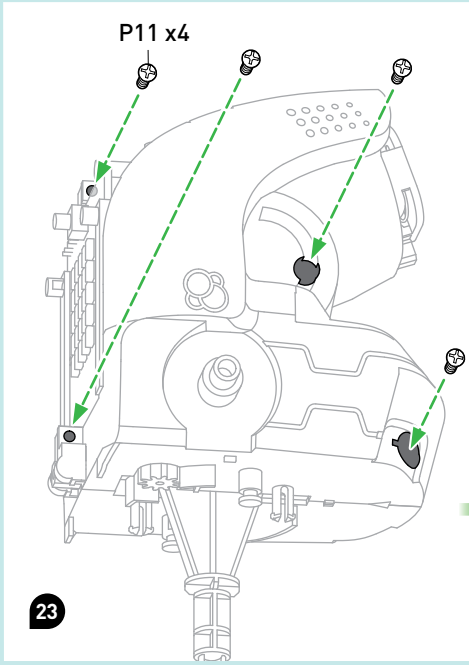
Make sure that the wires do not get pinched when you put B4 and B3 together.

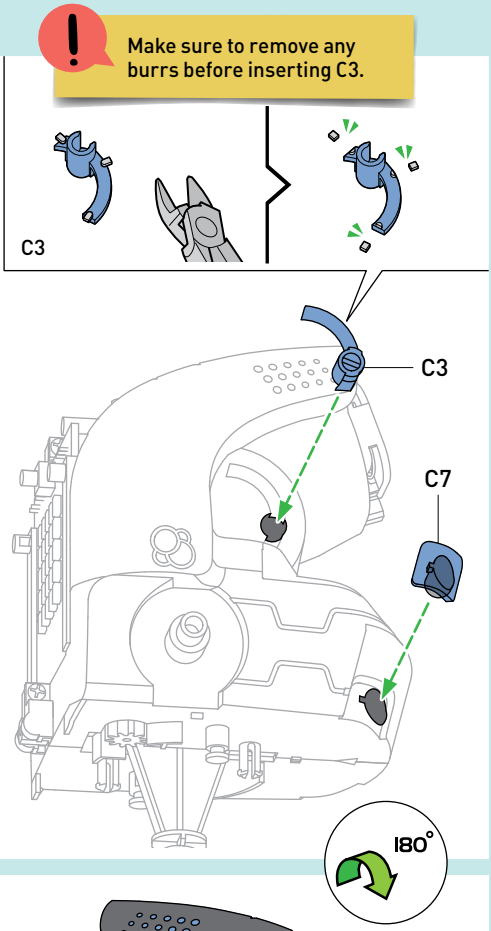


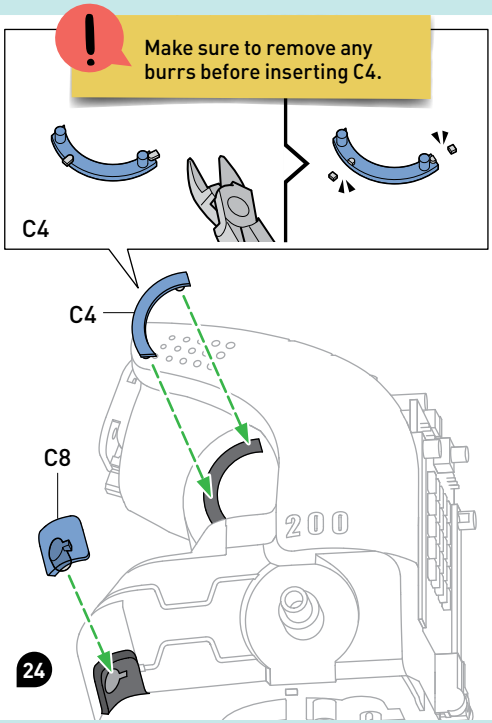


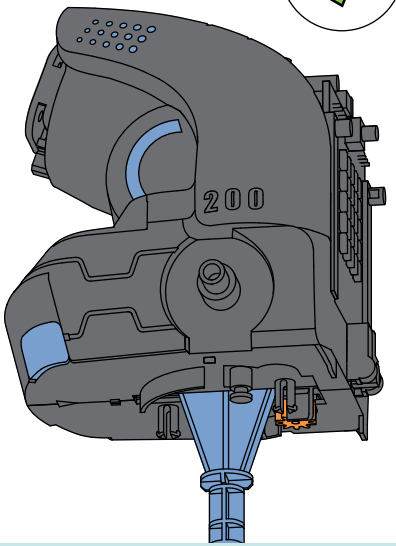
22

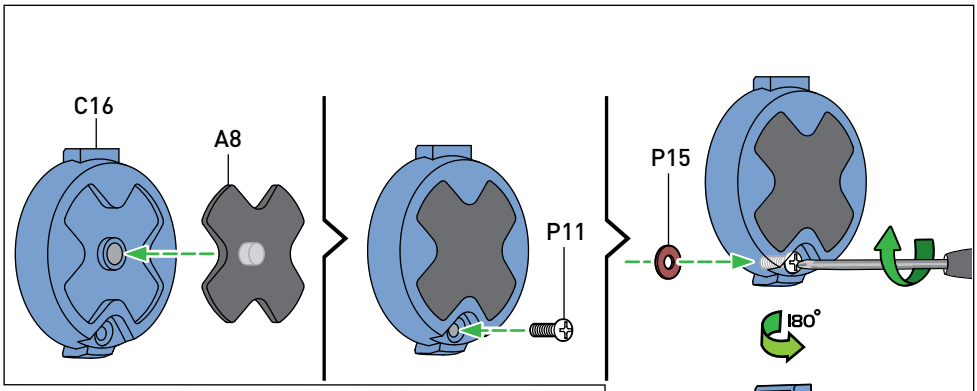
ASSEMBLING THE BODY MODULE

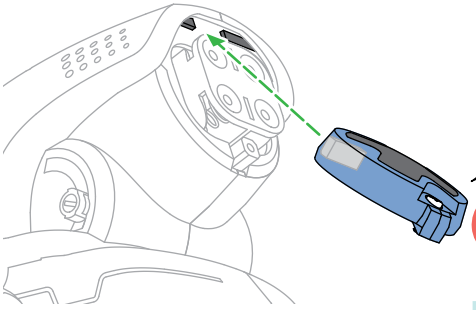


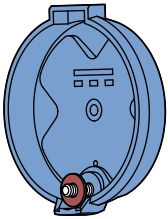




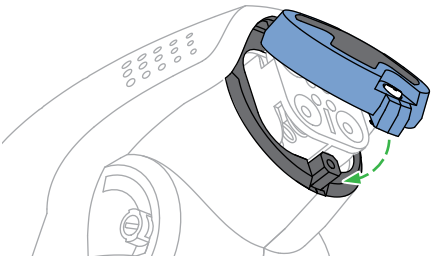


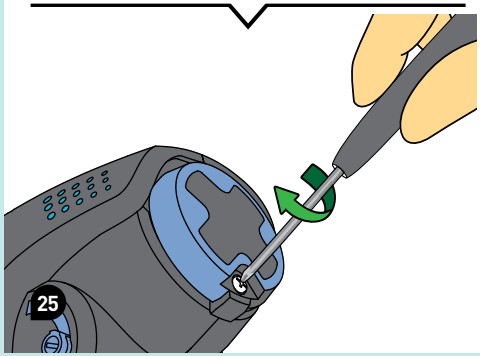






Push the end of the P11 screw through the hole in C16. Slip the washer over the end of the screw and tighten the screw. Then tuck the tab at the top of C16 into the hole as shown. Use a screwdriver to screw P11 in tightly.





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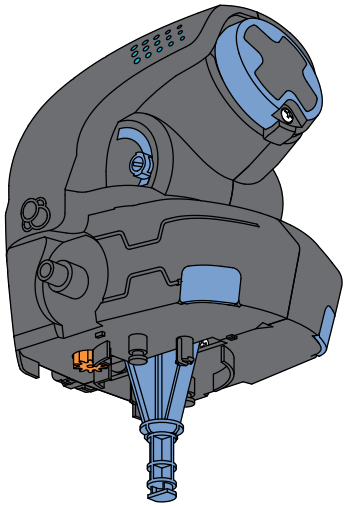

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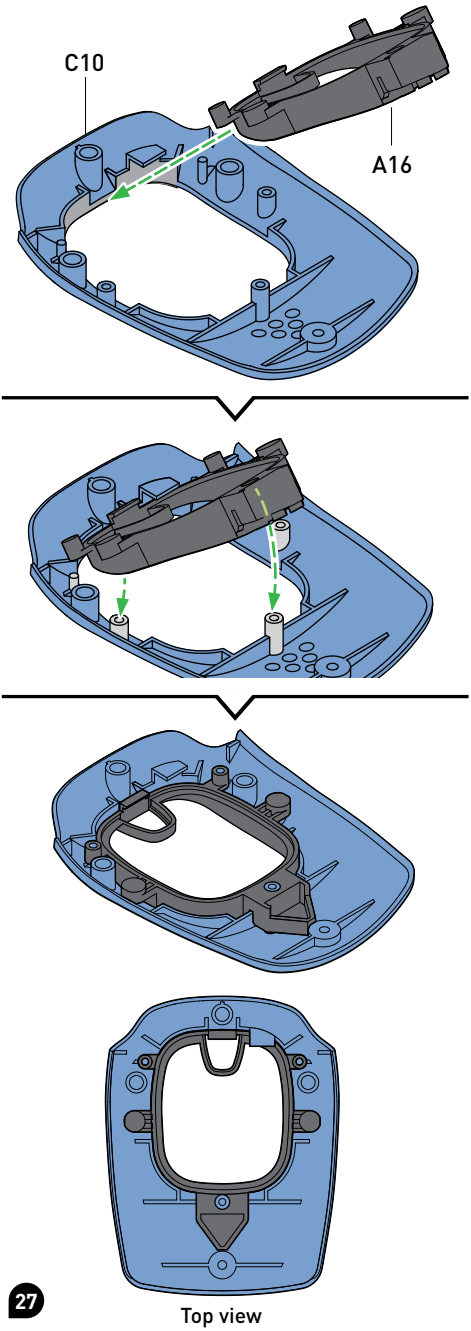
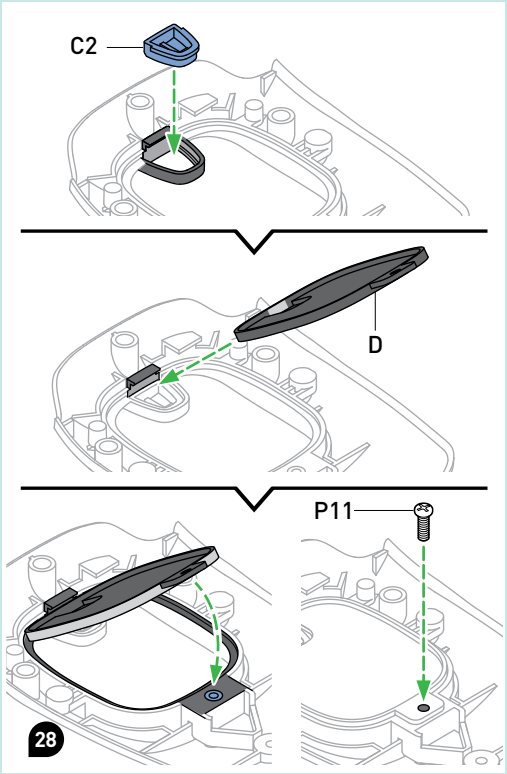
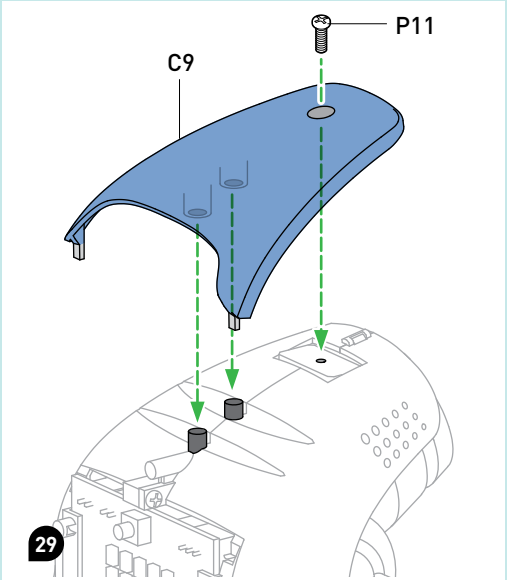
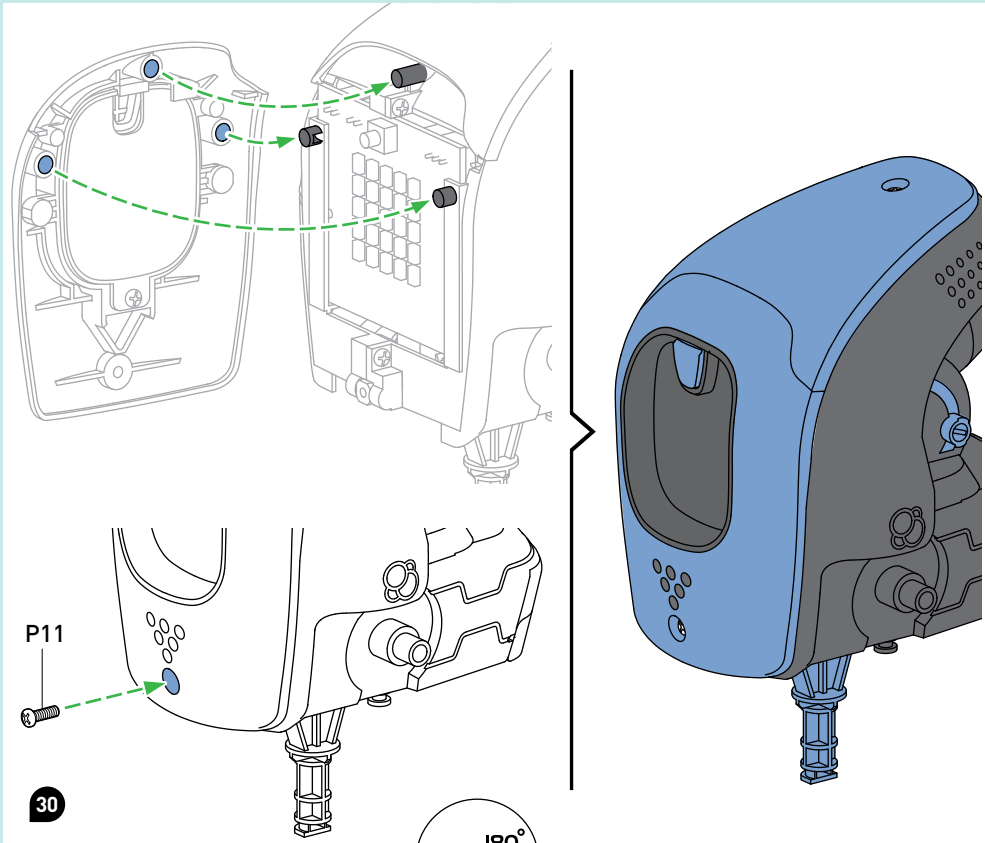

C10
A16
27
Top view


C2
D
P11
28


P11
C9
29



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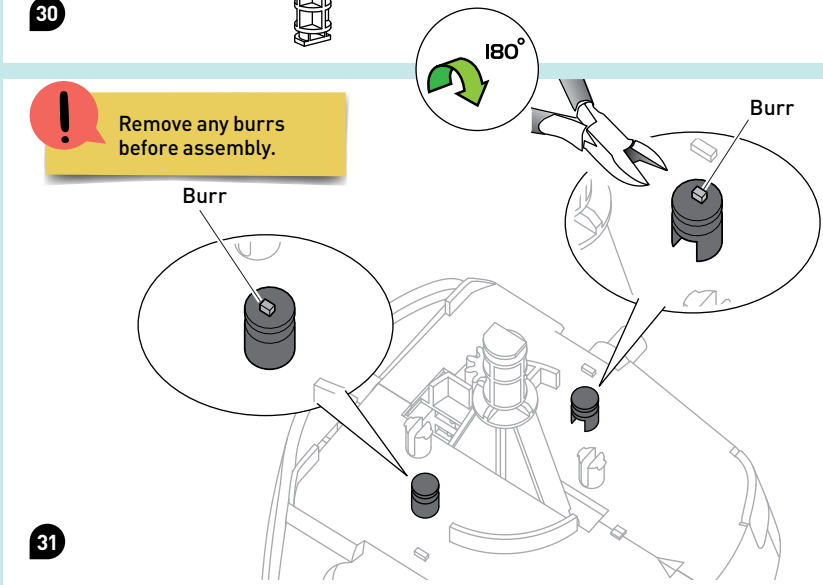
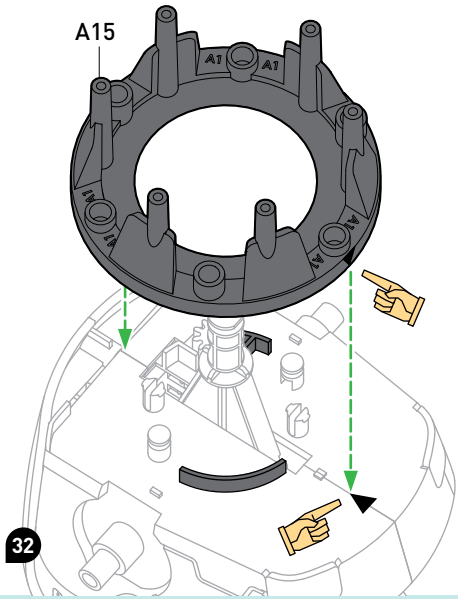
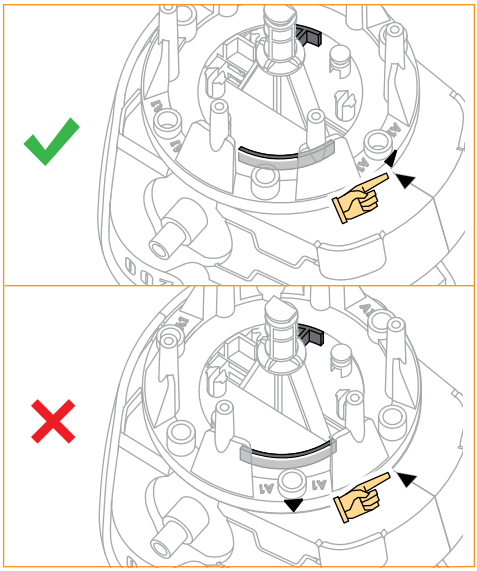


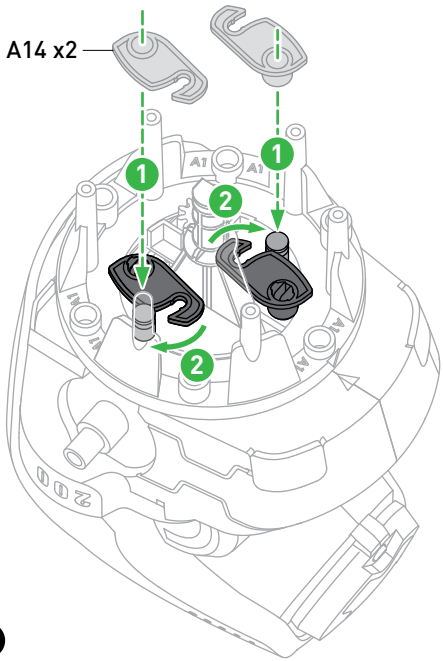
Remove any burrs before assembly.

31

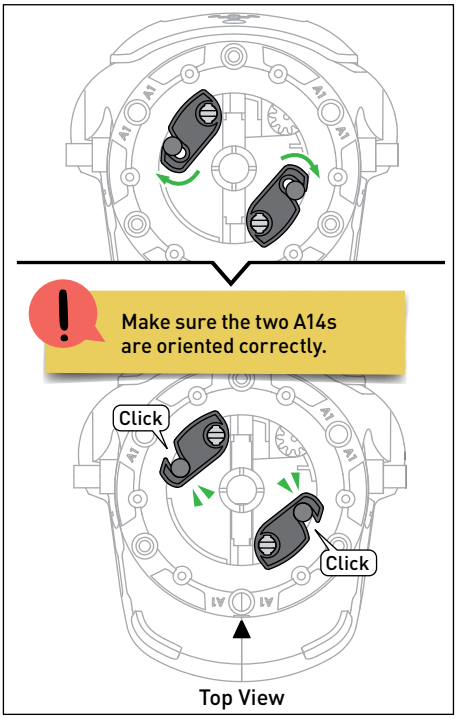

A15
A1
A1
A1
A1

32

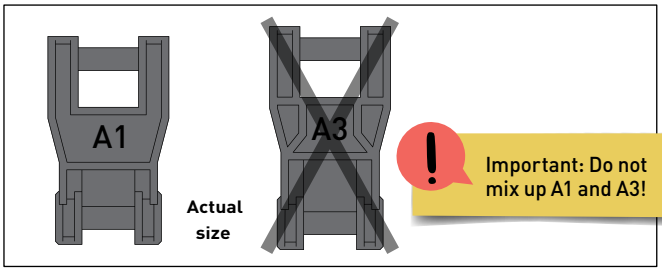


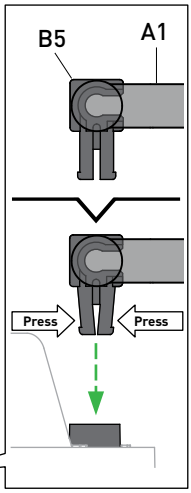

A14 x2
1
1
2
2

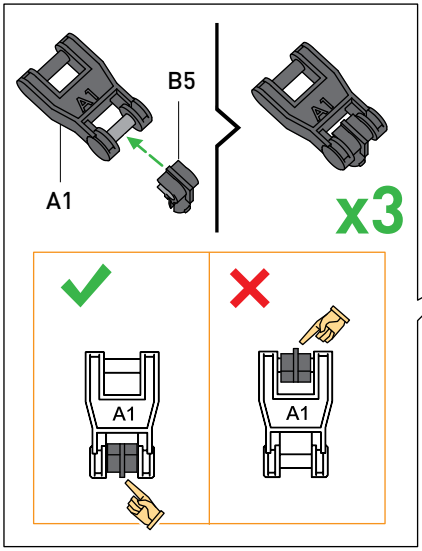
33

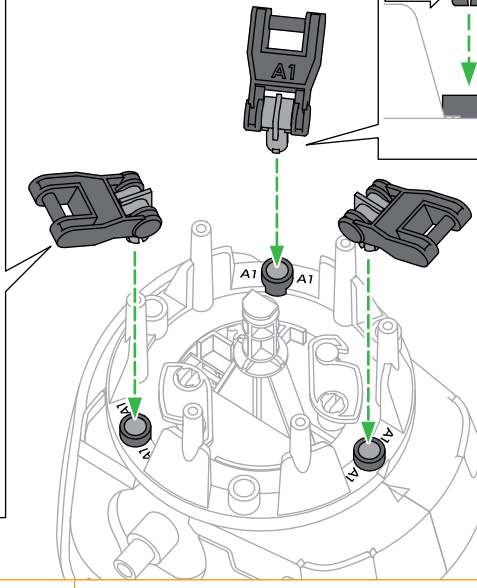

Make sure the two A14s are oriented correctly.
Click
Click
Top View

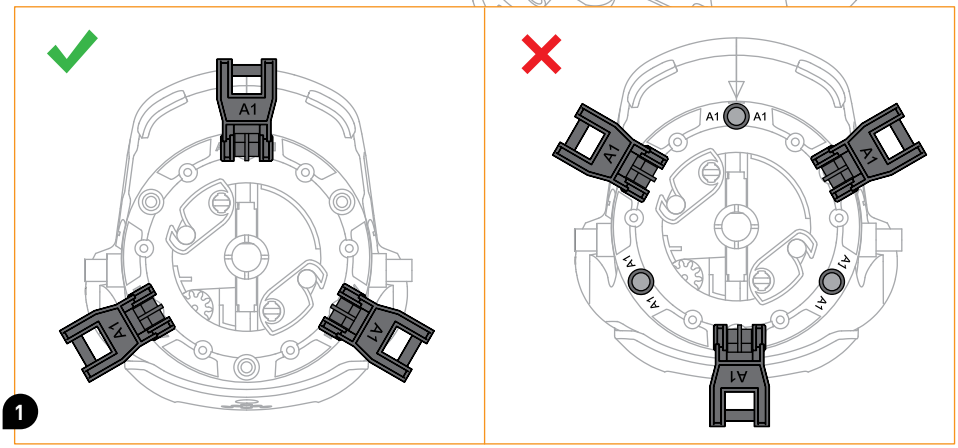
ASSEMBLING THE LEGS AND ARMS







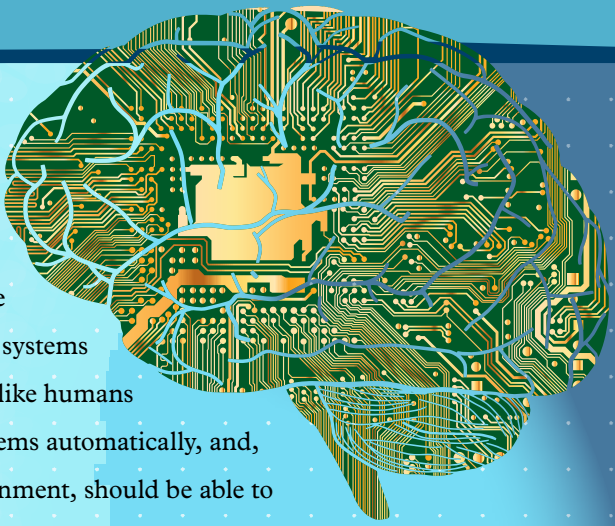




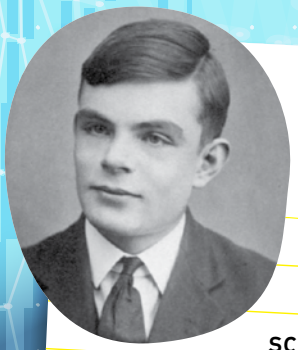
1

CHECK IT OUT

What is AI?



Artificial intelligence (abbreviated as **AI** throughout the manual) is the term for computer systems or machines that think and learn like humans do. An AI can solve certain problems automatically, and, because it has the power of discernment, should be able to perform specific tasks. Many developments and innovations were necessary to make artificial intelligence what it is today. Here are four major milestones in AI history.



ALAN TURING

THE FATHER OF DATA PROCESSING

Turing's passion was **cryptography**, a science that deals with the encryption of information and messages. During the Second World War, he decrypted German military messages for Great Britain and became known as a code breaker. He also developed a machine that is considered the precursor of modern computers. In 1950, Turing asked the famous question: Can machines think? This laid the foundation for artificial intelligence.

DARTMOUTH CONFERENCE

THE BIRTH OF AI

In the summer of 1956, a group of scientists at Dartmouth College focused on the subject of AI for two months, discussing automatic computers and neural networks. The conference included the presentation of the first intelligent computer program, called **Logic Theorist**. It was able to independently prove mathematical principles. It was here that John McCarthy, a scientist, coined the term "artificial intelligence."

Checkmate!

Man Against Machine

In 1997, the AI chess computer **Deep Blue** defeated reigning world chess champion Garry Kasparov. The victory was a sign that artificial intelligence was catching up to human intelligence.

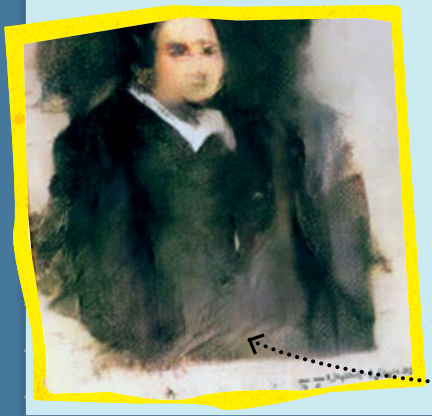
AI ANALOG

Most people interact with artificial intelligence every day without even realizing it. An automated chat bot, a language assistant, a navigation system, and even social media … all of these are powered by AI. You will be surprised how commonly it is used! More examples of AI can be found on page 59.

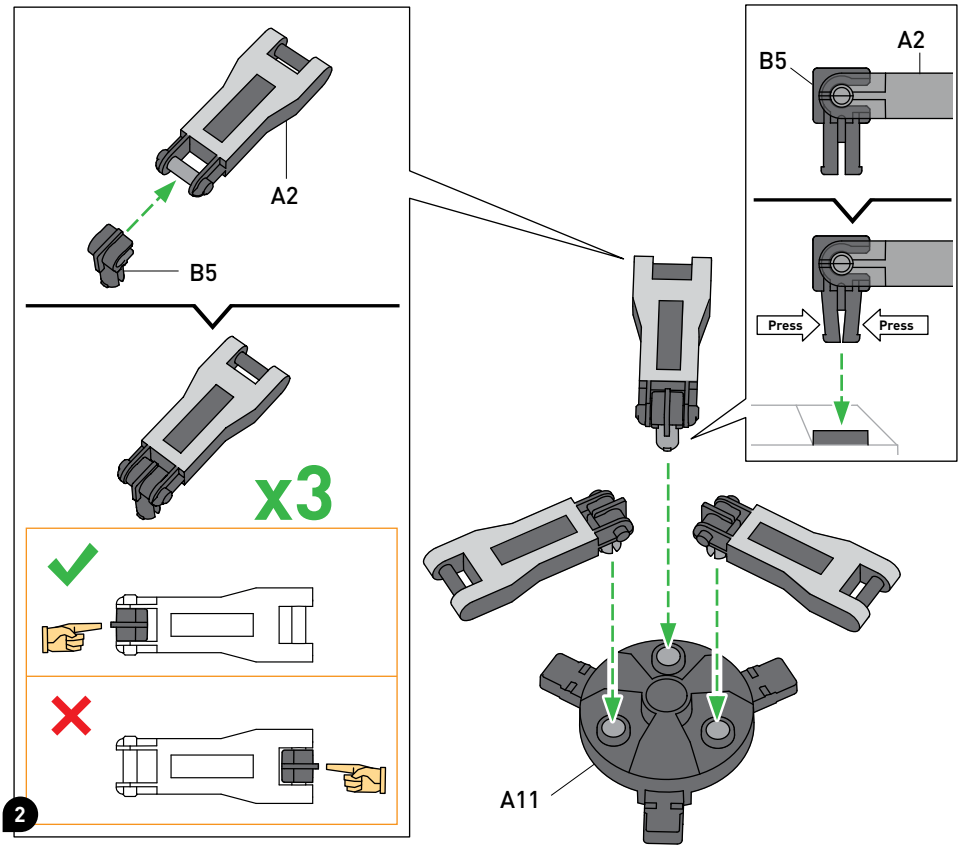
Machines BECOMING human

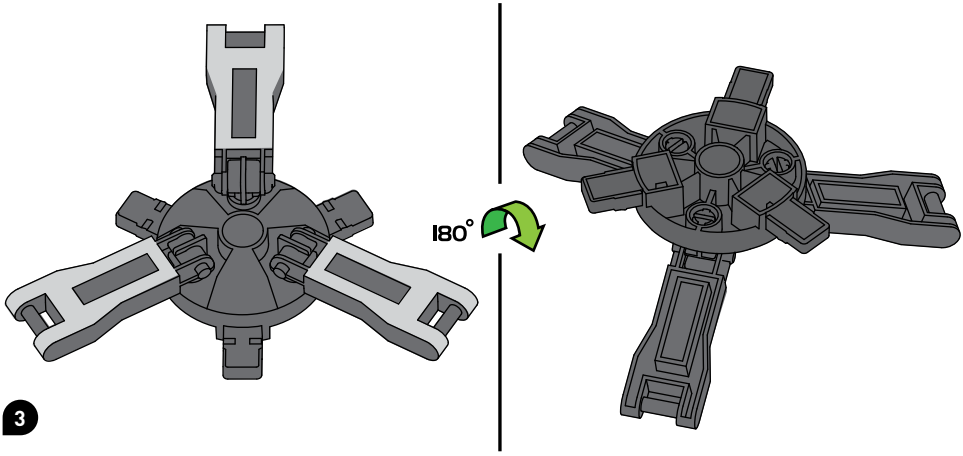
In recent years, machines have become more and more human-like, even reacting like humans and developing characteristics that we previously only associated with people.

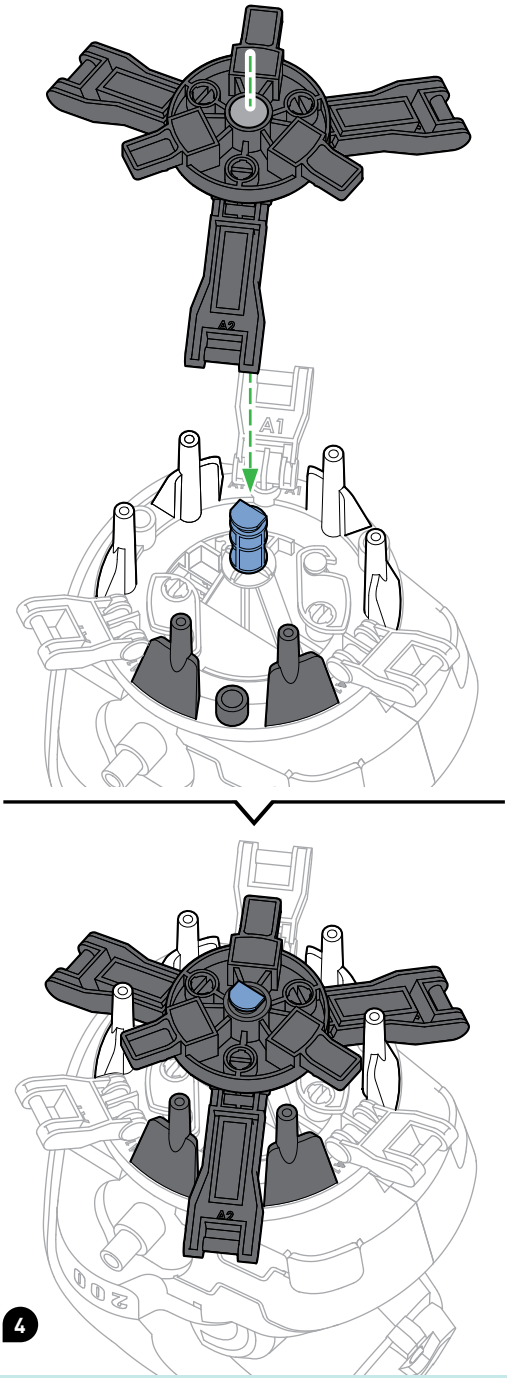
The **humanoid robot** Sophia can hold a fluent conversation. Sophia even received Saudi Arabian citizenship in 2017.

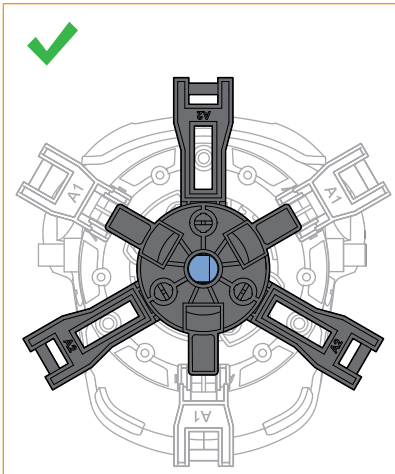


In 2018, an **AI-created painting** called "Portrait of Edmond de Belamy" was sold at action for $432,500. The AI system learned from a set of 15,000 portraits spanning from the 14th to 19th centuries. The goal of the AI was to create a work that looked like it was done by a human being.

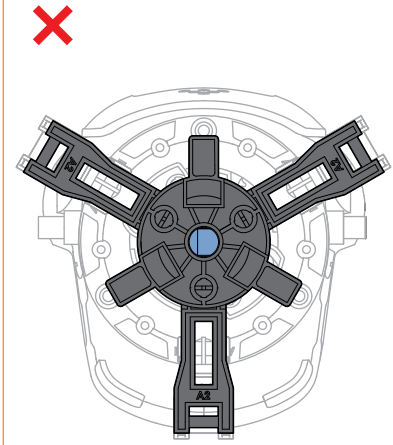

A2
B5
x3
B5
A2
Press
Press
A11
2


180°
3

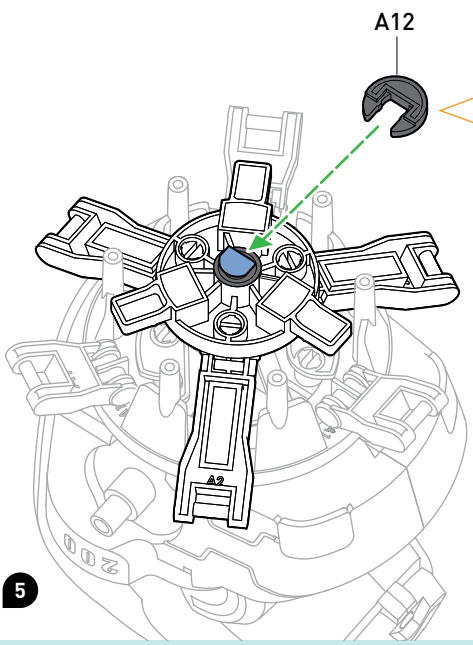




Top view



Top view



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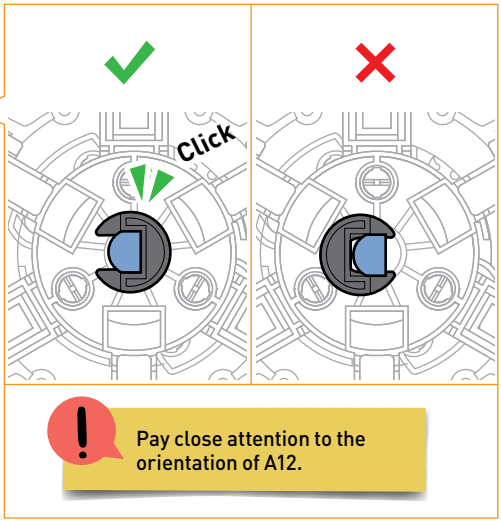
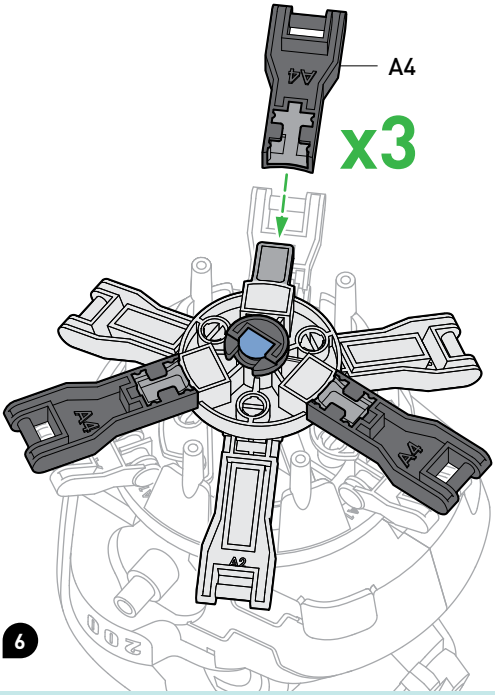


Pay close attention to the orientation of A12.



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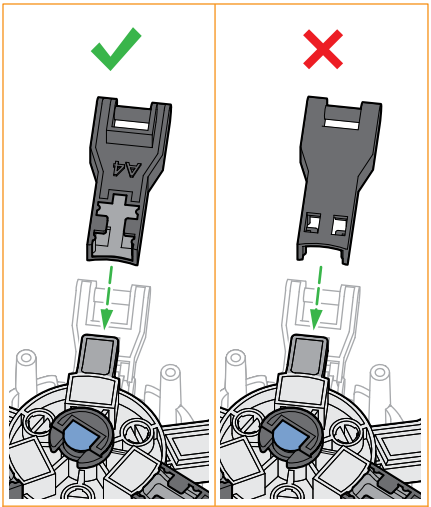
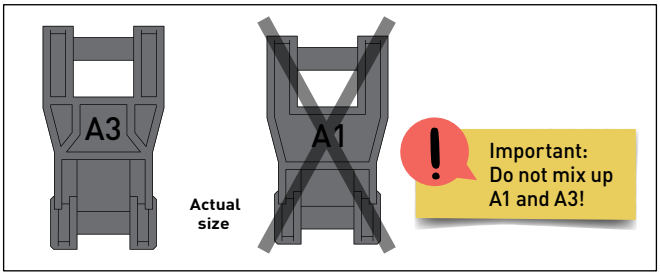
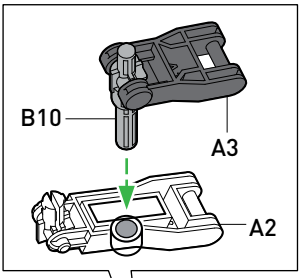
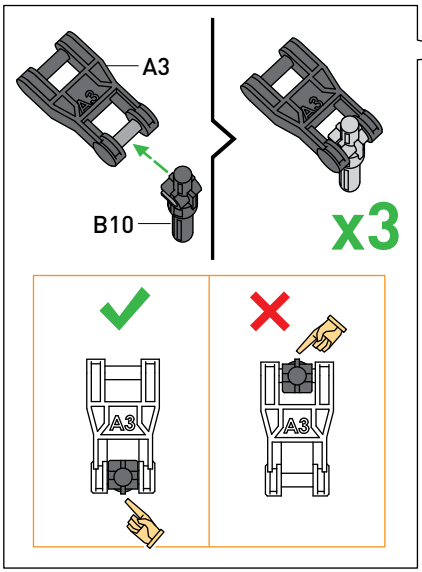
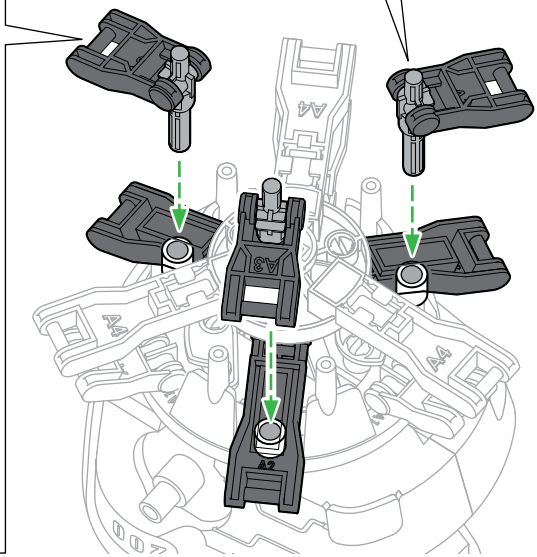


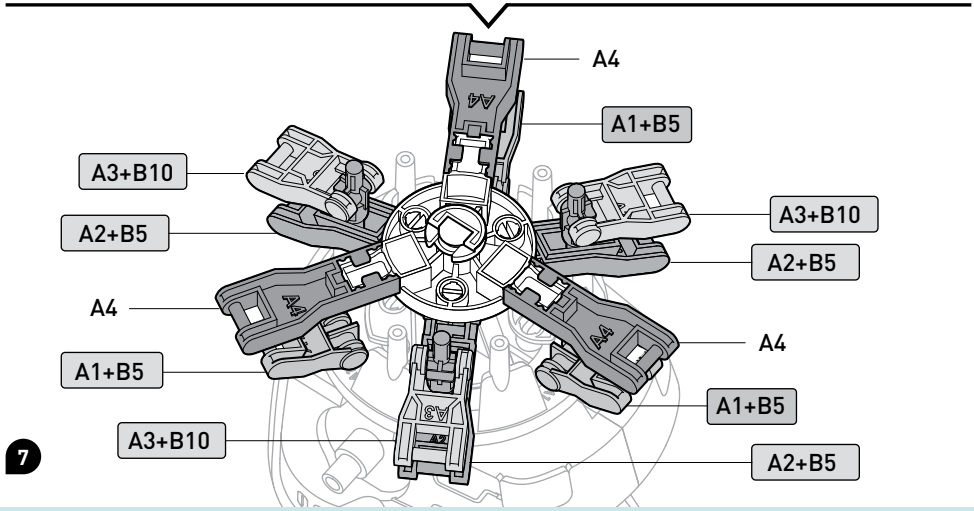
Pay close attention to the orientation of A4.


A3
Actual size
A1
Important:
Do not mix up
A1 and A3!

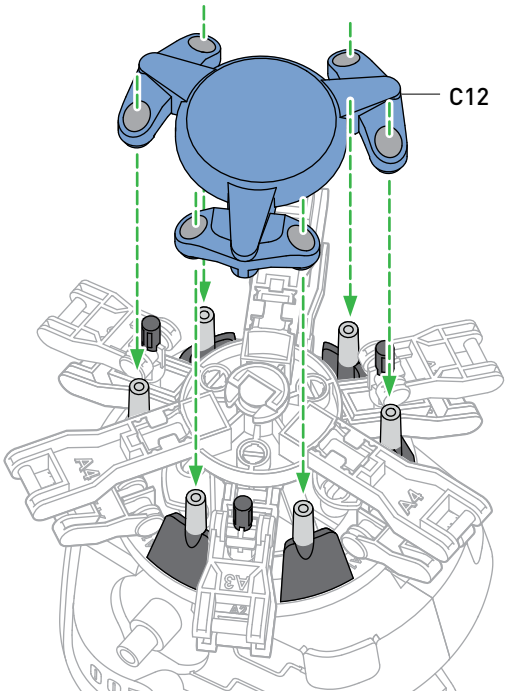

B10
A3
A2

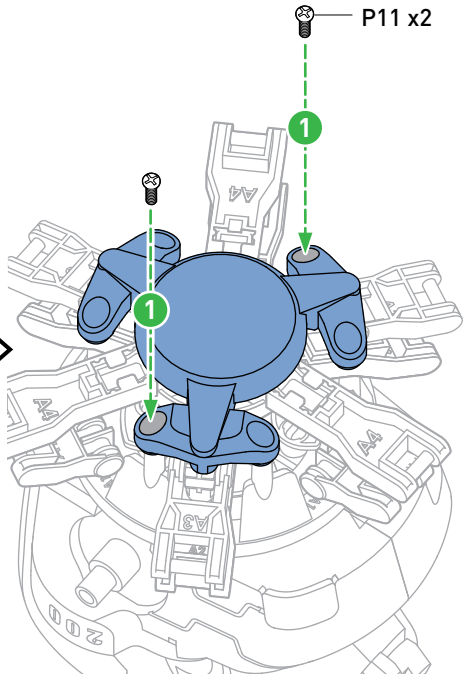

A3
B10
x3

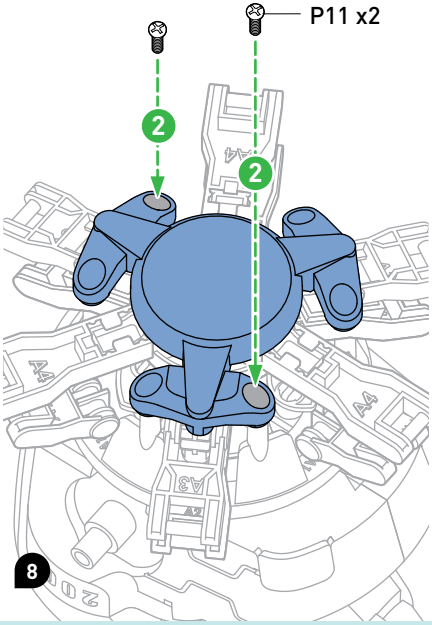


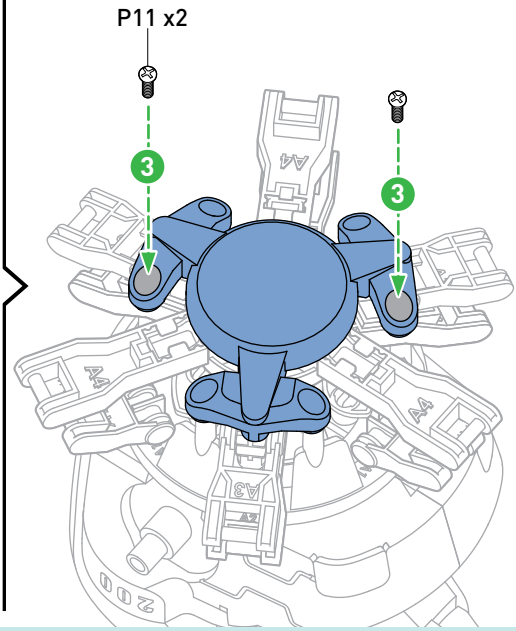

A4
A1+B5
A3+B10
A2+B5
A4
A1+B5
A3+B10
A3+B10
A2+B5
A4
A1+B5
A2+B5

7

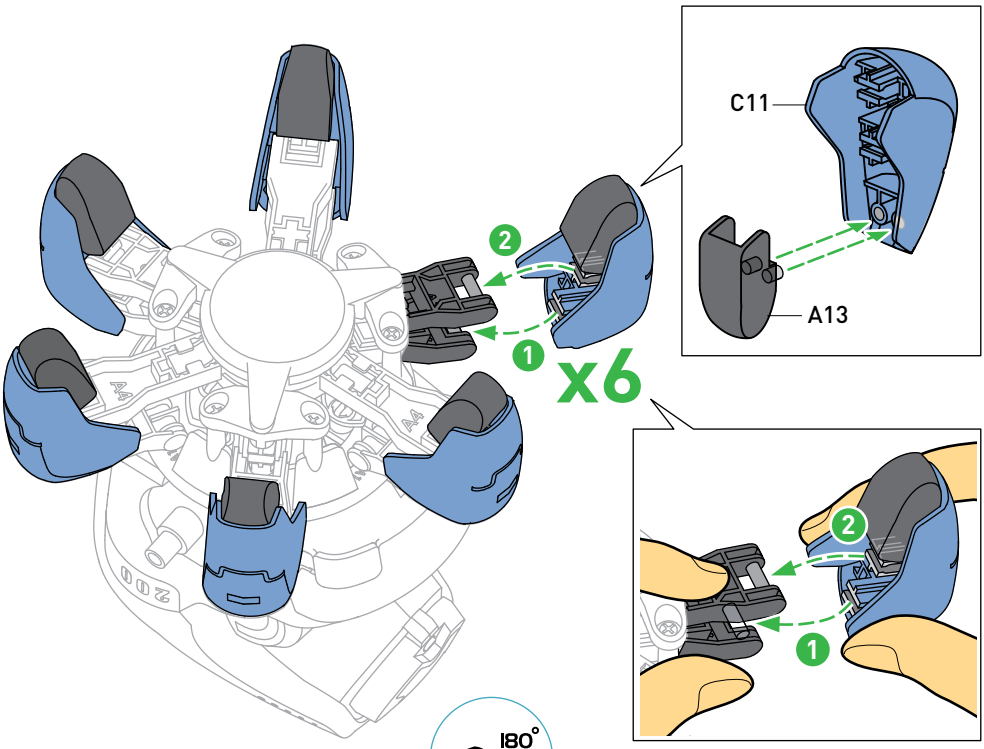


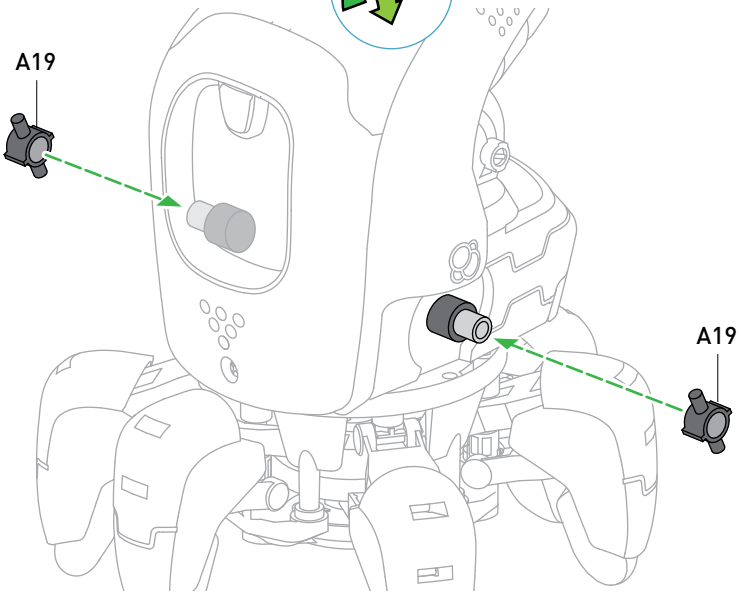






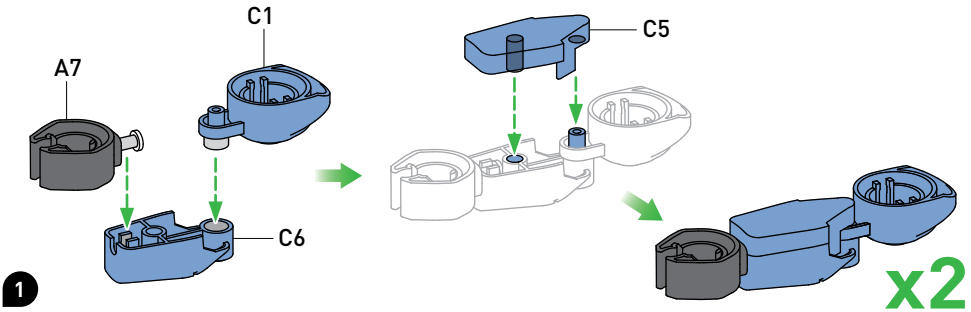
8



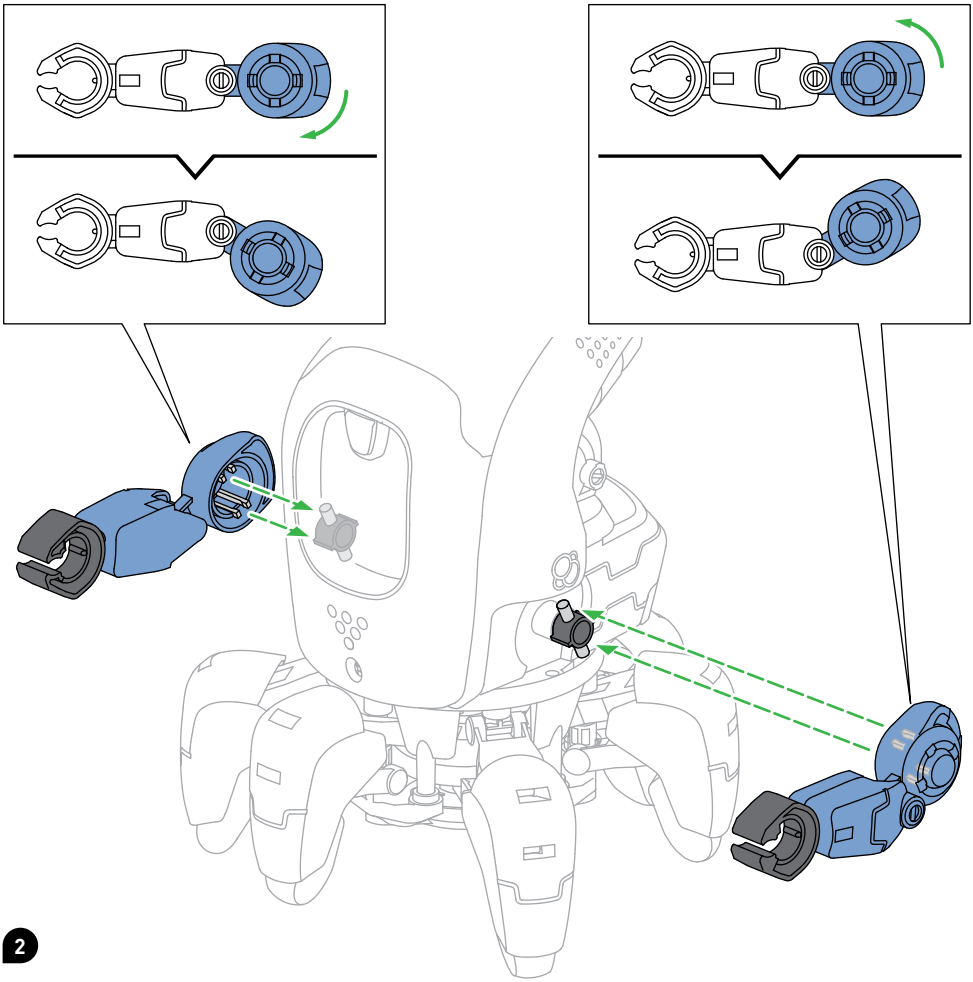


9

ASSEMBLING THE LEGS AND ARMS

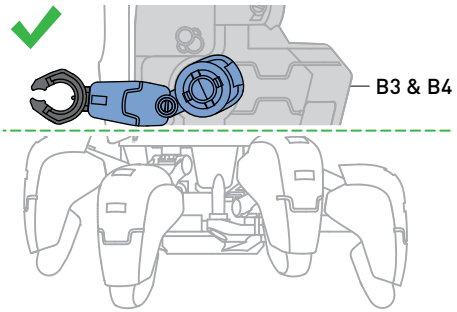


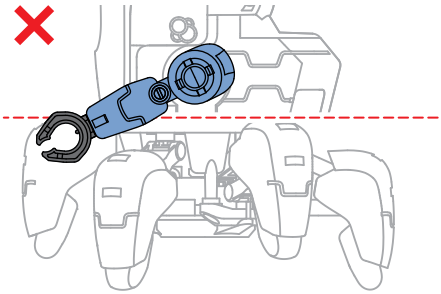
1



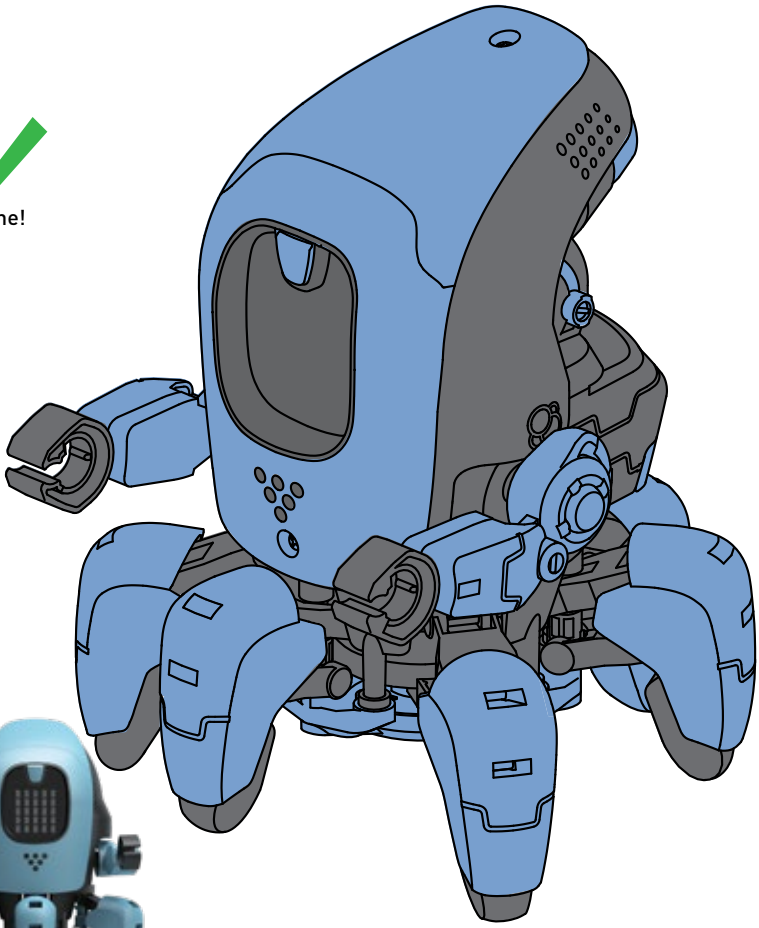
2

IMPORTANT! Position the arms so that they do not interfere with the legs while they are in motion.

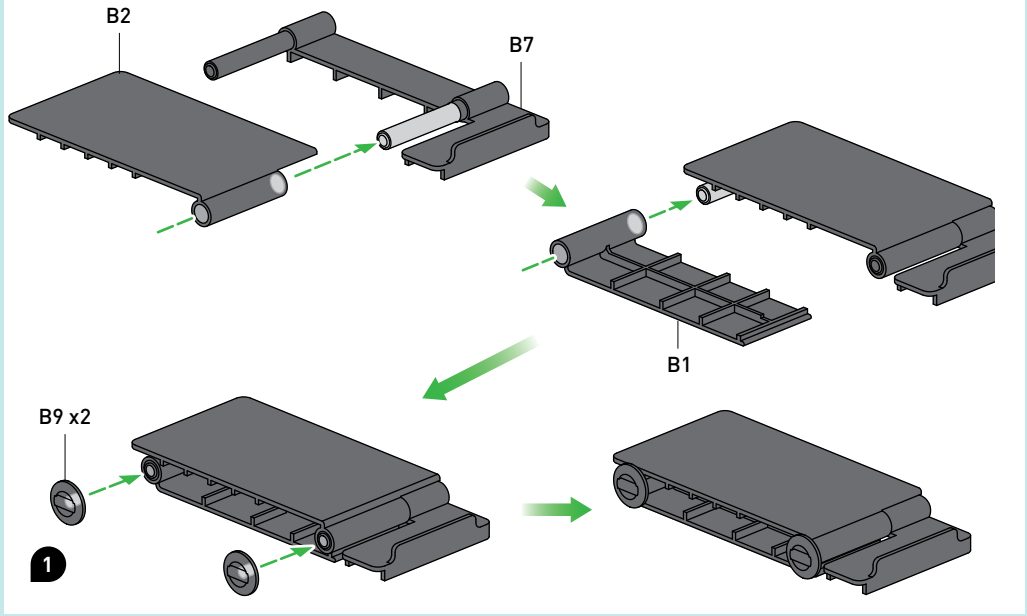


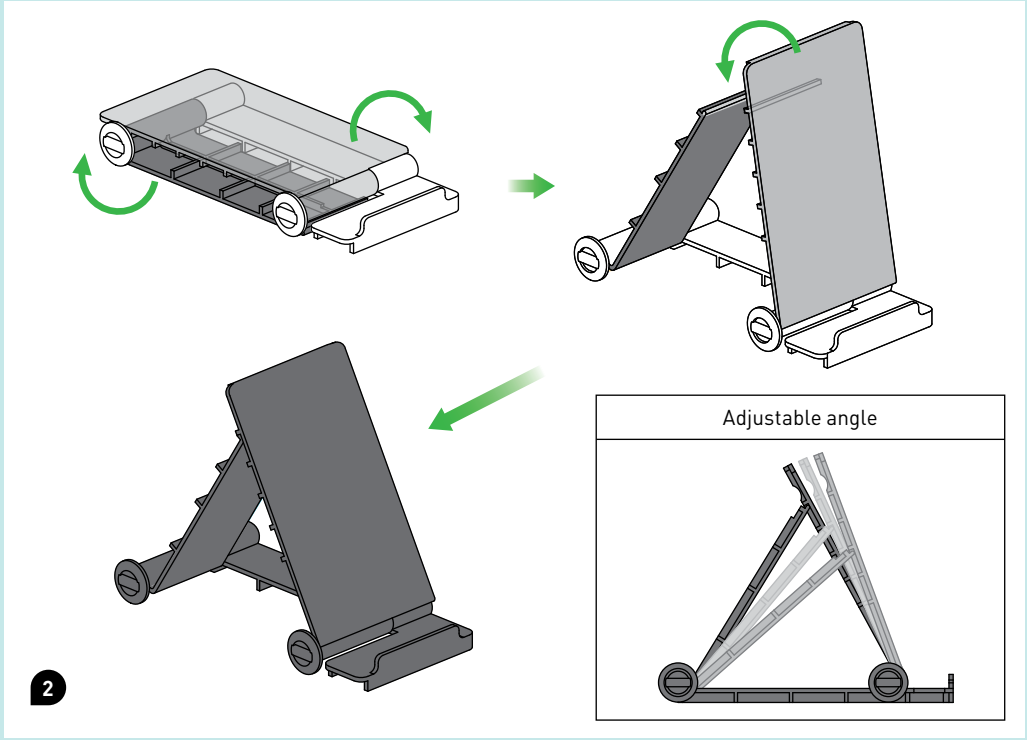


Done!



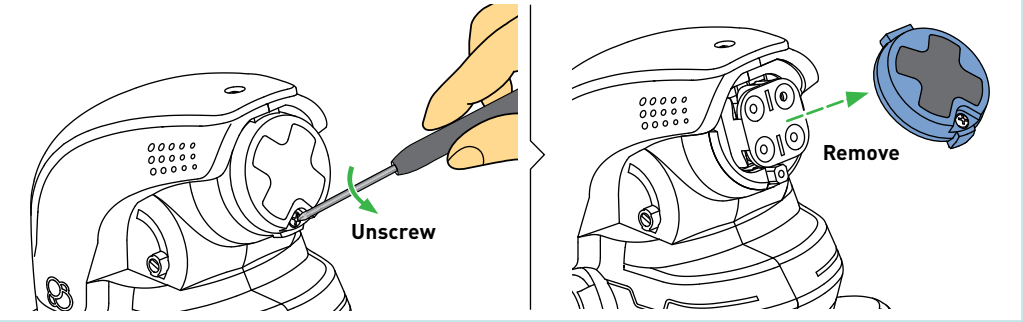
ASSEMBLING THE STAND

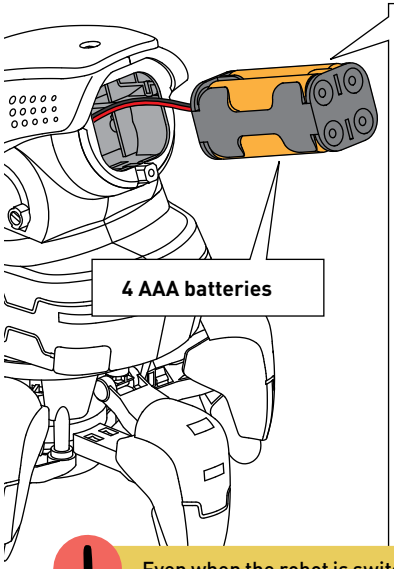


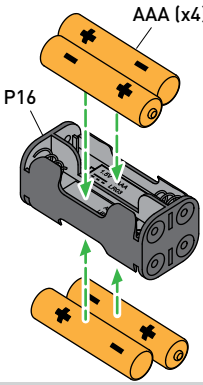


Adjustable angle

INSERTING & CHANGING THE BATTERIES



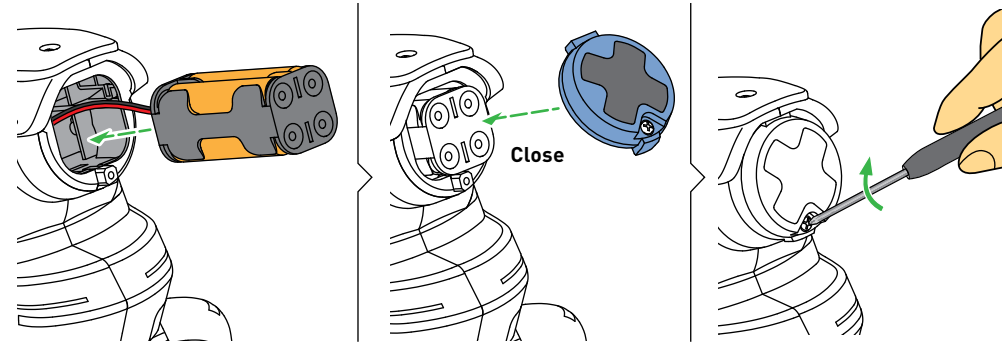




When inserting the batteries, make sure they are in the correct polarity (+ and -).

Please also reference the notes on handling batteries on page 2.

Even when the robot is switched off, the circuit board consumes a small amount of power. Therefore, you should remove the batteries if you are not going to use the robot for a long period of time.



How do people think?

When we think, individual thoughts are scattered throughout our brain. Thoughts jump from one nerve cell (neuron) to the next in the form of lightning-fast electrical signals. Individual neurons are connected by nerve tracts that form a huge neural network. Thought races through this network much like a car on a freeway.

I ask myself:
Do I want to eat an ice cream?

I think:
No, it's too cold.

The thought is not fired any further.

I think:
Yes, a scoop of strawberry ice cream

The thought is fired through the neural network.

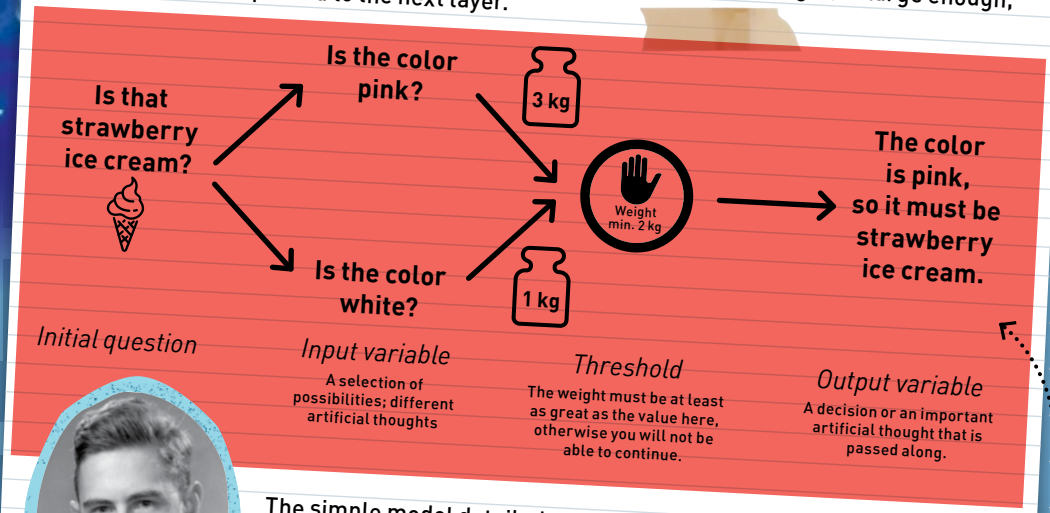
I think:
Preferably in a cone.

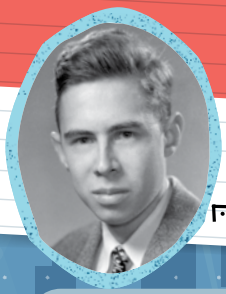
How do humans learn?

Nerve cells are constantly renewing themselves, so the neural network is constantly changing. Our brain is stimulated by new stimuli. As information flows, neurons are activated. Sensory inputs such as hearing, feeling, tasting, and smelling stimulate the flow of information in our brains. If the information is strong enough or repeated often enough, it will be stored in our long-term memory. What we remember, we have learned. These processes continue to work, even in old age. That means we keep learning throughout our lives.

HOW DO ROBOTS THINK?

"Thinking machines," such as intelligent computers or robots, have artificial neural networks modeled after the human brain. Information is routed through artificial neural networks via artificial neurons, according to a specific pattern. An active neuron transmits the information (or thoughts). However, if a neuron is not active, information is not transmitted. The decision of whether a neuron is active or not is made based on its weight — not its physical weight but a value by which data is evaluated. If the weight of the input (or the artificial thought) is large enough, the information is passed to the next layer.

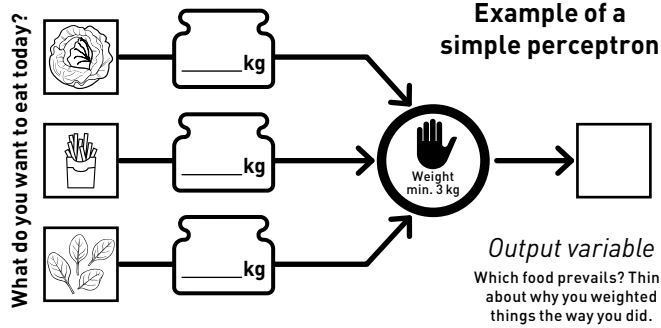




The simple model detailed above is called a perceptron, and is the precursor of today's artificial neural networks. The perceptron was introduced by Frank Rosenblatt in the 1950s.

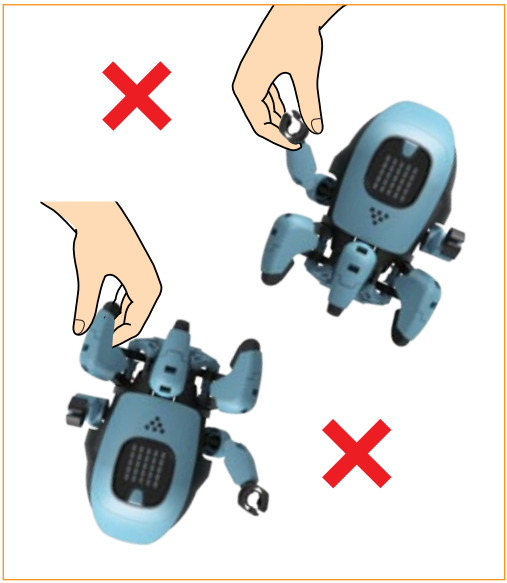
AI ANALOGUE

Try developing a perceptron (a decision-making machine) yourself: What would you like to eat today? You can choose between salad, fries, or spinach. How do you weigh these input variables?



Here are some things to keep in mind so you can enjoy your AI Robot for as long as possible. First, when you lift your robot, hold it by the upper body, as shown in the picture on the left.

Do not hold your AI Robot by the legs or arms.



To avoid injury, keep your fingers away from the robot's moving parts.

ROBOT FEATURES

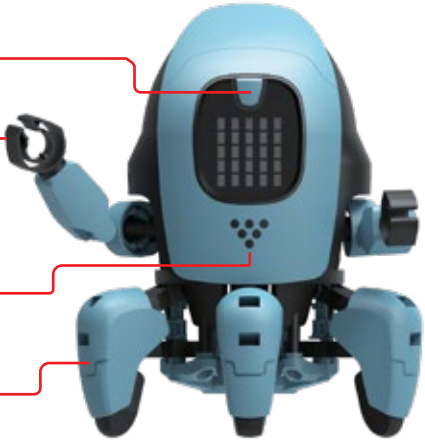
As you noticed during its assembly, your AI Robot is made up of many individual parts. The complex internal mechanics and the two motors make it mobile, and the circuit board is the brain. Your AI Robot's key components and functions are described below:

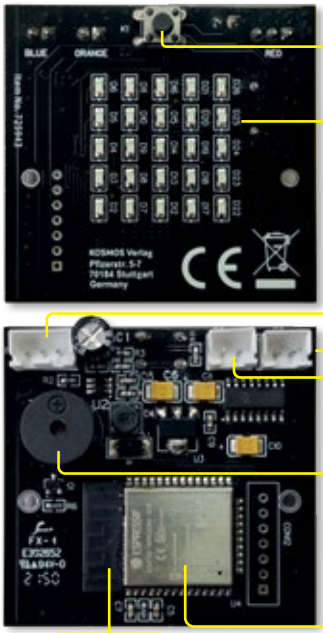
Power button: Hold for three seconds to turn the robot on or off.

With its poseable arms and flexible hands, your robot is able to carry small objects.

The entire upper body of the robot can rotate 360°. This is how your robot can change the direction of its movement.

The special mechanism lets your robot walk on six legs.





On / off switch

LED display: 25 red LEDs are arranged in a 5 x 5 grid, forming the robot's face. The app lets you control your robot's face. Choose from a variety of expressions or create your own.

Connector for the battery compartment

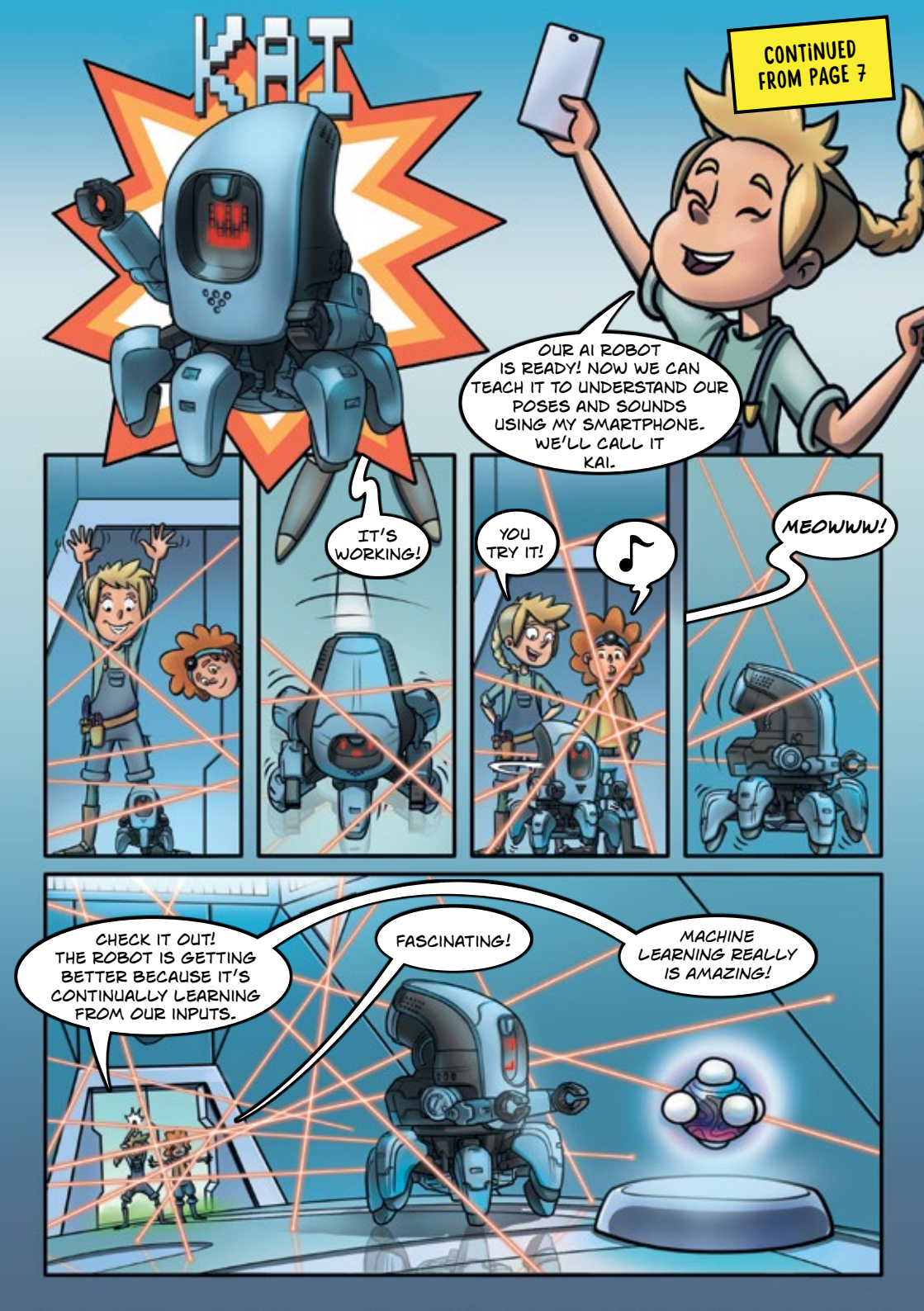
Connector for the motor that moves the legs

Connector for the motor that rotates the upper body

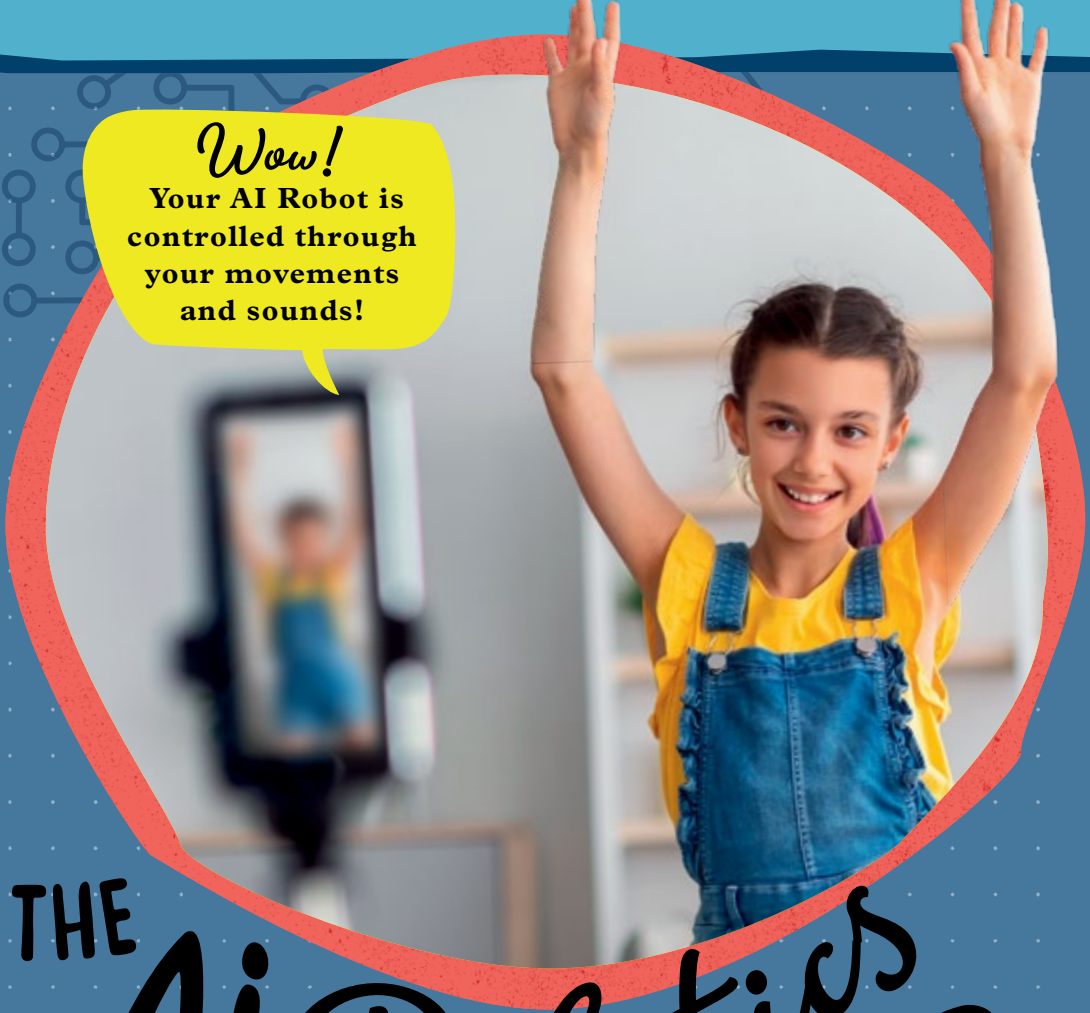
Speaker

The core of the board is the powerful microcontroller. This houses the processor and the Bluetooth antenna, which allows for wireless communication with the app.

Antenna


KAI
CONTINUED FROM PAGE 7
OUR AI ROBOT IS READY! NOW WE CAN TEACH IT TO UNDERSTAND OUR POSES AND SOUNDS USING MY SMARTPHONE. WE'LL CALL IT KAI.
IT'S WORKING!
YOU TRY IT!
MEOWWW!
CHECK IT OUT! THE ROBOT IS GETTING BETTER BECAUSE IT'S CONTINUALLY LEARNING FROM OUR INPUTS.
FASCINATING!
MACHINE LEARNING REALLY IS AMAZING!

TADAAAAH!
OH NO! THE LASERS ARE STARTING TO MOVE!
BZZT
BZZZZZZ
YIKES! HURRY! WE HAVE TO LEAD OUR ROBOT BACK!
BZZZZZZZZZZ
HNNNG!
CLAP! CLAP!
OOMF!
OOPS! SORRY, TOM!!
IT'S OKAY!
COCK-A-DOODLE-DOO!
WHEW! WE MADE IT! BACK TO THE SHIP!
HUFF! HUFF!
I MUST SAY ... THE ROBOT'S ABILITY TO LEARN IS REALLY IMPRESSIVE. I CERTAINLY GOT ALL OF MY WEEKLY EXERCISE WHILE CONTROLLING IT!
OOPS! DID I FORGET TO MENTION THAT THE APP ALSO DOUBLES AS A REMOTE CONTROL?
NOW YOU TELL ME!



THE AI Robotics APP

To control your AI Robot, you must first ask an adult to download the **KAI Robotics** app to a smartphone or tablet. The adult can either scan one of the two QR codes to the right (depending on the device's operating system — iOS or Android), or they can search for "KAI Robotics" by Kosmos in the device's app store.

App Store

Play Store

THE APP AT A GLANCE

Preparation

You can control all of your robot's functions via the KAI Robotics app, which contains the actual artificial intelligence of this experiment kit. Although your robot has significantly more computing power than the first ones that astronauts had at their disposal, it is still not sufficient enough to carry out the AI calculations.

Your smartphone or tablet provides the computing power required for the AI functions. From the point of view of the first astronauts, these smart devices are truly supercomputers!

TIP

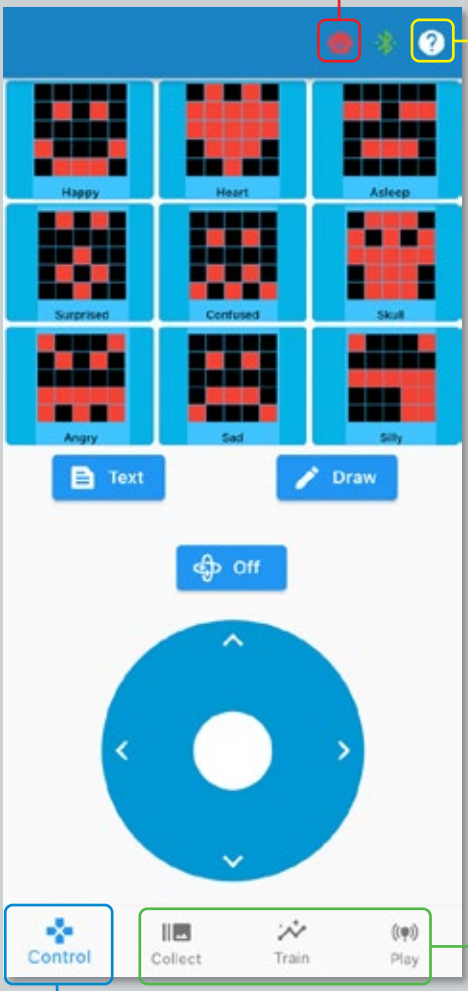
YOU CAN FIND OUT MORE ABOUT THE MINIMUM SYSTEM REQUIREMENTS BY SCANNING THE QR CODE ON PAGE 57.

Starting out with the app

The first time you use the app, you need to agree to the data protection declaration. You will also be asked to grant the app various permissions — location, camera, microphone, etc. You must grant these permissions for the app to function properly.

TIP

YOU CAN FIND DETAILED INFORMATION ON DATA PROTECTION ON PAGE 56 OF THE MANUAL AND IN THE DATA PROTECTION DECLARATION IN THE APP.



Press this robot icon to establish the Bluetooth connection between the app and the robot.

Tap this symbol to access the help feature, which includes a tutorial and further information about the app.

Use these three buttons to access the app's AI functions:

Collect data:
This screen is where you collect the data you will use to train the AI.

Train the AI model:
In this screen, you train an AI model with the data you collected on the collect screen.

Play with your robot using AI:
Use your trained AI model to control the robot with poses or sounds.

The control screen allows you to remotely control the movements of your robot and its LED display. This screen doesn't utilize any AI functions, but it's still fun!

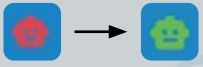
Establishing a Bluetooth connection

To establish a connection between the app and your robot, make sure of the following:

1. Bluetooth is active on your device;
2. Your robot is turned on (hold the button above the LED screen for three seconds to turn the robot on).

Then, press the red robot icon in the app (shown below). If your robot is detected, a white box containing a unique Bluetooth ID and "Kosmos AI Robot" will appear below the icon. Tap on the box to establish the connection.

When the Bluetooth connection is active, the color of the robot icon changes from red to green.



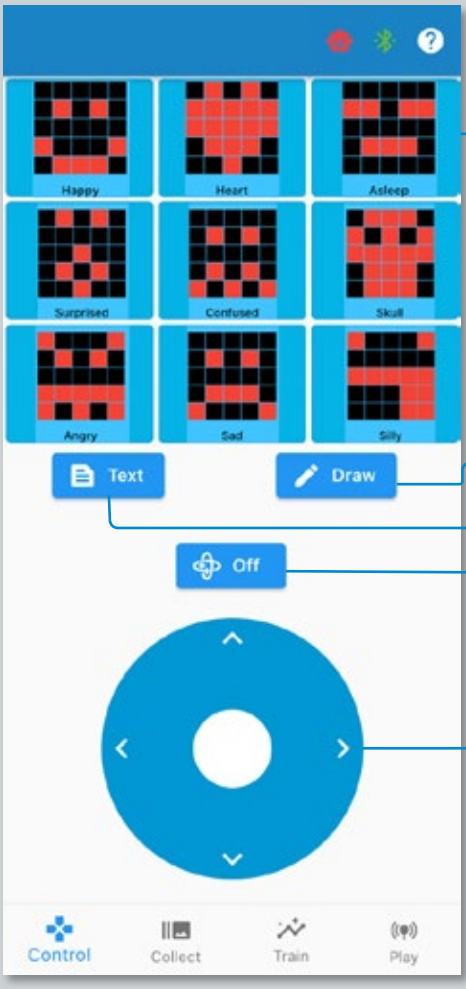
To let you know the connection was successful, your robot will display a smiley face and do a short dance.

The Bluetooth icon next to the robot icon should be green. If the Bluetooth icon is red, it means something is wrong. Either Bluetooth is not active on your device, or you did not agree to location sharing when you first started the app. (You can find more information on location sharing on page 57 of the manual or in the data protection declaration of the app.) If necessary, change the permissions in the device's settings or delete and reinstall the app.

TIP

MAKE SURE TO CONNECT FROM WITHIN THE APP AND NOT VIA THE BLUETOOTH MENU IN THE SETTINGS OF YOUR SMART DEVICE.

Remote control mode (not AI-based)



Tap on any of the expressions to change the face on the robot's LED display.

The draw button allows you to control the 25 LEDs on the robot's display.

The text button allows you to enter text that will scroll across the robot's display. (Some special characters cannot be displayed.)

As an alternative to the direction keys, you can use the Gyroscope function, which gives you the ability to tilt your smart device to control the movement of your robot. Your robot will respond to your device's inclination.

Use the direction keys to control the movement of your robot.

The AI functions

There are three steps to create a functioning AI model that allows you to control your robot using poses or sounds.

1. **Collect** data
2. **Train** the AI model with your data
3. **Play** with your robot using the AI model

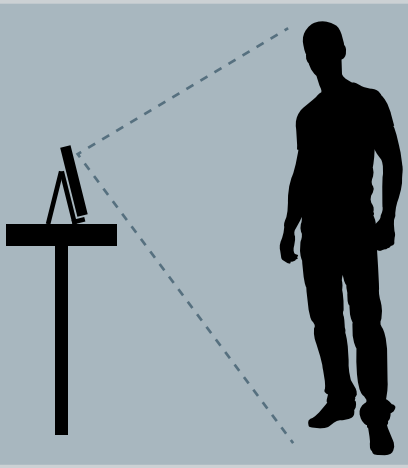
1. Collect data

The collect screen is where you determine which poses or sounds your robot will recognize. Be creative! Here, you will assign an individual pose or sound to each robot action. For example, you can teach your robot that when you raise your left arm, it should turn its body to the left. Properly-performed, non-conflicting data collection is the basis for a well-functioning AI model. The data you collect will be fed into the subsequent training of the AI.

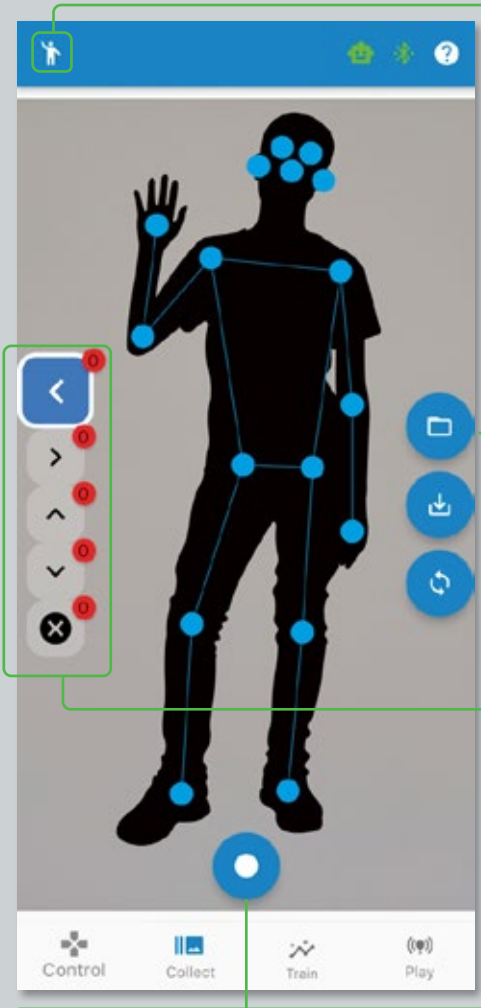
NOTE: It is easier to start in pose mode, since collecting data from poses is a bit easier than collecting it from sounds. Once you have an understanding of how data collection works, you can try audio mode.

Setup for collecting data

Find a quiet place where you have a table or other surface and a few feet of space. Place the stand that you built on page 34 on a table. Then place your smart device on the stand so that the screen is upright and the selfie camera is facing in your direction. Now open the KAI Robotics app.



1a. Collect data in pose mode



This button allows you to switch between pose mode and audio mode.

This button lets you load a previously saved dataset.

This button allows you to save your dataset. In order to be able to distinguish your saved datasets later, jot down the details on page 64 of the manual.

If you made a mistake or if you are not satisfied with your data, you can press this button to restart the data collection. You can either reset a single action or delete the entire dataset.

These are the five actions that your robot can perform:

- Rotate upper body to the left
- Rotate upper body to the right
- Walk forward
- Walk backward
- Stop (not available in audio mode)

Think of a specific pose for each of the actions, for example:

- Rotate left → Raise your left arm
- Rotate right → Raise your right arm
- Walk forward → Raise both arms above your head
- Walk backward → Cross both of your arms in front of your chest
- Stop → Let both arms hang at your sides

The number in the bubble next to the action indicates how many data samples you have collected.

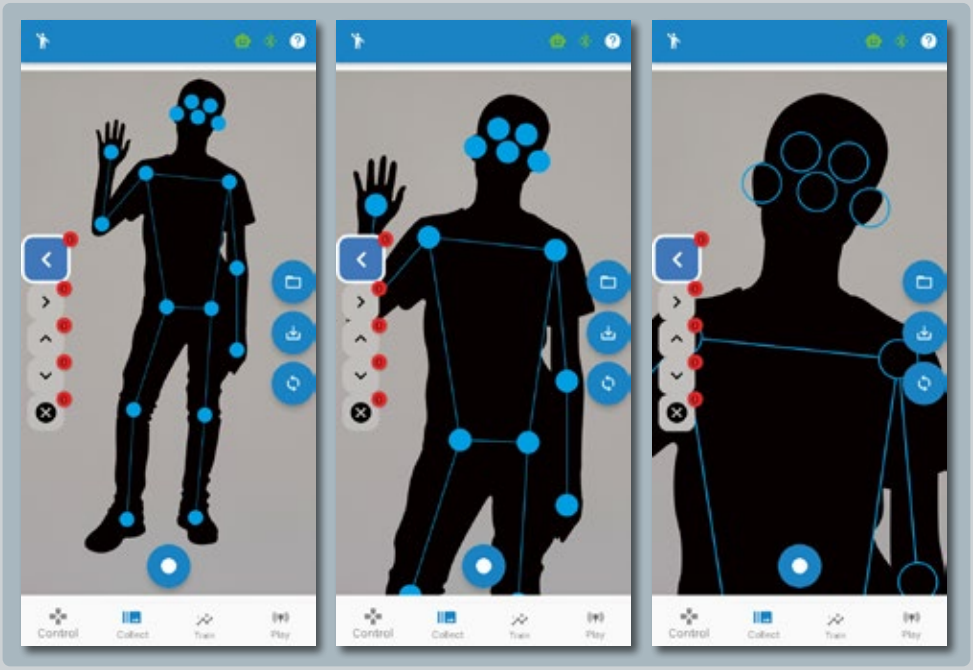
If the number is red, you will need to keep collecting data. Once it turns green, it means you have collected the minimum number of data samples. In pose mode, the minimum number of samples is 50.

This is the Start button. When you have chosen a pose to assign to an action, you can begin collecting data:

1. Select an action by tapping it on the left side of the screen.
2. Press the Start button.
3. A three-second countdown begins, giving you time to position your body in your chosen pose.
4. The app begins collecting data. In pose mode, samples are automatically collected in sets of 50.

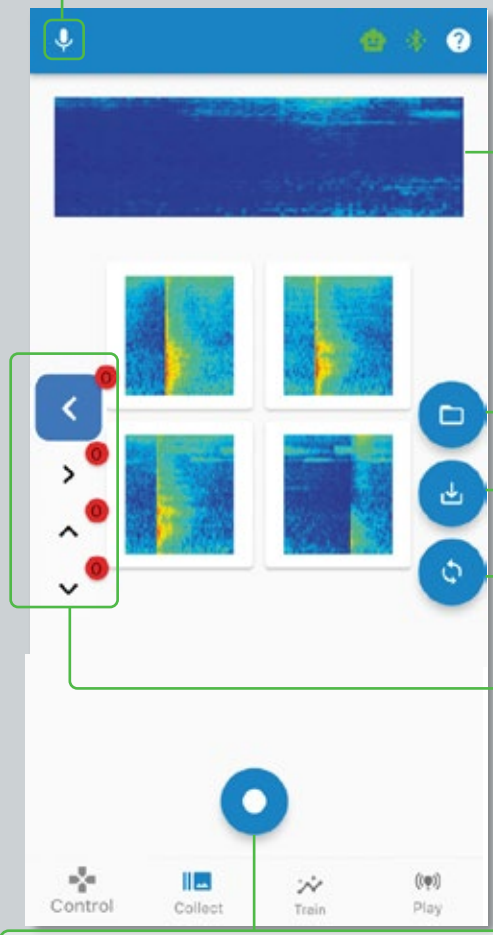
Tips for successful data collection in pose mode

- Choose poses that are unique and will not be confused with each other.
- Stand in front of a background that is not too busy.
- While the data is being collected, make small variations to your pose. For example: pivot slightly, lean back and forth, and move your hand side to side a few inches in each direction.
- Be sure to stay in the frame of the device screen while collecting data.
- Experiment with the distance between your body and your device's camera. If you stand closer to the camera, less of your body will be captured. If you stand further away, your legs will also be in frame and the app will use them as data points. The blue circles on your body indicate points recognized by the app. The app must recognize at least 12 points of your body for the recognition to work. If 12 points are registered, the circles will turn a solid blue. If fewer than 12 points are registered, you will see empty circles and you will need to adjust your distance until more points are found and the circles turn solid.



The device stand tilts so that it is easy to make adjustments to the area that the camera can capture.

1b. Collect data in audio mode



This button allows you to switch between pose mode and audio mode.

This visual representation of frequency is called a spectrogram. This allows you to see the sounds that your device's microphone picks up. The colors range from blue (low frequency) to red (high frequency).

This button lets you load a previously saved dataset.

This button allows you to save your dataset. In order to be able to distinguish your saved datasets later, jot down the details on page 64 of the manual.

If you made a mistake or if you are not satisfied with your data, you can press this button to restart the data collection. You can either reset a single action or delete the entire dataset.

There are four actions that your robot can perform in audio mode:

- Rotate upper body to the left
- Rotate upper body to the right
- Walk forward
- Walk backward

Think of a specific sound for each of the actions, for example:

- Rotate left → Whistle
- Rotate right → Clap
- Walk forward → Meow like a cat
- Walk backward → Bark like a dog

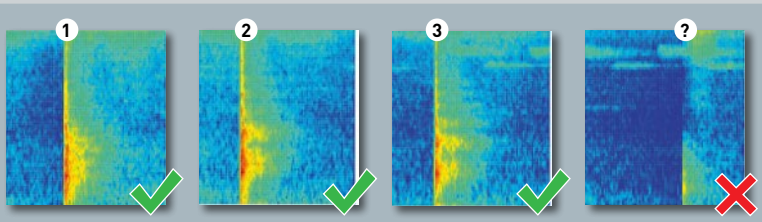
The number in the bubble next to the action indicates how many data samples you have collected. If the number is red, you will need to keep collecting data. Once it turns green, it means you have collected the minimum number of data samples. In audio mode, the minimum number of samples is 20.

This is the Start button. When you have chosen a sound to assign to an action, you can begin collecting data:

1. Select an action by tapping it on the left side of the screen.
2. Press the Start button.
3. Four one-second data samples will be collected back-to-back after you press start. This means you need to make the sound four times in a row.
4. The four data samples will be displayed graphically in the center of the screen. Tap on a data sample to add it to your dataset (see p. 51 for more details).

Tips for successful data collection in audio mode

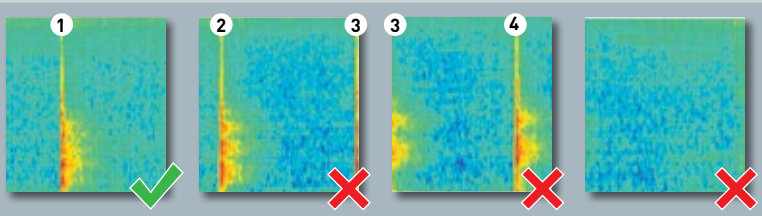
- Make sure the environment is quiet and free of background noise. All sounds are registered during data collection, so any additional noise can negatively affect your data sample.
- Choose sounds that differ as much as possible from each other. The graphical representation in the spectrogram helps you see how distinct sounds are from each other.
- Audio mode does not include speech recognition, meaning the AI is not able to receive and interpret spoken language. This means that, if you use voice commands for all of the actions, the AI will likely not be able to sufficiently distinguish between them.
- Make sure to collect enough samples. The minimum number needed to create an AI model in audio mode is 20 data samples per action. Collect more samples to make the recognition even more accurate.
- Take a look at your data samples before including them in your dataset. Each signature will have a visible signature in the spectrogram. Select only those data samples where you can clearly see the intended signature.



Here are four examples of data samples. The sound signature is clearly visible in the first three samples, but it is not as visible in the fourth sample.

In this example, you would tap the first three samples to add them to the dataset.

- Maintain an even, consistent rhythm when recording. Don't execute your sounds too quickly or too slowly. In the data samples below, you can see what happens if you are not consistent.



Speed matters: The first data sample is good, but the second data sample shows that sound 3 was made too soon. It is cut off at the end of the second sample and then continues into the beginning of the third sample. This caused sound 4 to be recorded in the third sample, which means the fourth sample is empty. In this example, there is only one good data sample: **sample 1**.

2. Train the AI model

Your dataset forms the foundation for your AI model. On the train screen, you create an AI model with the data you collected. The AI takes your data samples and tries to recognize patterns in it. You can see how well the learning process is going by looking at the learning curve, which is explained in more detail on page 53.

Here is where you select the mode of the data you want to use. Press this button to toggle between pose mode and audio mode.

The Confusion Matrix shows you which actions the AI model has properly learned. The distribution of the numbers will indicate whether or not the AI is confusing one action with another (see p. 53).

This button lets you load a previously saved dataset.

This button allows you to save your dataset. In order to be able to distinguish your saved datasets later, jot down the details on page 64 of the manual.

If you made a mistake or if you are not satisfied with your model, you can press this button to restart the training.

Use the number of epochs slider to set how many times your model will run through a training session. For each epoch, the AI will review your data once. However, a greater number of epochs is not always better, as too much training can result in an overfitted model, which means it will not be able to recognize new data properly.

Use the learning rate slider to set how quickly the training should run. If the learning rate is too high, the model will remember all of the training data, but it may get mixed up when validating the data and become overfitted. If the learning rate is lower, the training will take longer.

The learning curve shows how accurately the AI model is learning the data that you collected. The accuracy is shown as a percent (%). The higher the accuracy, the better your model will work.

Press Start to initiate training.

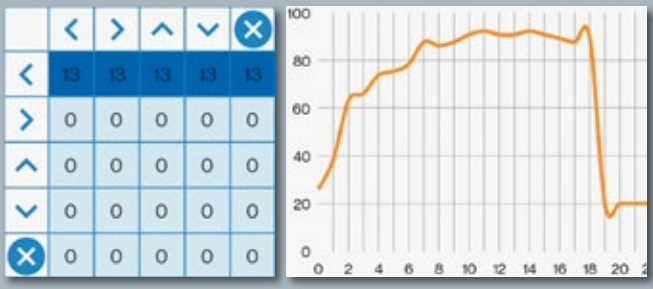
Tips for successful AI training

- The key to successful training is a good dataset. It forms the foundation for a well-functioning AI model.
- Play around with the number of epochs and learning rate sliders until you get the best result. If you are not satisfied with the result, you can restart the training any time.
- If you still aren't getting a satisfactory result, you can make your data recognition more accurate by collecting even more data samples.
- If your AI model isn't working well, despite a large dataset, return to the collect screen, start a new dataset, and choose different poses or sounds that are more distinct from one another.

This is what an optimal training result looks like:

Confusion Matrix: Ideally, all numbers higher than zero are in the diagonal, and every other field has a zero in it. Achieving this result means that no commands are being confused with any others.
Learning Curve: Ideally, the curve rises until it reaches 100% accuracy.

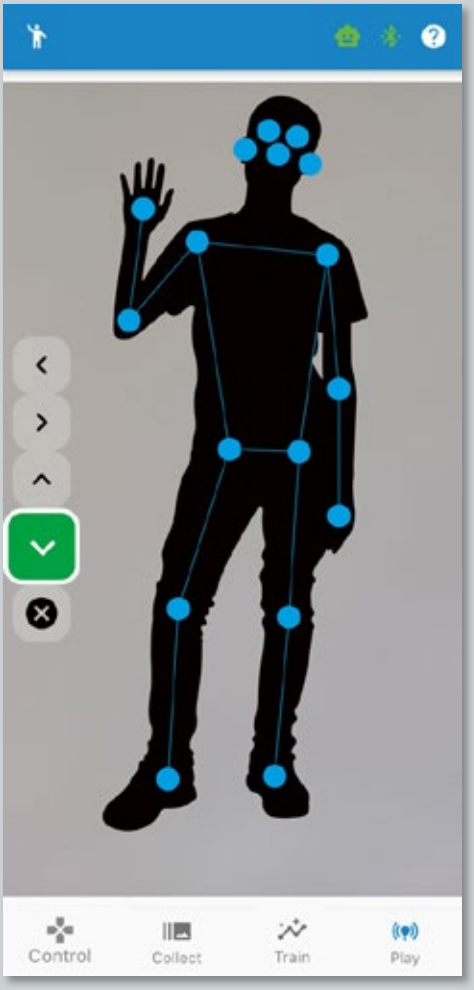
This is what an overfitted model looks like:



Confusion Matrix: If all numbers greater than zero are in one row or are randomly distributed across the matrix, the commands are being confused with one another. In the example above, the AI interpreted each command as a left turn.
Learning Curve: In this case, the curve initially rises, then levels off, and then drops rapidly. This is the result of overfitting. If you experience this, try reducing the number of epochs or the learning rate. In the example above, the model would have achieved an accuracy of approximately 90% with fewer runs.

3. Play with your robot using the AI model

In steps 1 and 2, you collected data and used it to train an AI model. Now the AI can finally be put to the test! On the play screen, perform the poses or sounds that you assigned to the various actions to give commands to your robot. It's as easy as that!



Pose mode

When a pose from the AI model is detected, the associated action on the left side of the screen will turn green. The robot will perform the action for as long as you hold the pose.

TIP

IF YOUR POSES ARE NOT BEING ACCURATELY RECOGNIZED, REVIEW THE TIPS FOR SUCCESSFUL DATA COLLECTION IN POSE MODE ON PAGE 49.

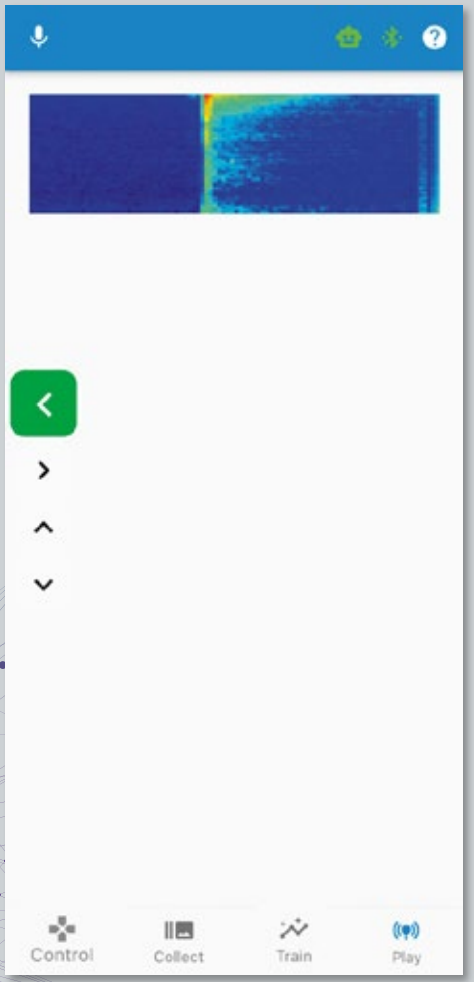
Experiment:
How well does my AI model work?

Ask another person to step in and perform the poses that your AI learned. Does the robot still perform the same actions? Try changing some of the conditions. For example, try changing the lighting, standing in front of a different background, or putting on a different shirt. What happens?

NOTE: For this experiment, it is best to use a well-functioning AI model.

Audio mode

When a sound from the AI model is detected, the associated action on the left side of the screen will turn green. The robot will perform the action for as long as you are making the sound. In audio mode, there is no stop action. The robot will automatically stop if no sound is detected.



TIP

IF YOUR SOUNDS ARE NOT BEING ACCURATELY RECOGNIZED, REVIEW THE TIPS FOR SUCCESSFUL DATA COLLECTION IN AUDIO MODE ON PAGE 51.

Privacy and the KAI Robotics app

You have likely heard the phrase **data protection**, but why is it so important, and what exactly should be protected when it comes to our privacy? Data is anything that can be processed by a computer. We are constantly producing data, whether we are on the phone, working on a computer, watching a video on a smartphone, or talking to a voice assistant. Data protection is determining what data is stored by whom and for what purpose, as it would be detrimental for someone's personal data — like their address, telephone number, pictures, or messages — to end up on the Internet and be freely accessible to everyone. However, many companies would also like to access your data for business purposes. For example, by finding out what interests you, businesses can show you advertisements that are tailored to your personal preferences.

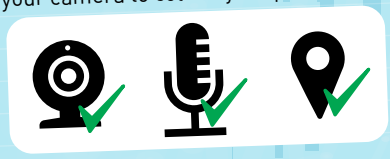
What happens to my data in the KAI Robotics app?

We have developed the KAI Robotics app to keep your data as safe as possible. The best way to protect data is to produce as little data as possible. The data samples you collect with the camera and microphone are not saved by the app as photos or audio files, as the AI only pulls abstract **metadata** (data that describes other data) from your samples. This means the data saved is not recognizable as the actual image or sound. As a result, third parties, which include strangers and businesses, cannot determine anything about you from it.

The second best way to keep your data safe is to keep it off the Internet, which is exactly what the KAI Robotics app does. The app works completely offline, meaning that all calculations are made locally on your device.

WHAT PERMISSIONS DO I NEED TO GIVE THE APP?

- **Data protection declaration**: A data protection declaration is mandatory for every app. It explains what exactly happens to your data.
- **Camera**: The first time you tap on the collect button at the bottom of the screen, you must agree to allow the to app access to your camera. Otherwise the app will be unable to use your camera to collect your poses.
- **Microphone**: When you switch to audio mode for the first time, you must agree to allow the app to access your microphone. Otherwise the app will be unable to use your microphone to collect your sounds.
- **Location**: If an app uses Bluetooth, you must agree to share your location. This allows your device to share where it is geographically located, which then enables it to find Bluetooth devices within its range. **NOTE**: The app does not collect any location data.



IS MY SMARTPHONE / TABLET COMPATIBLE WITH THE APP?

All calculations are made locally on your smart device. However this can be quite demanding. As a result, the AI controls may not run as smoothly on older devices or devices with weaker hardware as they would on a device with more state-of-the-art technology. You can find out which devices we tested as well as additional information regarding compatibility by scanning the following QR code:

DOES THE KAI ROBOTICS APP COLLECT ANY DATA AT ALL?

The app only collects data if you agree to send us **crash data.** This means that, should the app crash, the app will send a data package to us that helps us find the cause of the malfunction. This enables us to make any necessary changes and improvements to the app. However, please keep in mind that this data will not contain any personal data that would allow us to identify you or make conclusions about you. At the end of the data protection declaration, there is an option to switch this function on and off. If you wish to know exactly what data is collected, details can be found in the data protection declaration of the app.

CHECK IT OUT

How do we know if something is AI?

How can you distinguish between AI applications and non-AI applications? It's actually not that easy. Since permanently programmed processes (called algorithms) can be assigned to an AI, they can often seem similar. The main difference is that an AI is based on learning instead of rigid algorithms. This is the case with your AI Robot. Prior to teaching the system to understand your poses and/or sounds, it wasn't able to do anything with them. The technical term for this is **machine learning,** one of the most important subfields of artificial intelligence.

CAN AN AI LEARN ON ITS OWN?

Your AI Robot's system is intelligent, meaning it can, at best, understand your poses or sounds even if they differ slightly from what you showed the system when collecting data. But an AI always needs to practice with data. The more data it has, the better the AI can learn from it. However, as a rule, the data has to originate from something external. In the case of your AI Robot, the data comes from a human.

Every time you perform a pose, while it may seem exactly the same, it tends to differ slightly in the small details. The AI must learn to recognize the pose despite these small differences.

DO WE EXPERIENCE AI IN EVERYDAY LIFE?

Artificial intelligence has been in our lives for some time. Here are some everyday examples that are performed by AI:

1. Internet search engines: Without AI, it would be impossible for search engines to understand and scour the vastness of the Internet in order to produce accurate results in mere seconds.

2. Electronic translators: AI allows translation tools not only to translate individual words into any language, but they can even translate entire sentences and apply proper grammar. With input from humans, the results keep getting better and more accurate.

3. Recommendation systems: Whether for products, services, news, and even the movies and TV we watch, we are offered content almost everywhere on the Internet that is tailored to our preferences. This is an example of AI that makes offerings based on the information it learns from our previous searches and clicks.

4. Navigation: Modern navigation systems using AI are not only able to find the shortest route from your starting point to your destination, but they can also determine the fastest route by taking into account real-time data such as roadwork and traffic.

5. Facial recognition: Unlocking your smart device by having the camera recognize your face works essentially the same way as pose recognition in the KAI Robotics app. Facial recognition can also be used by governments to monitor the population.

6. Email filter: Unfortunately, email is a popular method of communication that dishonest people use to commit fraud and steal money from innocent people. AI filters recognize these fraudulent emails and sort them out of our inboxes so they are flagged and filtered out before they reach us.

Just how intelligent are AI SYSTEMS ?

Go (shown above) and chess are very complex games with very clear and finite rules. These are conditions under which AI thrives.

Can machines act independently? Can they learn from experience like R2D2 from Star Wars? Is artificial intelligence superior to us? Should we be afraid of a superintelligence that will overthrow humanity?

No! Machines with intellects superior to that of humans will likely not exist any time soon. AI systems can only be trained for very specific tasks, and only in that particular way are they superior to the human brain. But this superiority only applies to pattern recognition in tasks with very large data sets, or when there are clearly defined rules, such as in abstract strategy games like **chess** and **Go**. Humans are capable of a much wider range of skills.

CHECK IT OUT

In general, AI can be divided into two groups: strong and weak. A **strong AI** is human-like in that it can learn independently and adapt to new situations, even being able to learn from experience. A **weak AI** supports humans in individual, specific activities.

Let's take an example of an AI that can examine thousands upon thousands of X-ray images for abnormalities without getting tired. We would consider this a weak AI because, while it is looking at the different X-rays, it isn't taking the vast amount of knowledge from looking at X-rays to develop new insights or experience, skills that humans are capable of.

Weak AI systems are already widespread, while strong AIs are, as of 2023, only theoretical, with research and development currently underway in 37 countries and counting.

Tricked

Look at the exchange below and try to guess if person 1 is speaking with another person or a chatbot.

Person 1: I'm hungry.

Answer: Is there anything to eat or is it time to get creative?

Person 1: No, there is nothing there.

Answer: I hope you will be able to eat something good soon.

Person 1: What would you like to eat?

Answer: Hm, let me think for a moment.

Person 1 is speaking with a chatbot. If you guessed correctly, it means the chatbot did not pass the **Turing Test.** Most chatbots can be debunked by replying with the phrase "I hope you will be able to eat something good soon." A human would probably react very differently.

THE TURING TEST

In 1950, cryptanalyst Alan Turing famously asked the question: **Can machines think?** The Turing Test, also known as the Imitation Game, showed that it is not always possible to distinguish whether a certain task was carried out by a human or a machine. This approach is still used today in order to test how well an intelligent machine can simulate human work. If a user is not able to distinguish whether the action was performed by a human or a machine, the machine passes the Turing Test.

CONVERSATIONS WITH AN AI

The computer program ELIZA is considered the first **chatbot** in history. First developed in 1966 by Joseph Weizenbaum, the program simulates a psychotherapist with whom you can communicate as a patient. However, ELIZA would not have passed the Turing Test because a patient would quickly discover that they weren't dealing with a real human being.

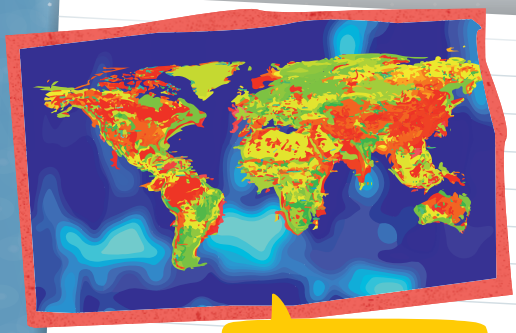
Sleeping while driving may be a reality soon, thanks to AI!

What does the future hold?

Machines and computers like when thing are clear and structured. It's no wonder, since computer language basically consists of zeros and ones. But the real world is complex, unclear, and unstructured. Real-world complexity is often what causes today's AI systems to fail.

A good example of this is self-driving cars, which have been the subject of intensive research for a long time. A self-driving car can manage well on freeways, which have long, straight stretches and clear lane markings. But the real challenge begins as things get more complex. For example, can an AI understand that when a ball rolls onto the street, a child could run after it? How does the system orientate itself when there are no lane markings? What if the cameras can't read road signs because they're dirty or there is limited visibility? When an accident cannot be avoided, and the only options are hitting a school bus or swerving into a tree, how would an AI make the decision between them?

All of these questions must be answered, and all of these obstacles overcome, before cars can drive without any human control. But in spite of all of these variables, self-driving cars may be on the road very soon.



Can AI help us combat climate change?

And AI can do much more! Computers will soon make it possible to simulate very complex systems. This will allow weather forecasts to become more accurate, and it can help to create models that will help us predict the future course of climate change. AI systems may help to develop new medications and treatments, or help fight world hunger by optimizing agricultural processes.

WILL AI MAKE THE WORLD BETTER?

Graphical representation of a filter bubble

As with most technologies, AI is not without its downsides. For example, ubiquitous recommendation systems ensure that we only see content that reinforces our interests and opinions. This can, unfortunately, lead us to question things less frequently and become more hostile to other ideas and opinions. This effect is known as the **filter bubble** or **echo chamber.**

Like many other technologies, AI can also be misused.

Can AI be bad?

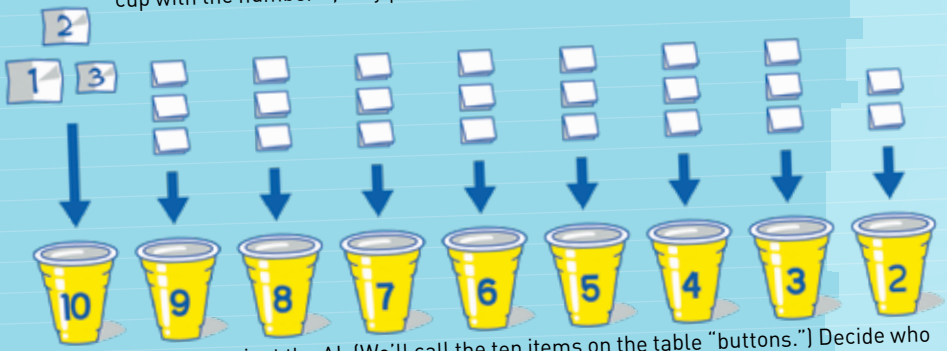
Technology doesn't know the difference between good and bad, so it is up to society to decide how a revolutionary technology like AI is developed and used. We rely on professionals and our government to determine whether regulatory interventions are necessary or if implementation should be allowed to proceed autonomously.

Right now, big tech companies like social media and streaming sites know a lot about us because we constantly produce data that they are evaluating. These corporations mainly use the collected data for commercial purposes, meaning they use it for the purpose of making money. However, when governments get access to that kind of data, or even begin collecting it themselves, there may be far-reaching consequences. For example, there are countries where you can get into trouble for expressing an opinion on the Internet that the government doesn't approve of.

CREATE YOUR OWN AI SYSTEM

You can you build your own AI to play a game called Nim, using a pen, paper, nine paper cups, and ten items (like buttons, coins, cotton balls, etc.). Train the AI by playing against it, and it will become unbeatable, and all without a computer!

Nim is an old game with countless variations. This version of the game is simple: Place the ten items in a row on the table. Two players take turns taking one, two, or three items from the table per turn. **Whoever takes the last item loses.** To get an AI version, you need nine cups in a row labeled in descending order from 10 through 2. Then cut out three small pieces of paper (that are about the same size) and write the numbers 1, 2, and 3 on them. Fold the pieces of paper and place them in the cup with the number 10. Repeat these steps for cups 9 through 3. In the last remaining cup with the number 2, only place two pieces of paper numbered 1 and 2.



Now you can play Nim against the AI. (We'll call the ten items on the table "buttons.") Decide who has the first move. On your turn, take one, two, or three buttons. Your turn is over. Now it's the AI's turn. Count the number of buttons that are left on the table and take the cup with the corresponding number. Choose any slip of paper from the cup — the number on the slip indicates the number of buttons that the AI takes away. The AI just made a decision. Your moves can be strategic, given the current standing of the game, but the AI's choices are entirely random. This makes the AI easier to beat, as the chances of pulling the exact number to lose the game are two out of five. In order to make the AI invincible, we need to train it!

TRAIN YOUR AI

Now, let the AI take the first turn. After each of the AI's turns, place the piece of paper next to the cup from which it came. When the game is over, perform the following actions, based on the outcome:

- If you lost and the AI won — fold the papers and put them back in the cups.
- If the AI lost and you won — Take the last piece of paper that was pulled from the cup out of the game and return all of the others to the cups they came from.
- If the last cup has only a single piece of paper left, return that piece of paper to the cup and discard the piece of paper from the previous turn instead. Each cup must always contain at least one piece of paper.
- **What just happened?** The AI just learned that this play was bad and, now that it has been removed, the AI will not repeat that play. Repeat this process until there is only one piece of paper left in each cup. By eliminating previous "bad plays," the AI is left with the best move from every game situation. The AI has completed its learning process and will always win, if given the first turn. If you make the first move, you'll need to be very clever to win. **Try it for yourself!**

My datasets and AI models

When you save datasets or AI models in the app, take notes here to help you remember which poses or sounds you used. This chart will help you differentiate them later on.

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

File name:

Pose mode ☐ **Audio mode** ☐

Robot action:	Pose / Sound:
Rotate left	
Rotate right	
Move forward	
Move backward	
Stop (pose only)	

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