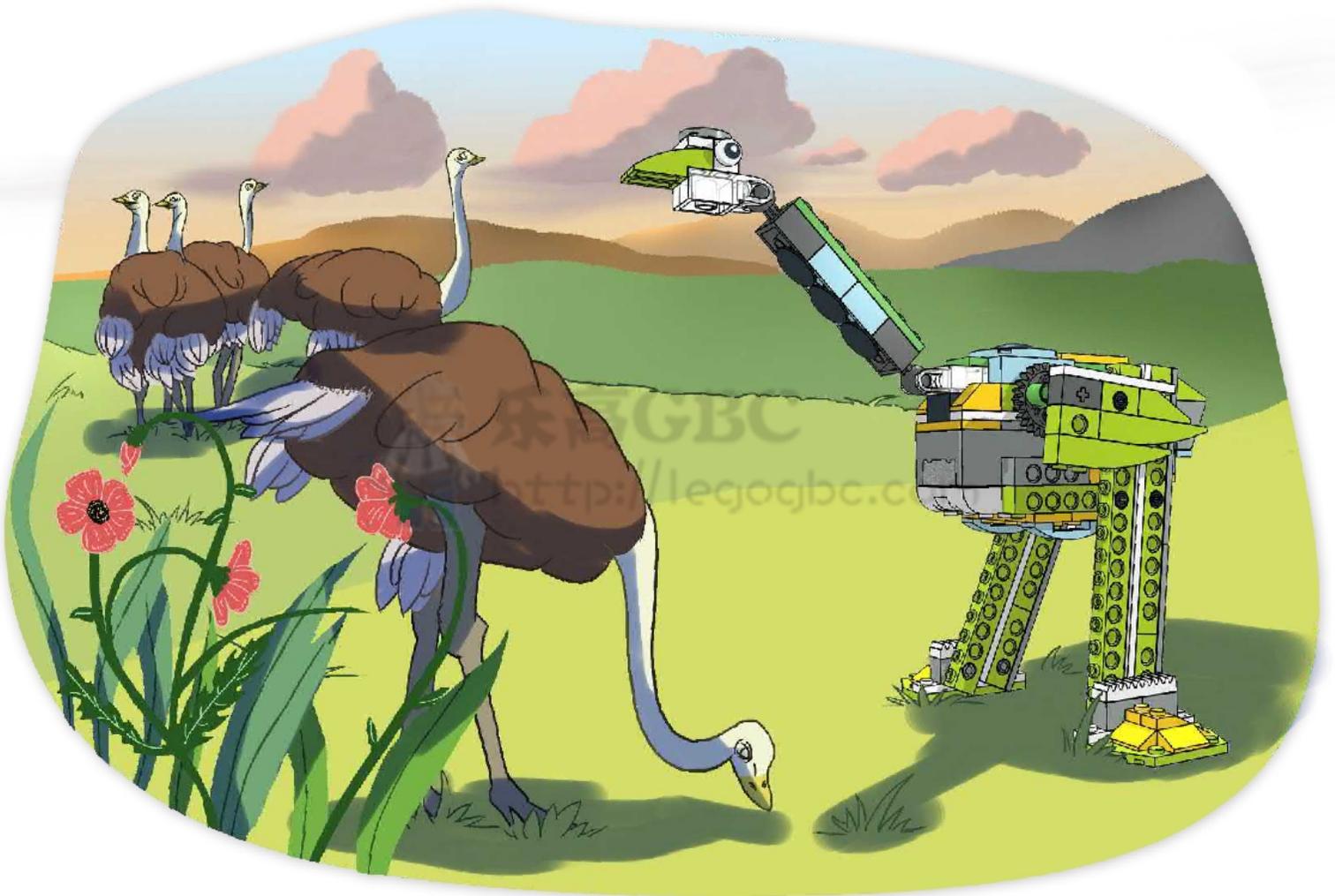


AMERICAN RHEA



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Design phase: Stable motion

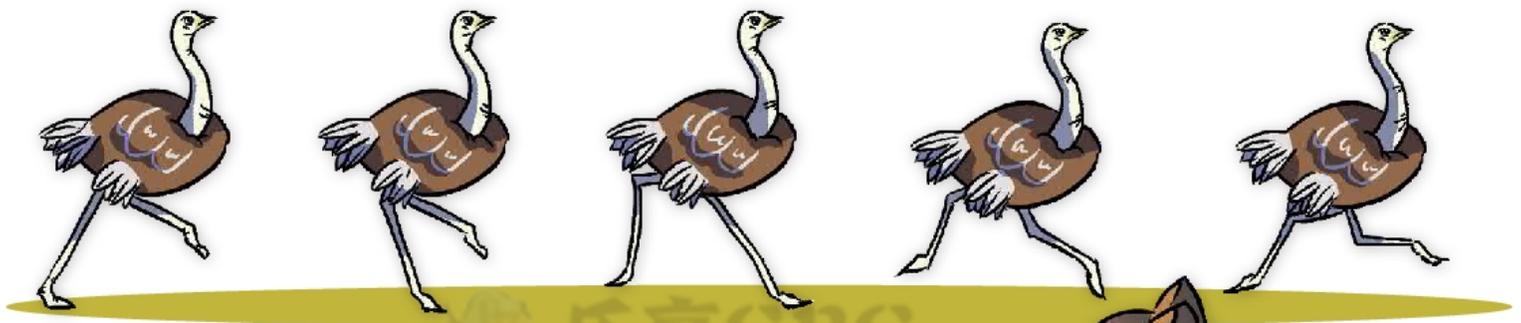


- Remember to have a **white paper** and a **pencil** to start drawing your ideas!

Looking for inspiration

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- **American rheas** are a species of flightless birds native to eastern South America.
- They are the **largest** South American **birds** and are related to **ostriches** and **emus**.
- They use their long, **powerful legs** to outrun trouble.
- Their **wings** are used to **change direction** while running, helping them to keep their balance at any moment.



Wow, American rheas are extremely fast when they run!

- On a piece of paper, you can sketch some **ideas** to replicate the American rhea's running motion!
- There is a concept that you have to keep in mind while designing a walking robot: **center of gravity**.



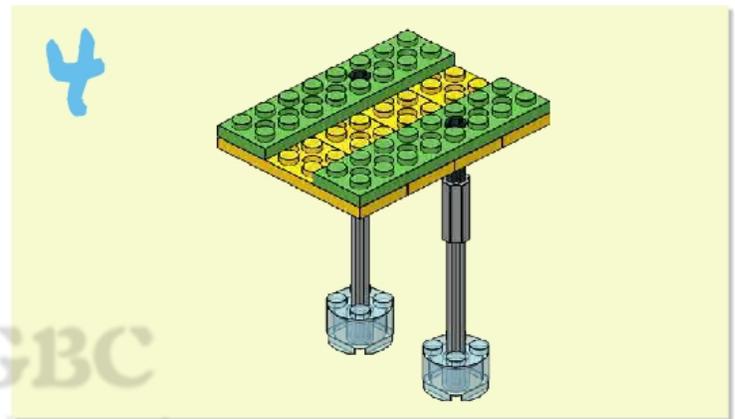
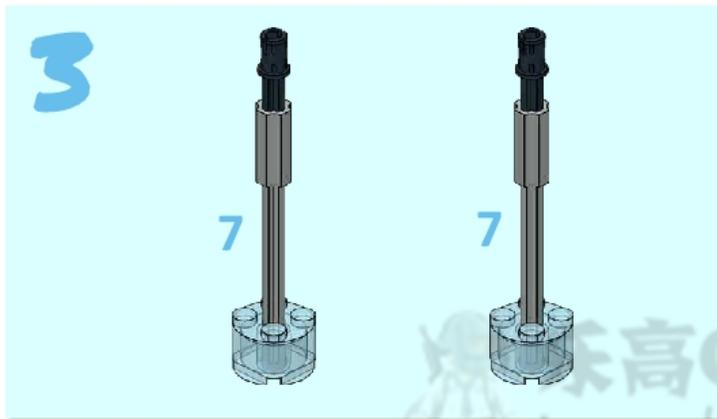
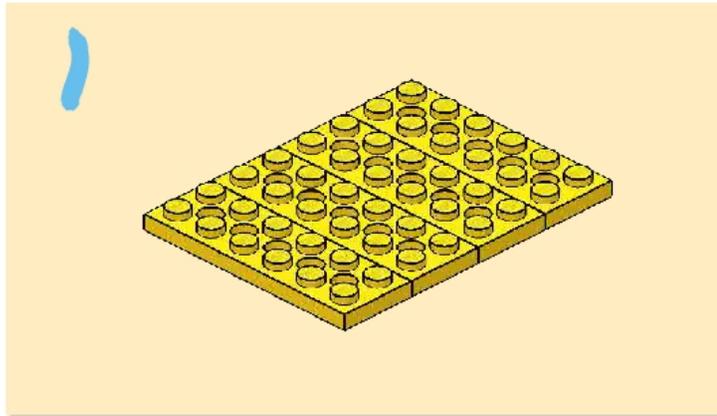
Center of gravity

- The **center of gravity** of an object is the point at which its **weight** is evenly dispersed and all sides are **in balance**.
- You can **change** your **center of gravity** if you move your body in different positions. For example, try standing using only one leg; is it more difficult to keep the balance than standing using your two legs?
- When you design a walking robot, you have to keep the concept of **center of gravity** in mind, since the legs of your robot will be moving to make it walk. At all times, your robot must keep its balance while walking to avoid falling.

Build phase: Center of gravity

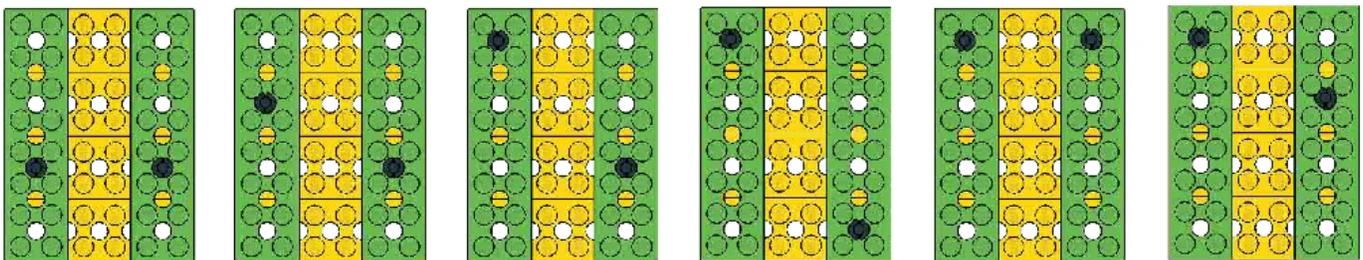


• Let's explore more the concept of the center of gravity.



Keeping the balance

- Let's see if your structure can keep its balance for different positions.
- Change the **position of the legs** as shown in the following:

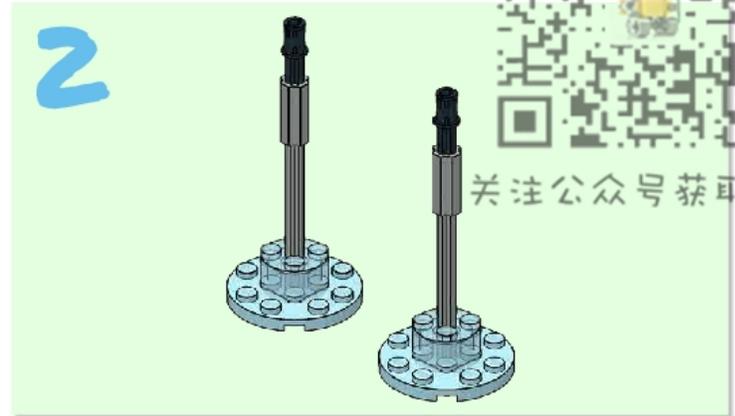
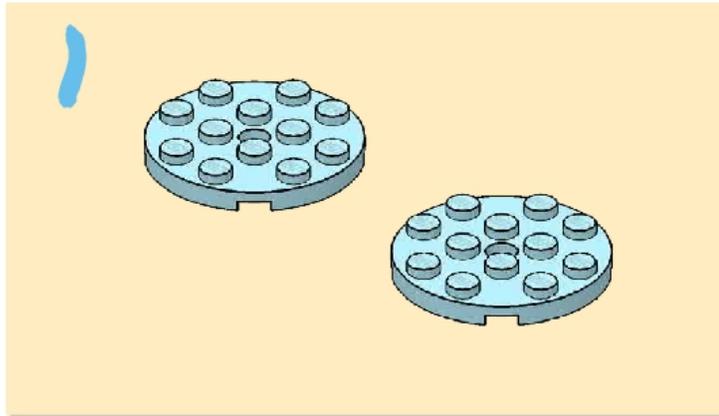


- Does it keep its balance in all **six cases**?
- Why in some cases the structure does not fall and in others it does? The answer is the **location** of the **center of gravity**.
- So, how can you solve this falling issue? Well, there are **two possible solutions**: one is modifying the body, making it smaller, and the other solution is increasing the **contact area** between the legs and the ground.

- Modify the legs to increase the **contact area** with the ground.



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Improving the stability

- Try again testing all the different positions of the legs. Does it keep falling?
- Since we have increased the **contact area** between your structure and the ground, the **center of gravity** is now always located between the legs, **avoiding falling**.

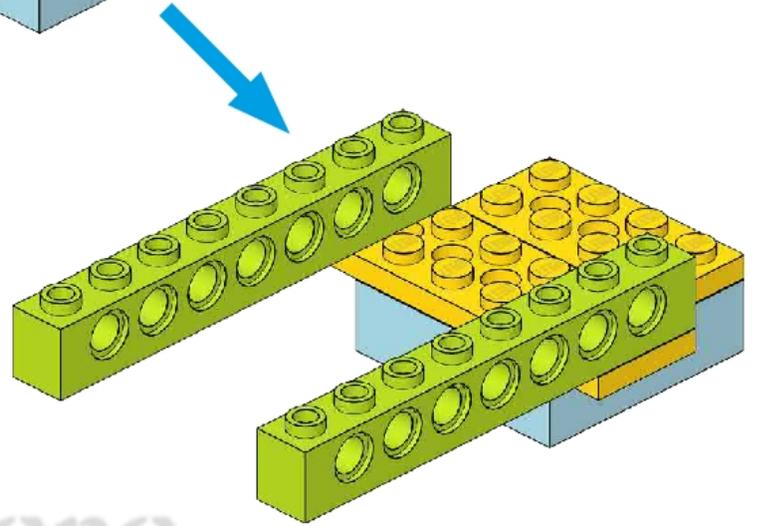
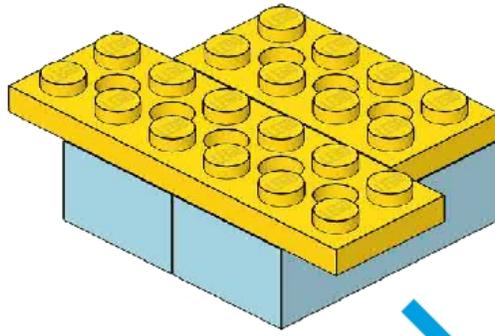
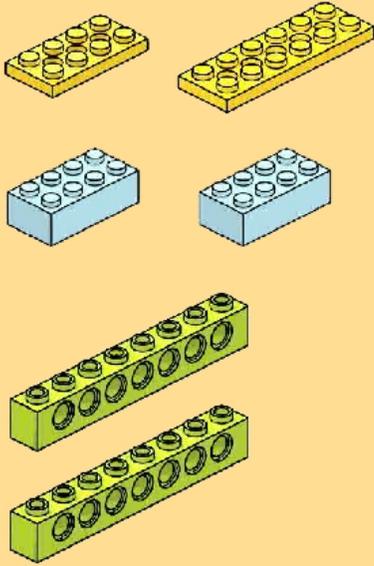
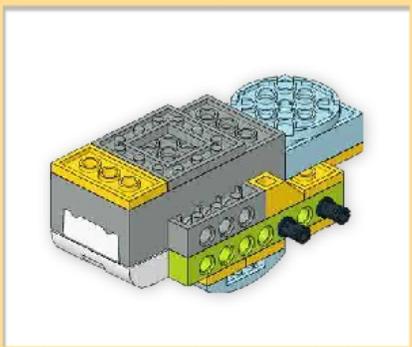


- Now you are ready to build your WeDo American rhea prototype!
- Before you start building, be sure to prepare a **suitable workspace**.
- Keep in mind that the WeDo set has small pieces, so prepare a table with enough space to easily identify all the pieces and prevent them from getting lost.

Building instructions



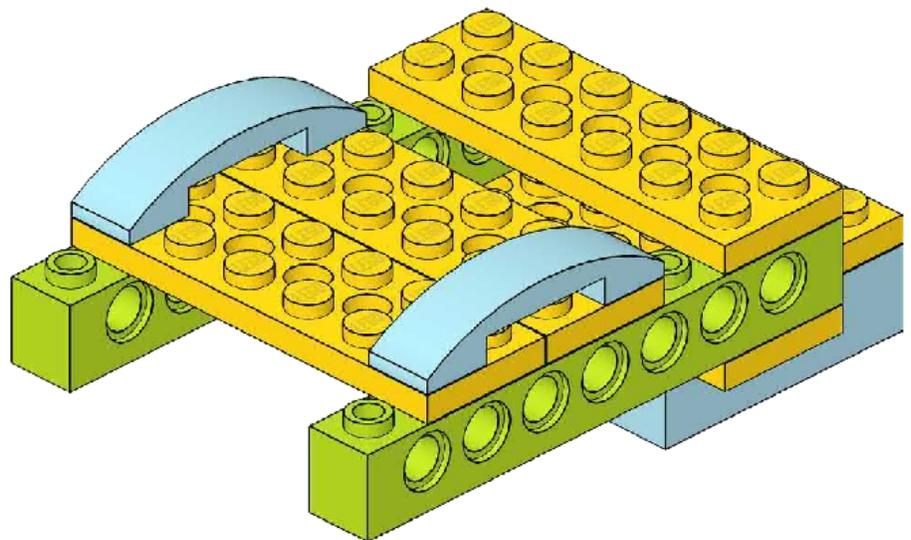
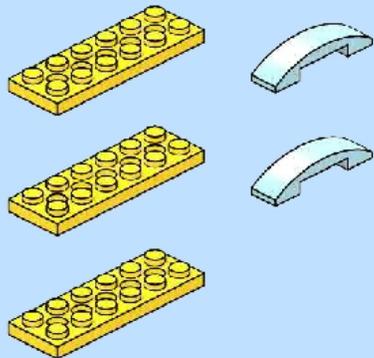
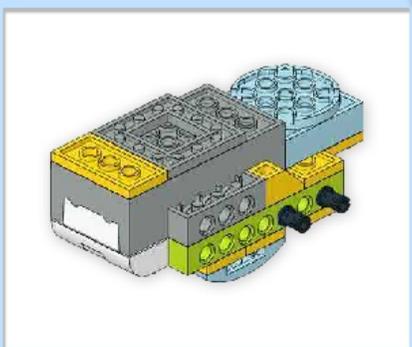
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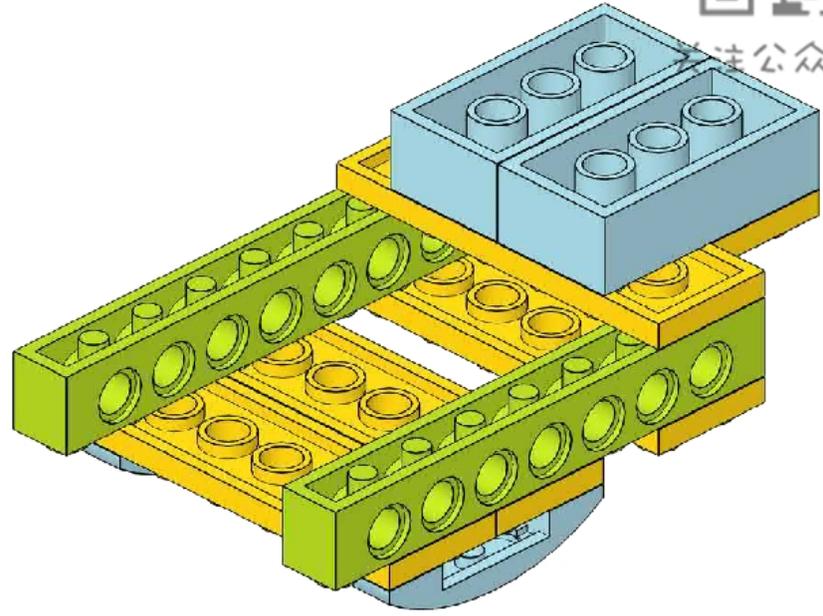
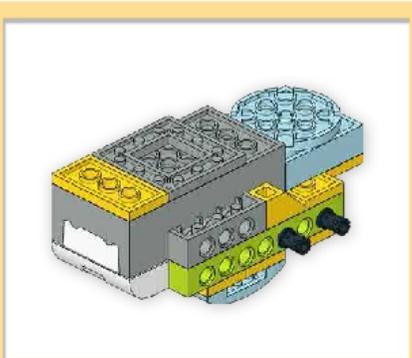
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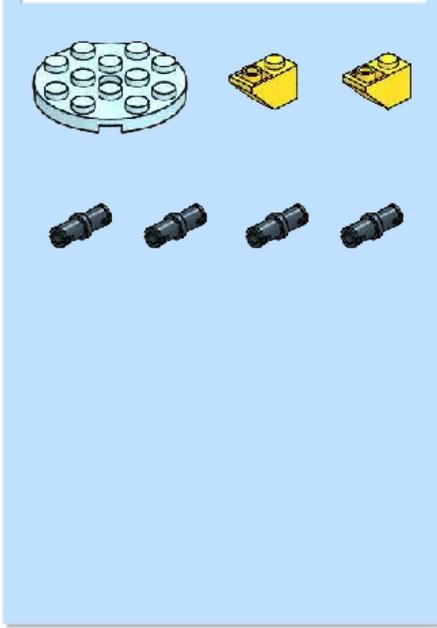
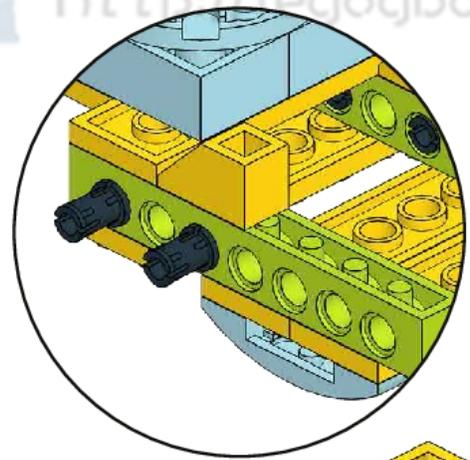
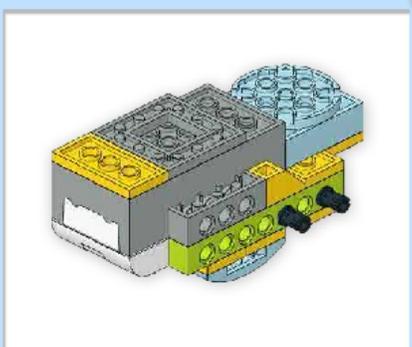
Flip your prototype upside down to have the same view.

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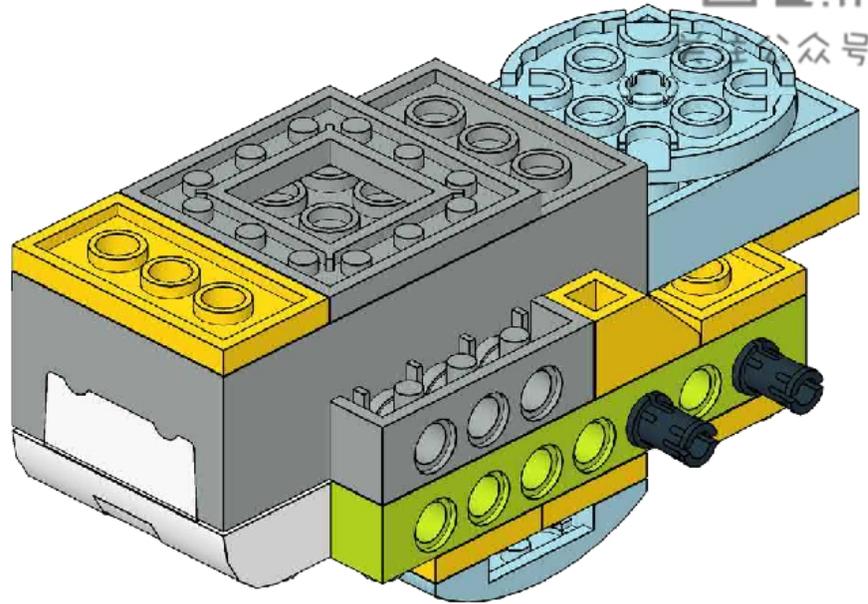
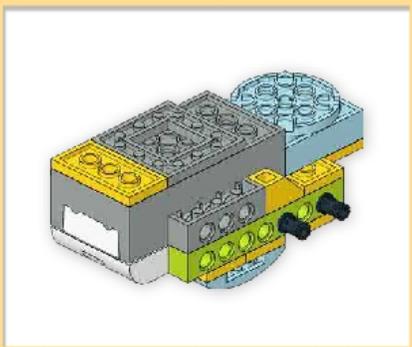
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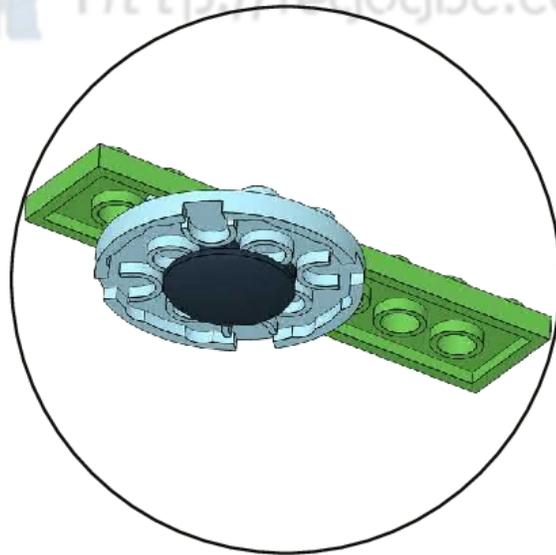
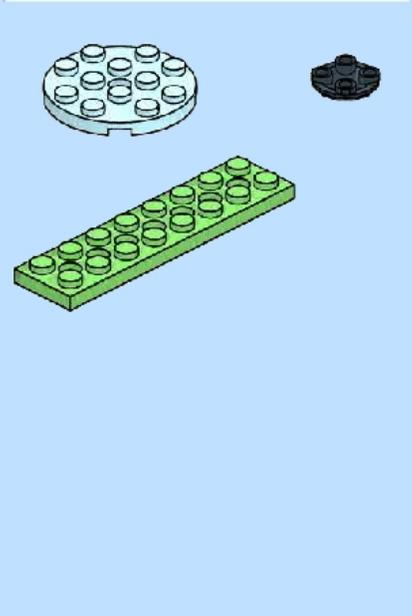
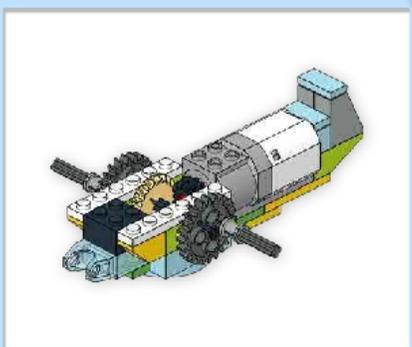


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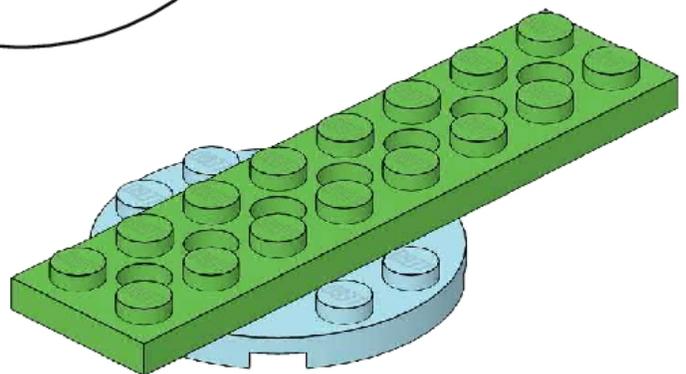


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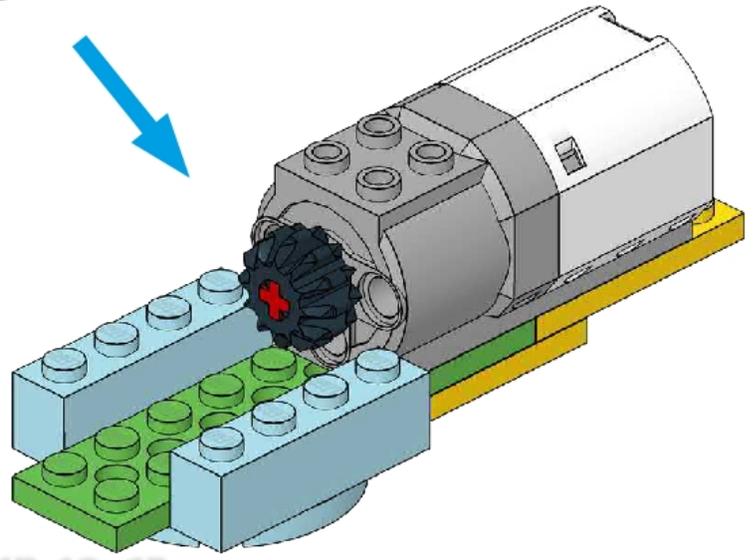
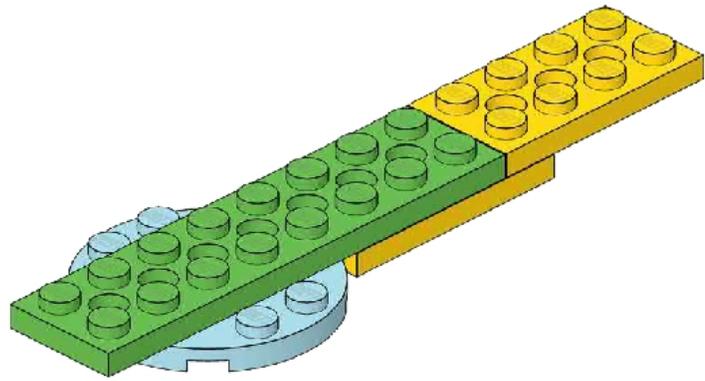
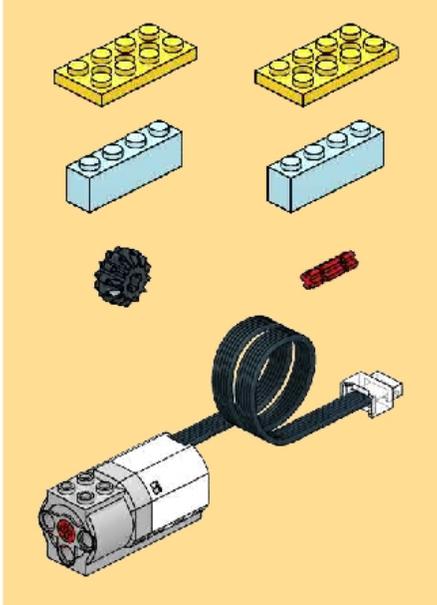
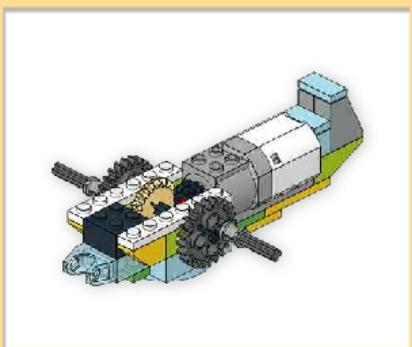


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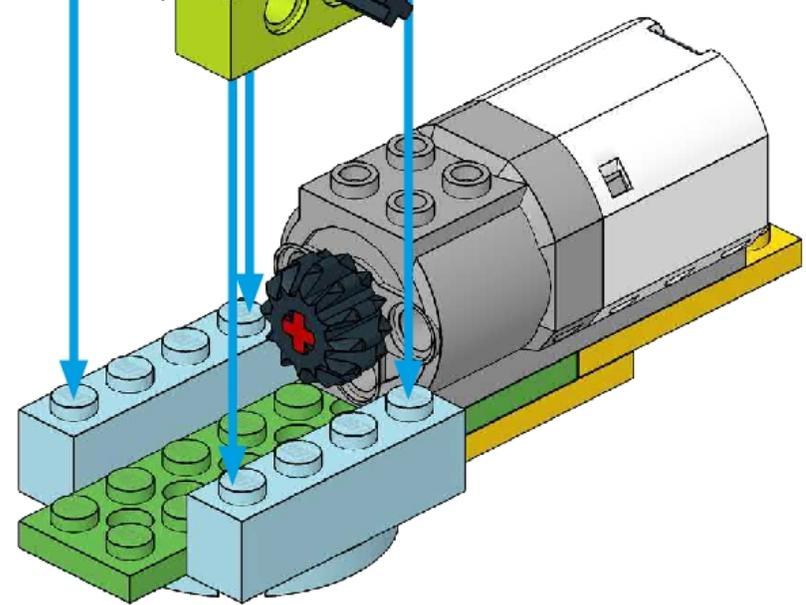
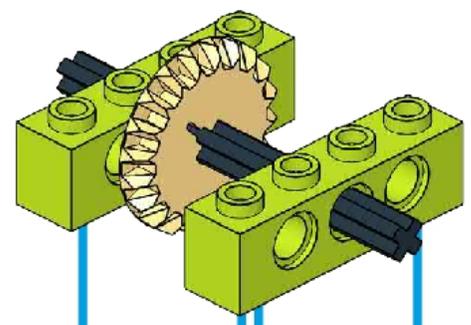
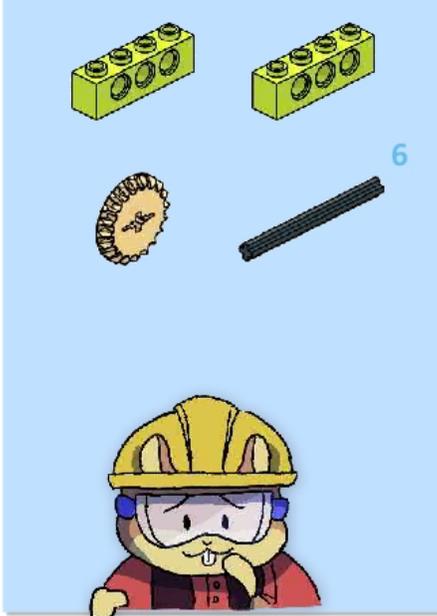
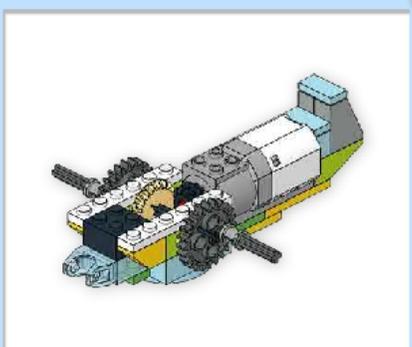
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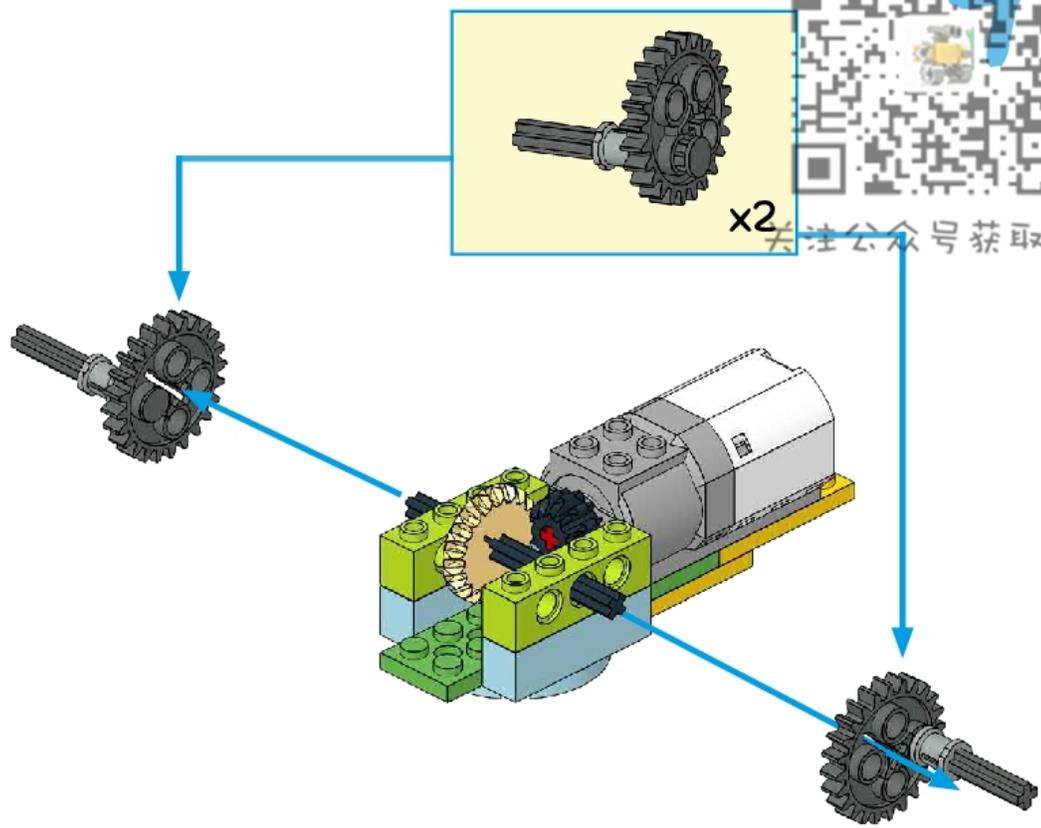
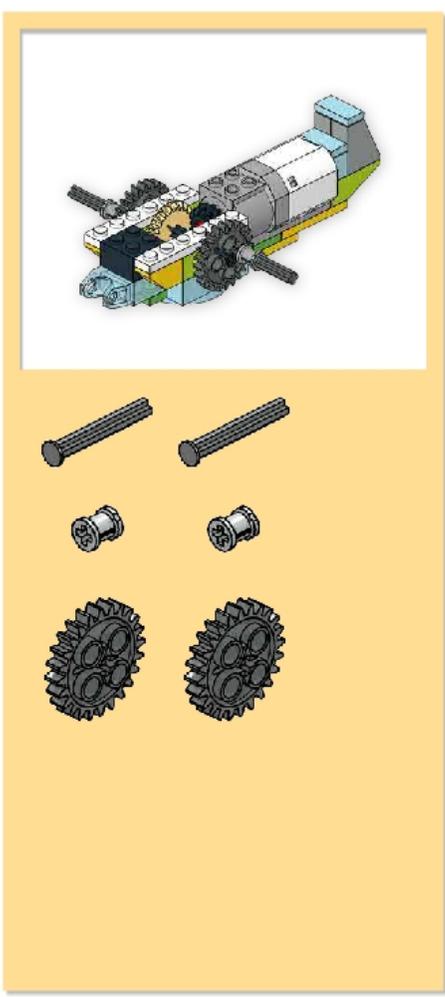
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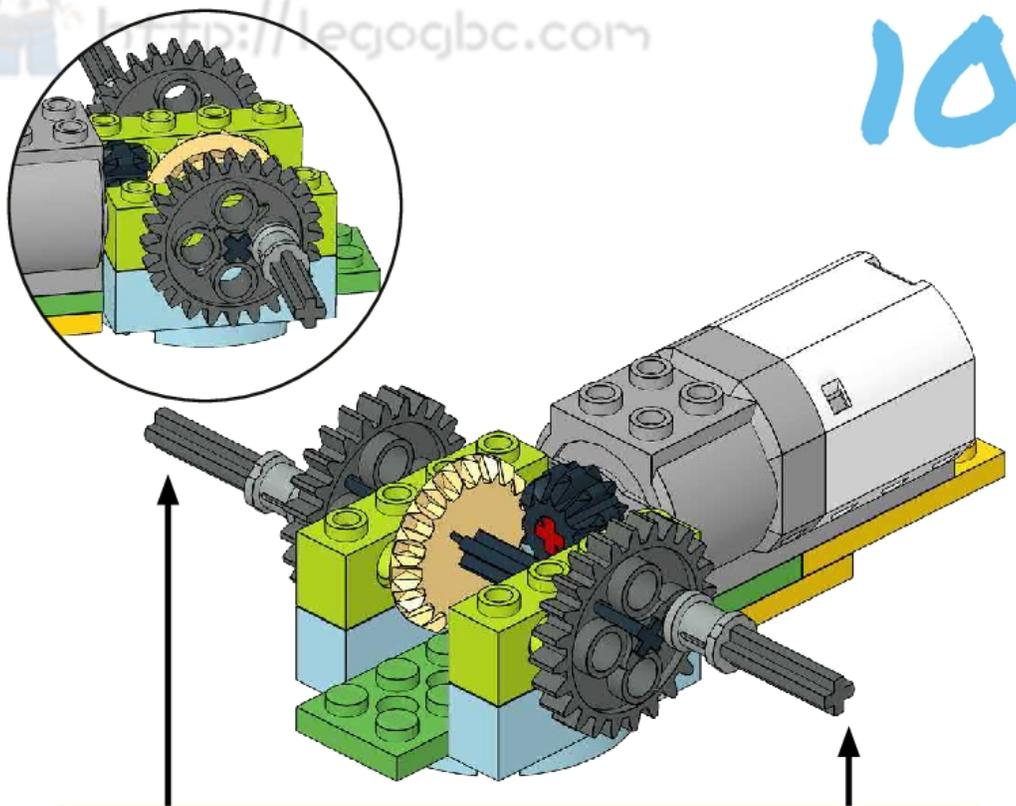


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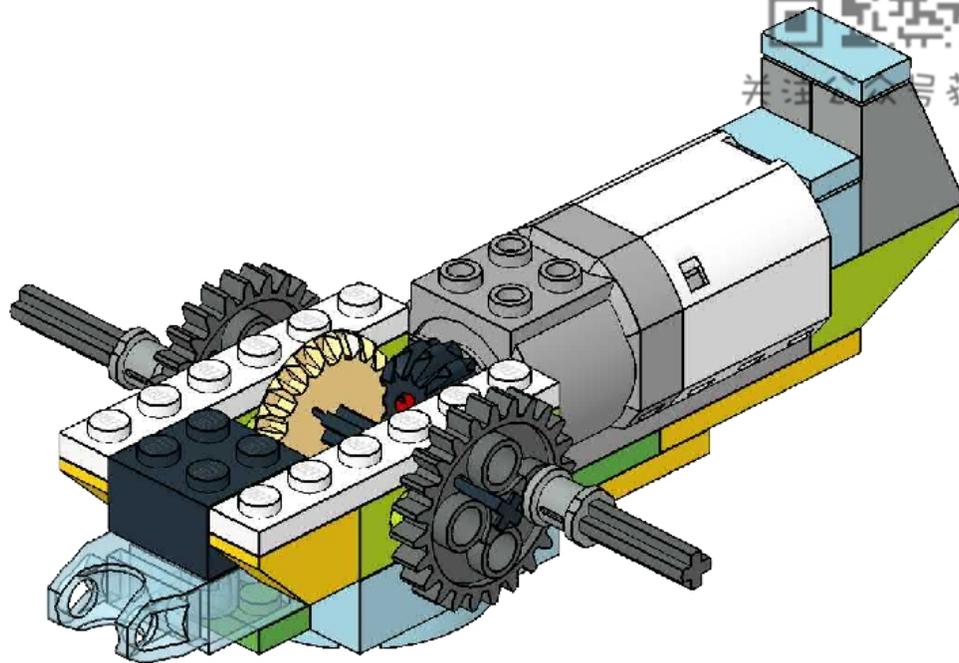
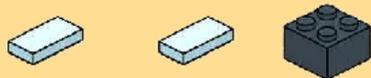
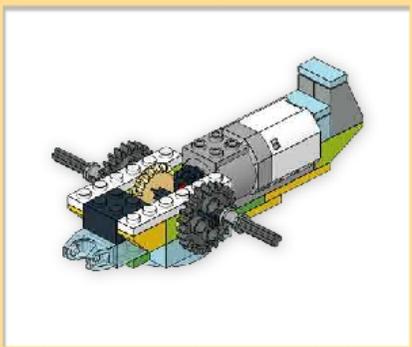
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Be careful! The American rhea uses an “out-phase” motion, which means that one of the axles is in the opposite position of the other one.

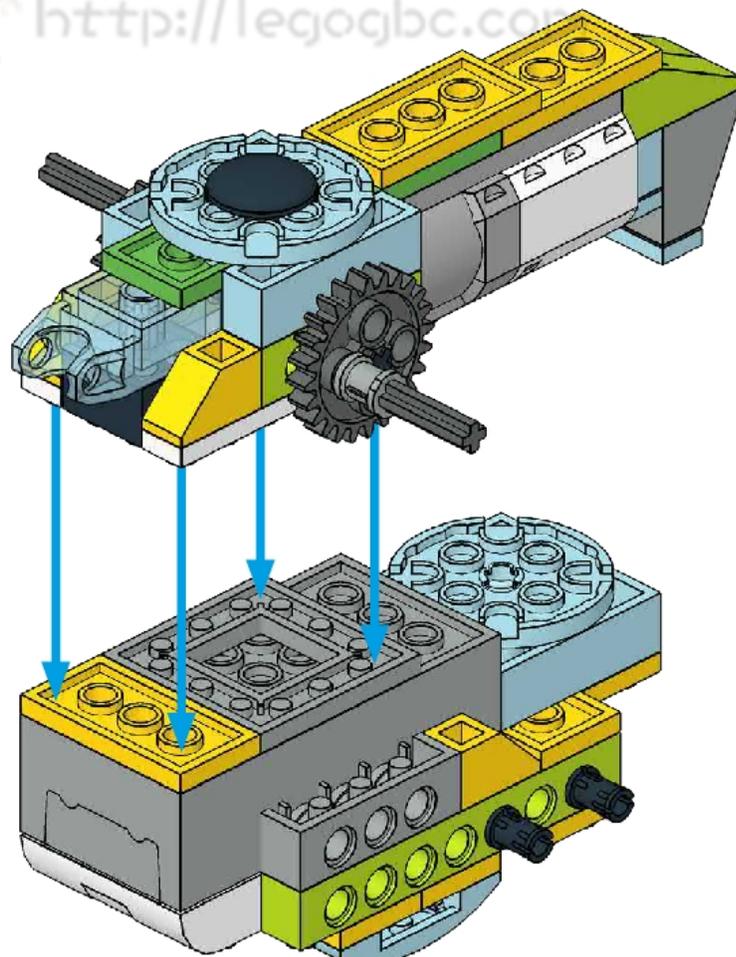
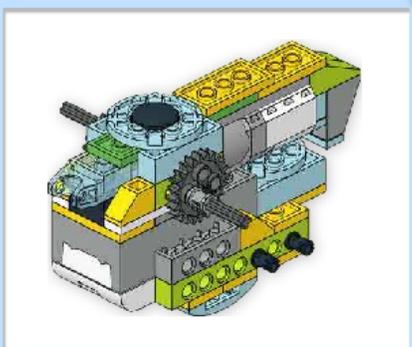


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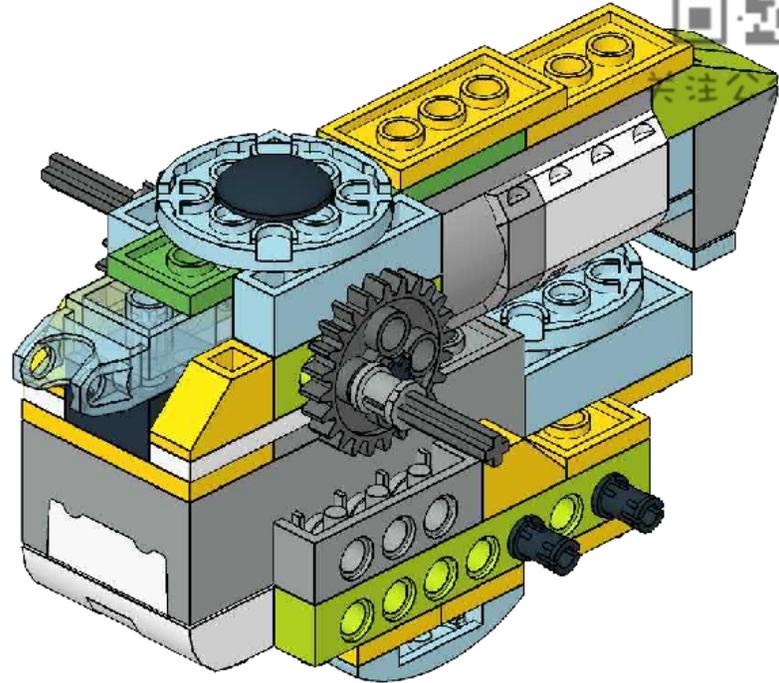
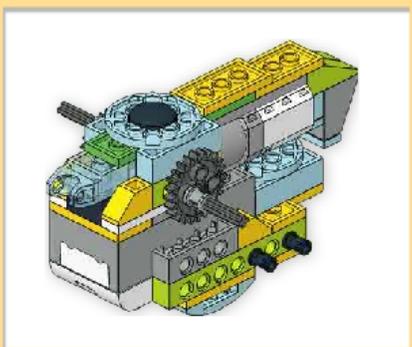


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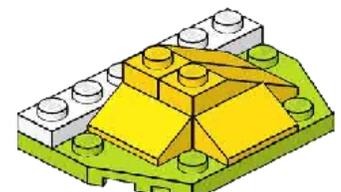
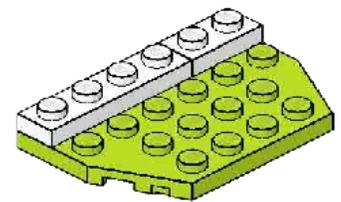
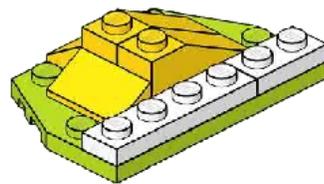
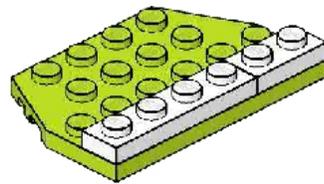
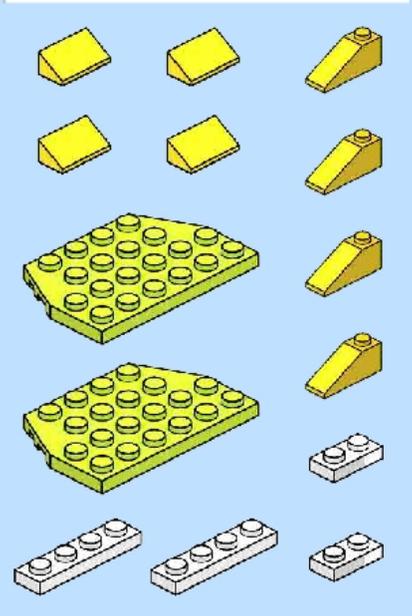
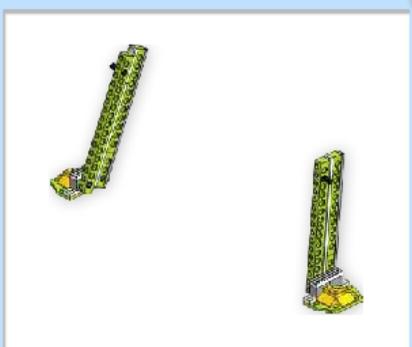
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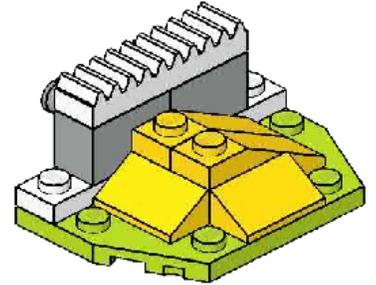
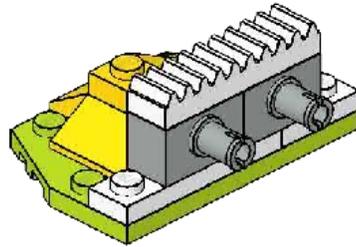
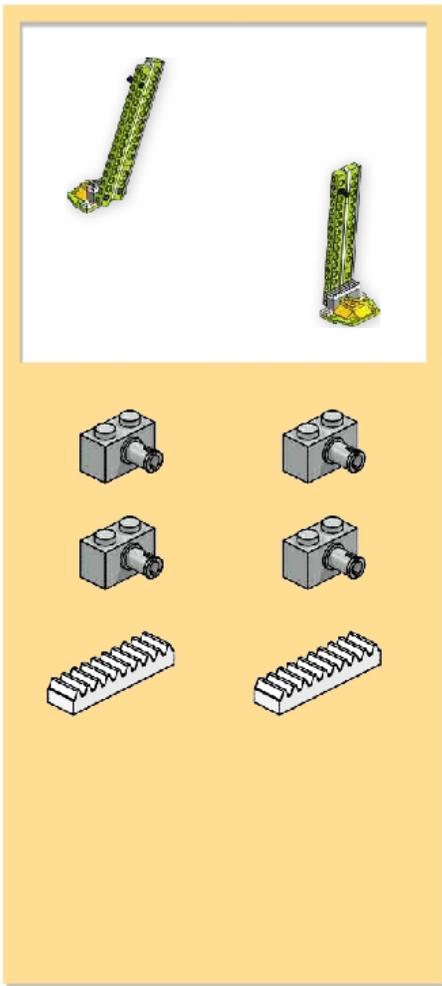
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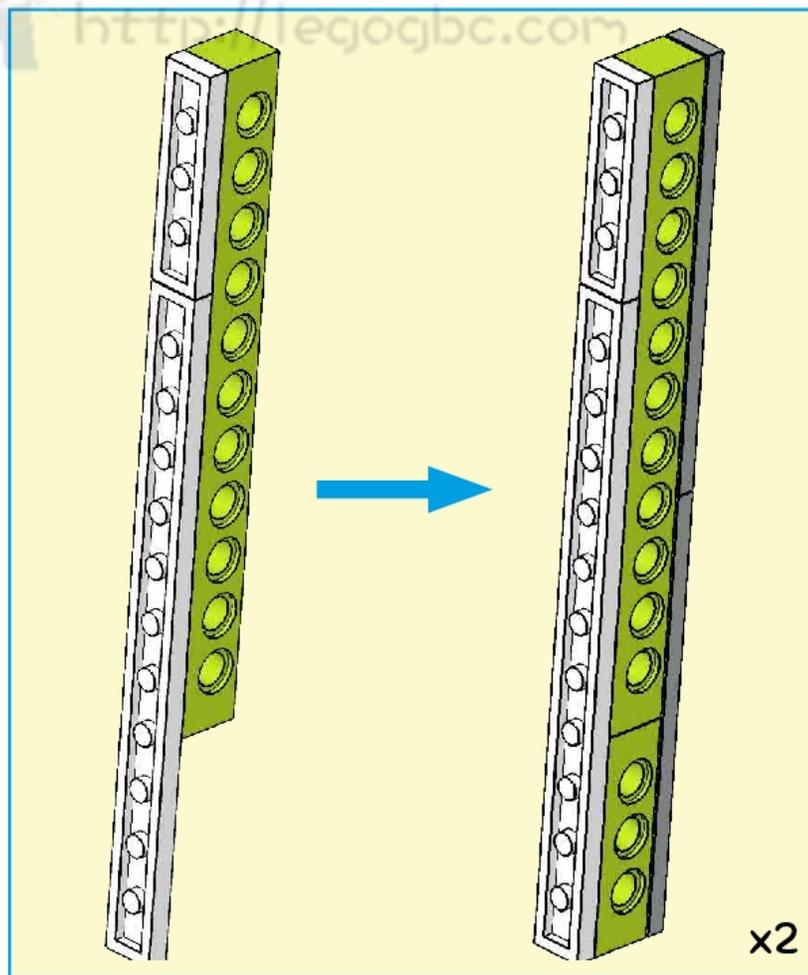
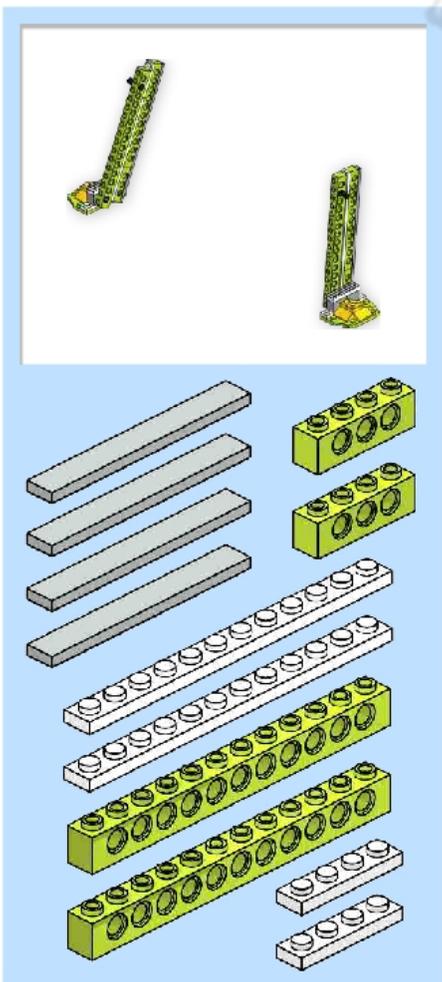




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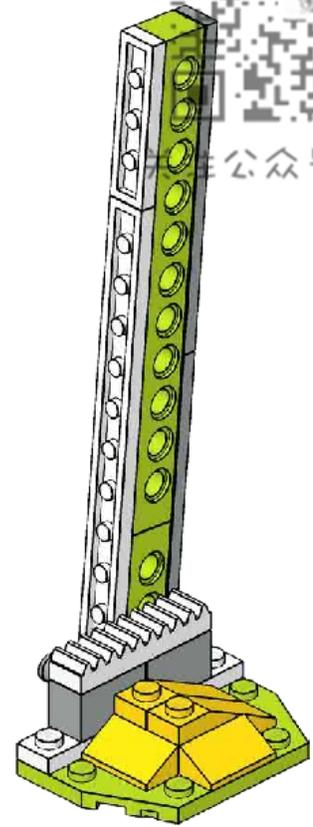
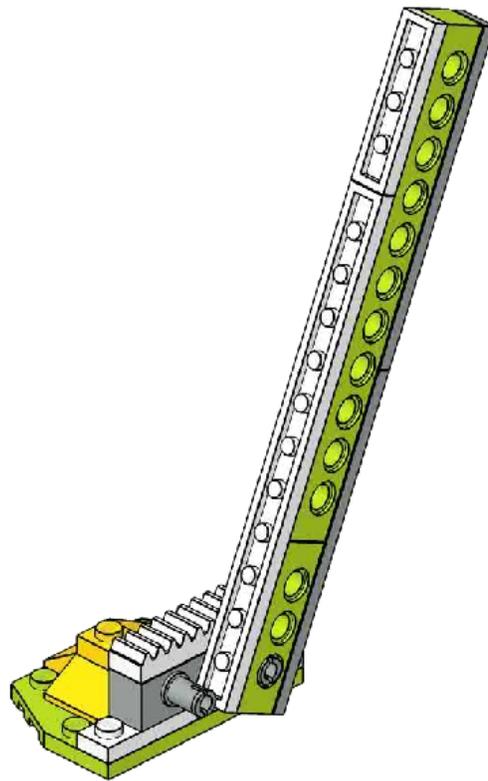
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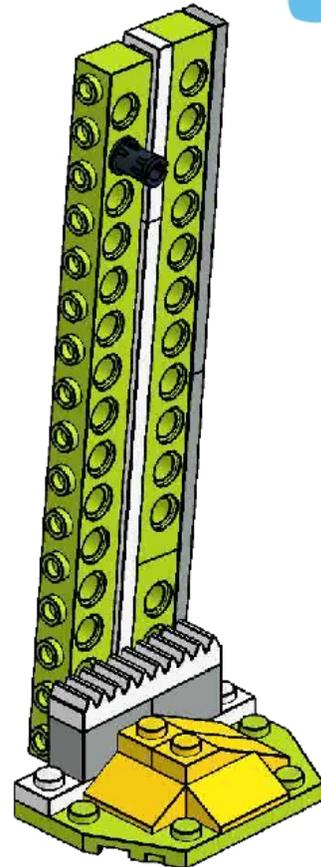
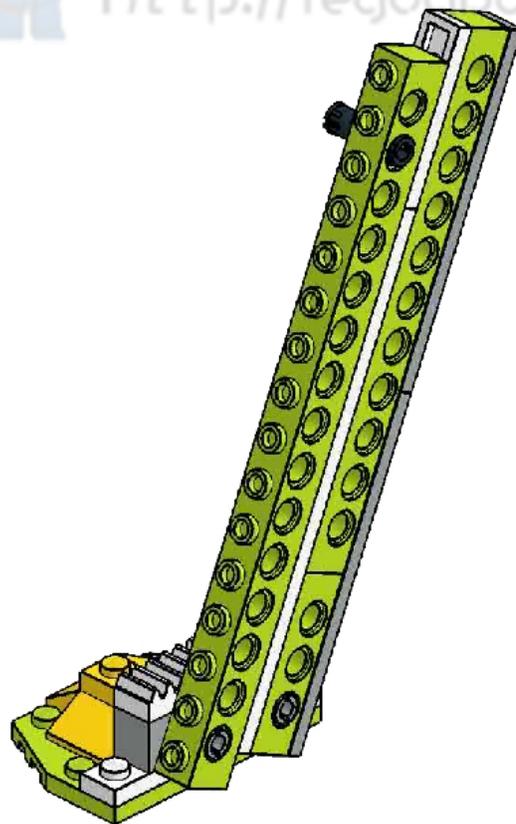
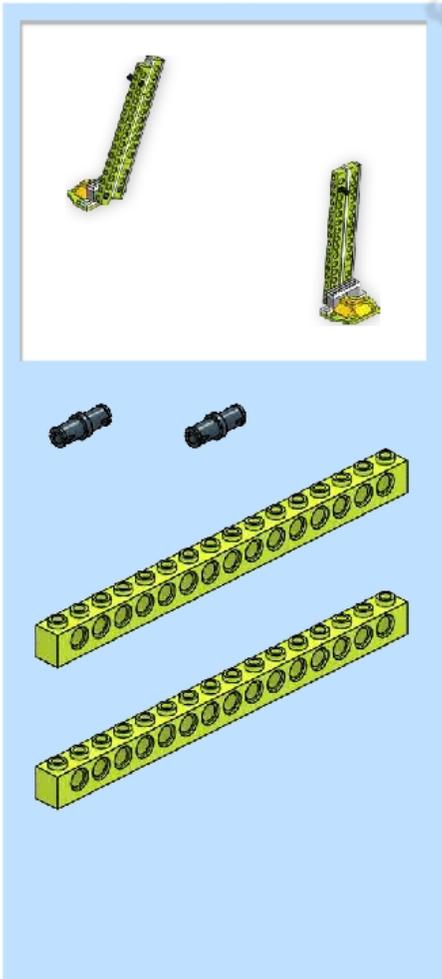
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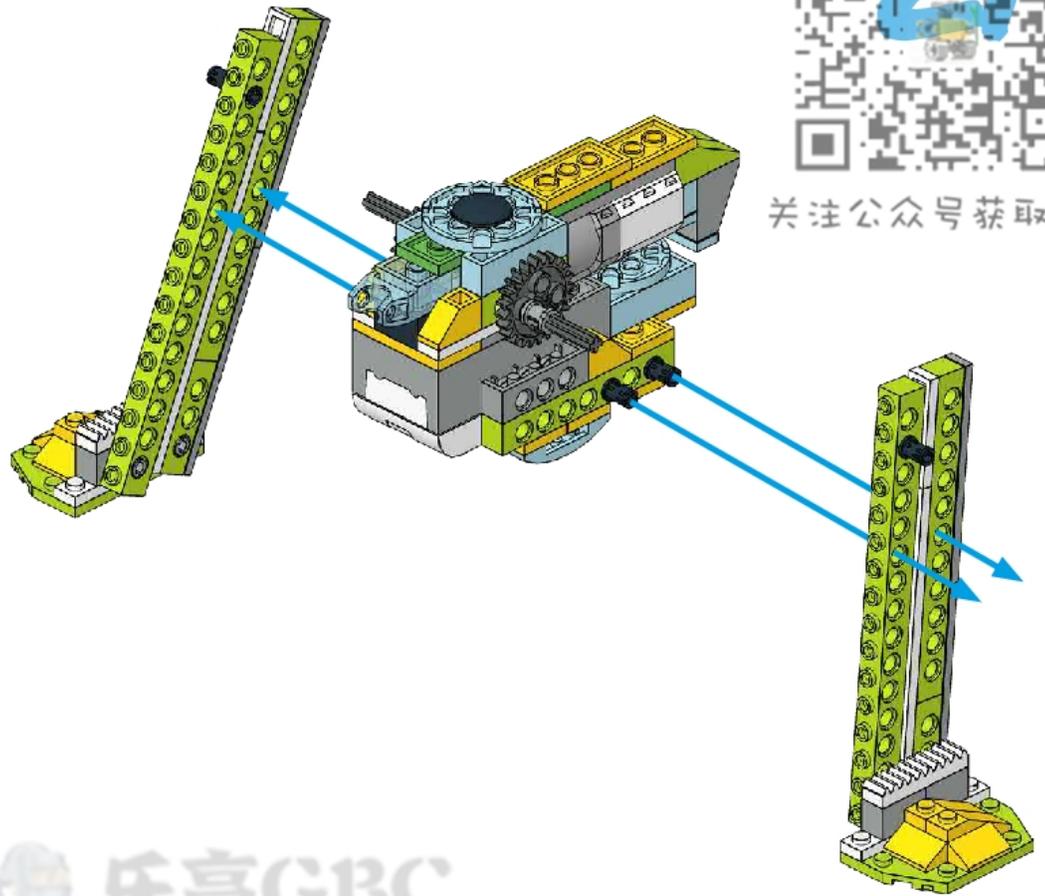
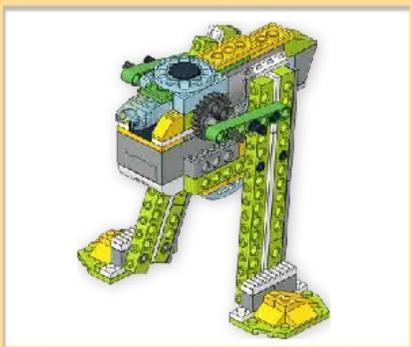
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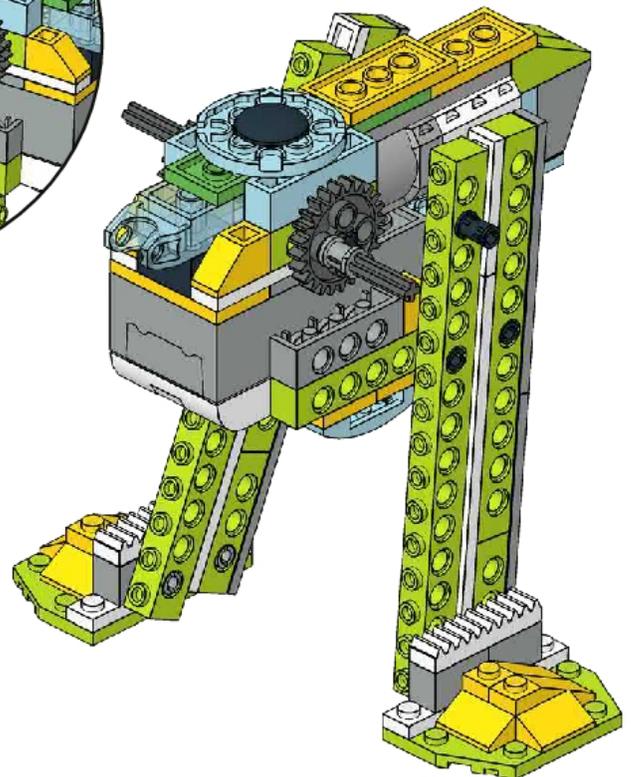
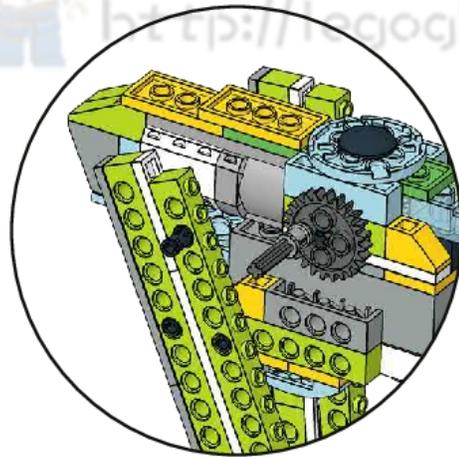
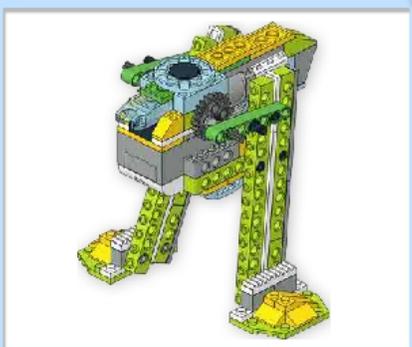
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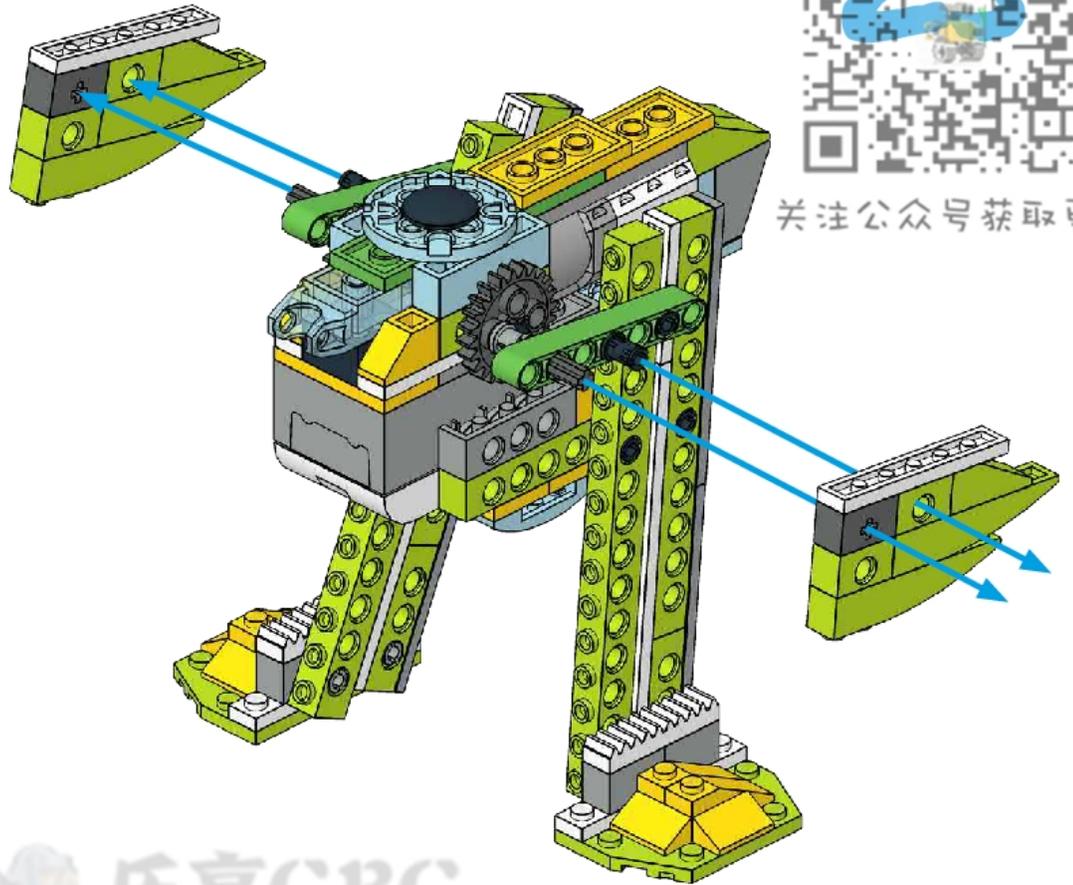
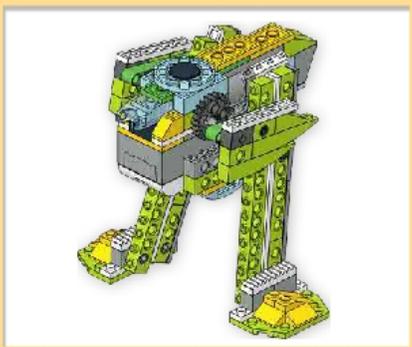
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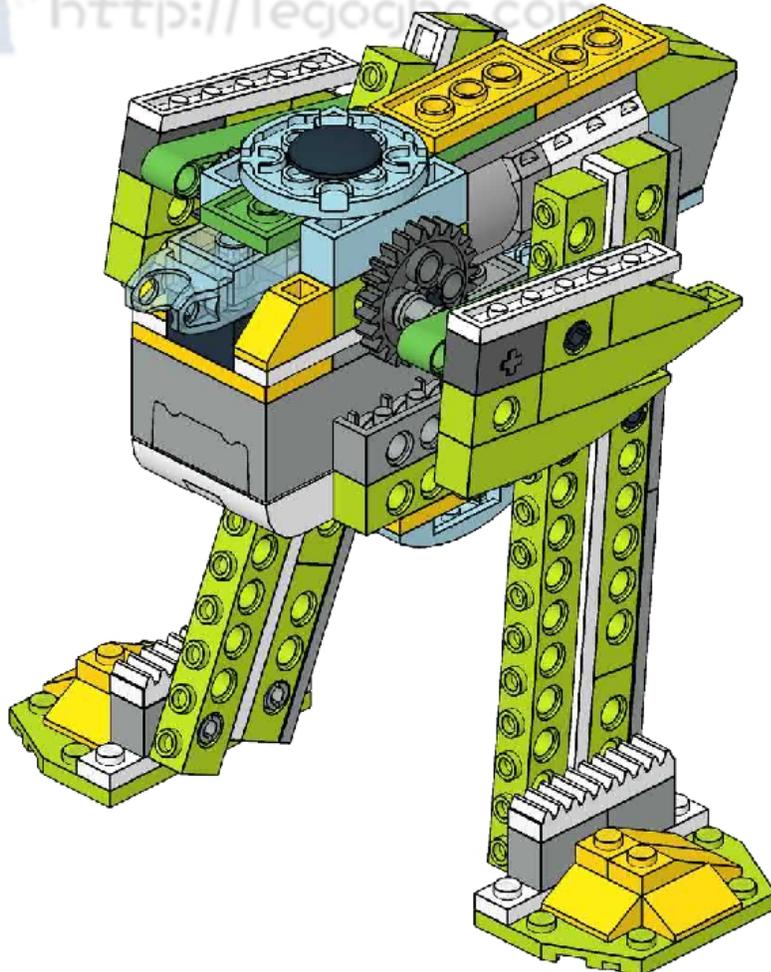
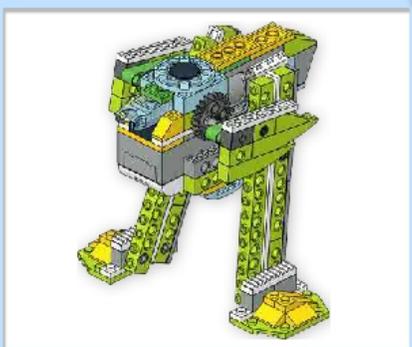
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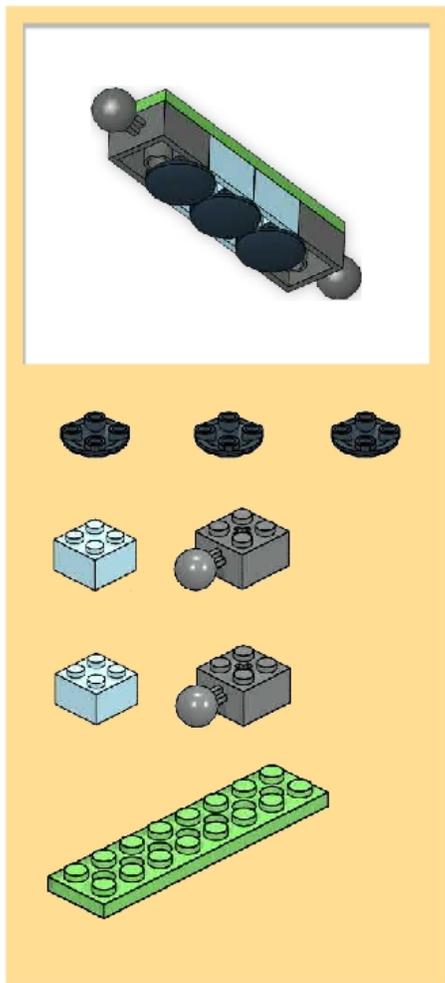
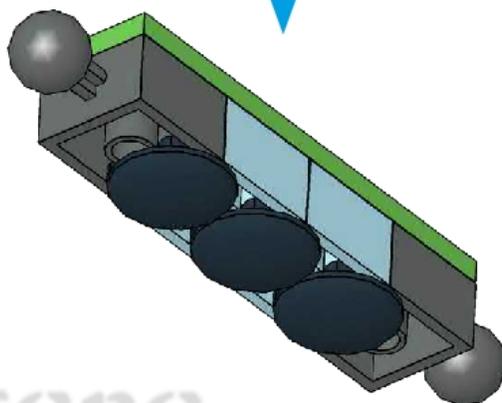
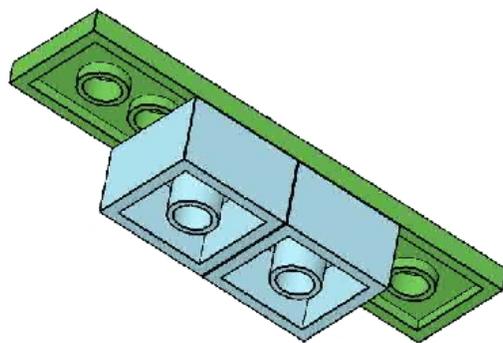
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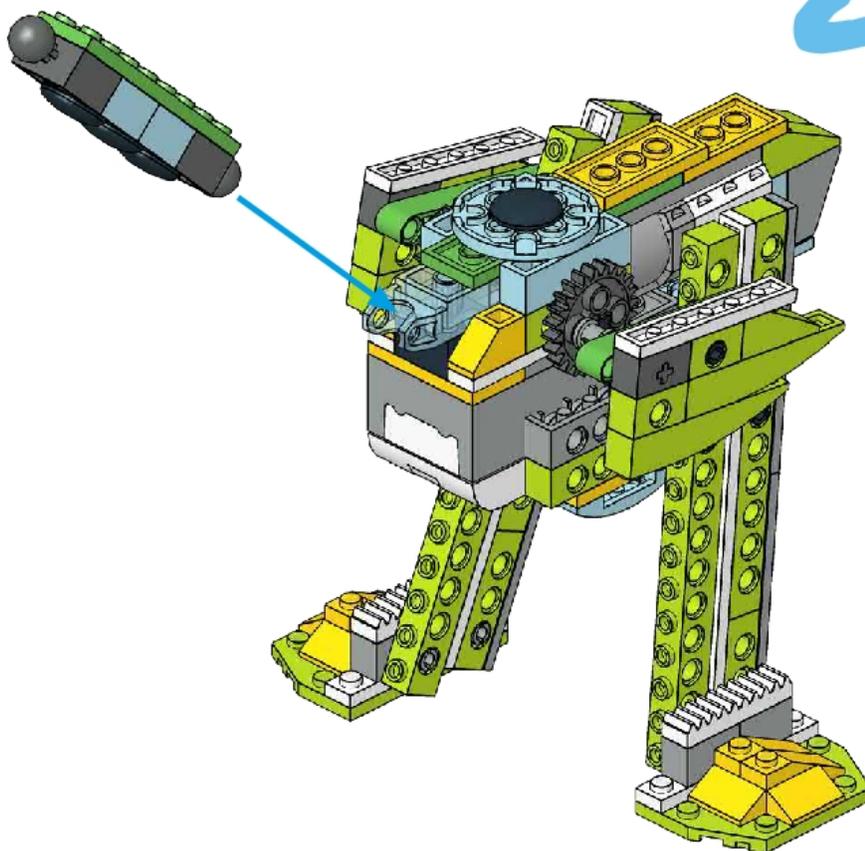
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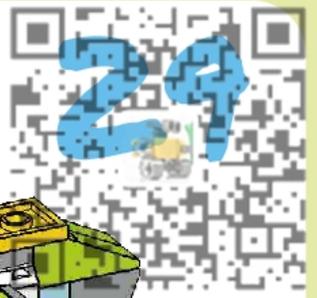


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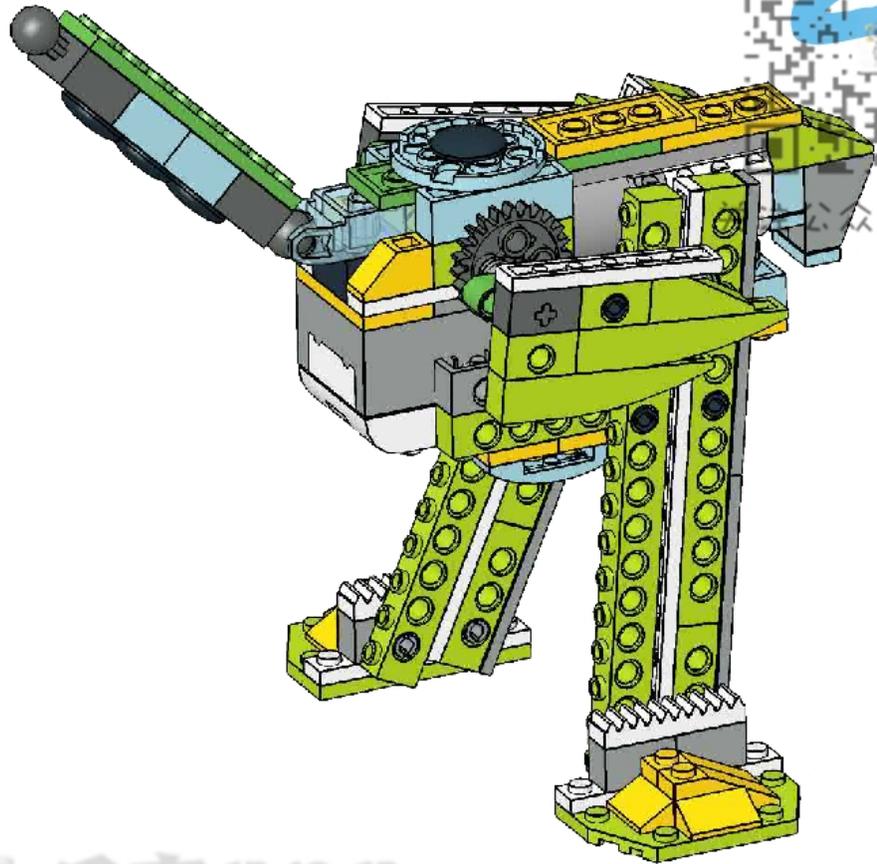
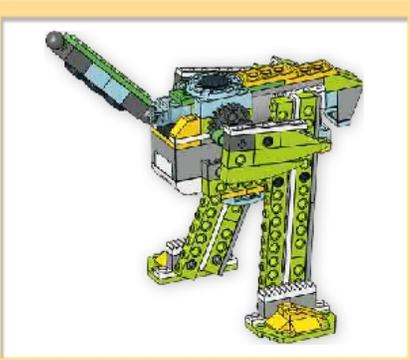
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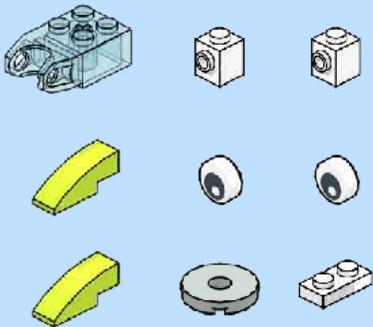
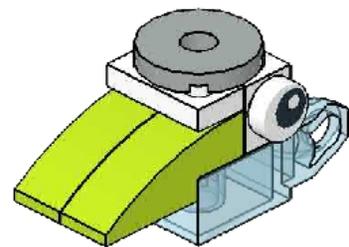
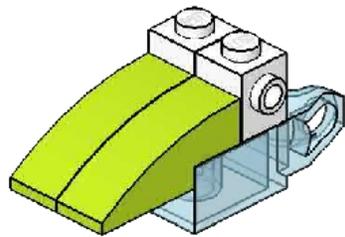
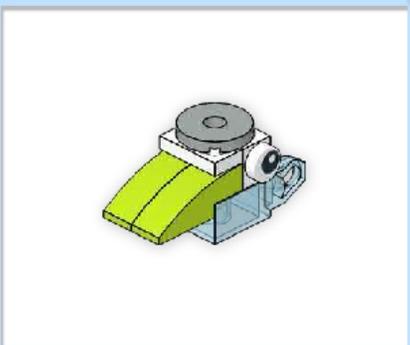
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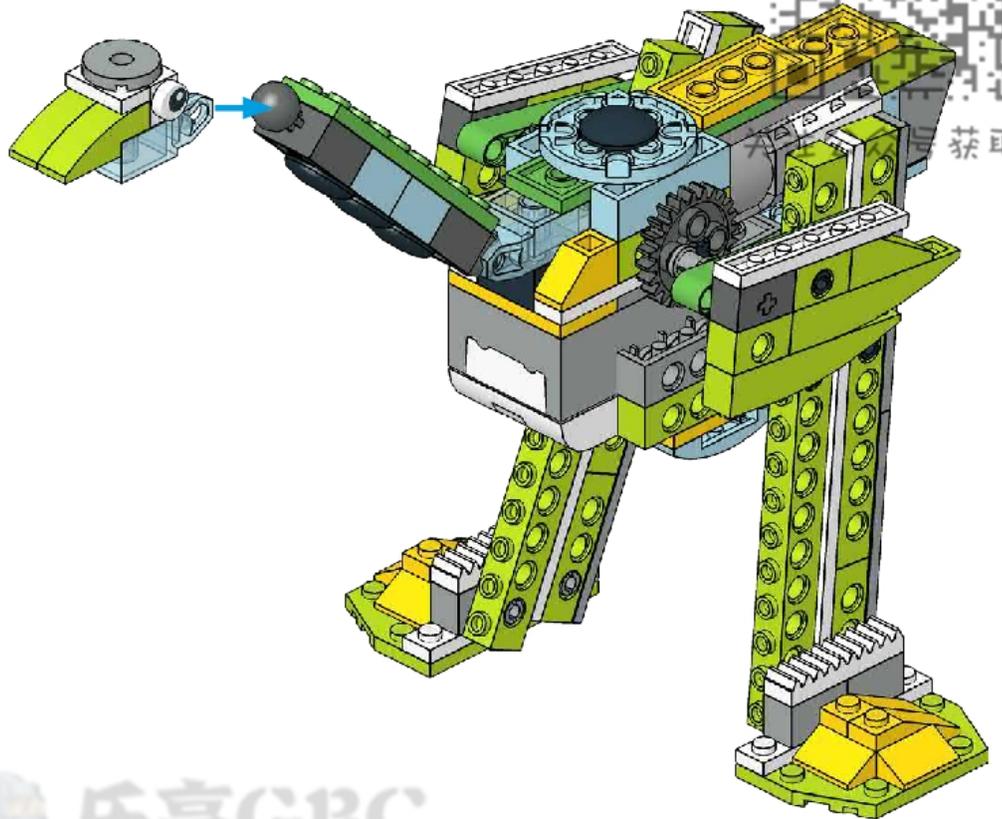
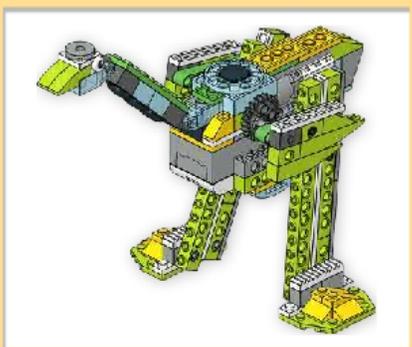


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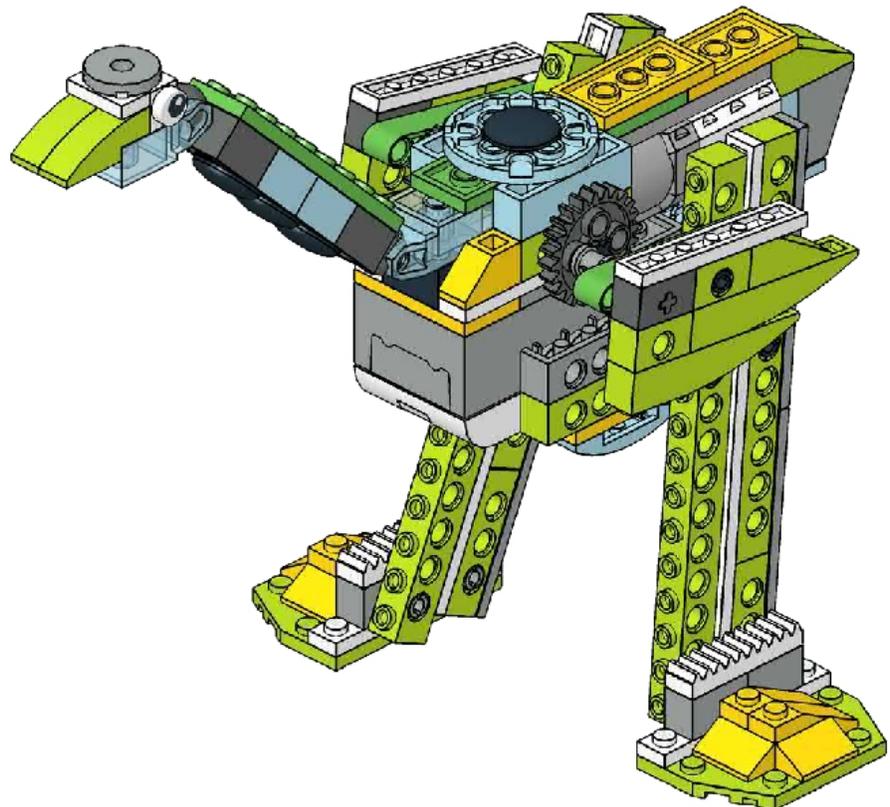
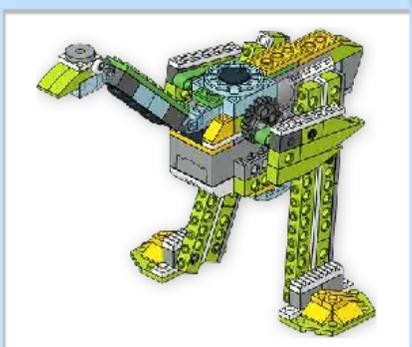




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- Before going to the next phase, you can identify the mechanisms you are using in your American rhea prototype.
- Can you **predict** how your American rhea prototype will move by only seeing the model?
- How many **gears** are you using in your American rhea prototype?
- How many **legs** does your American rhea prototype have?

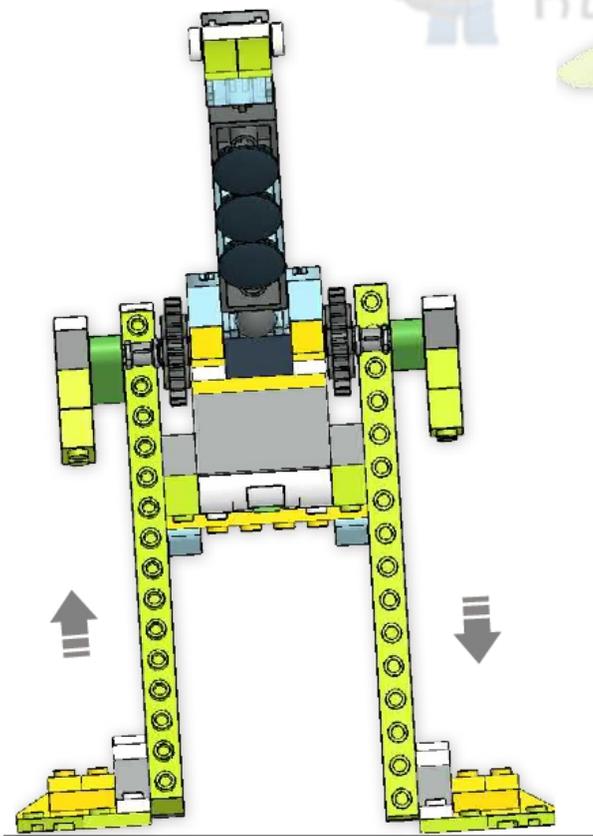


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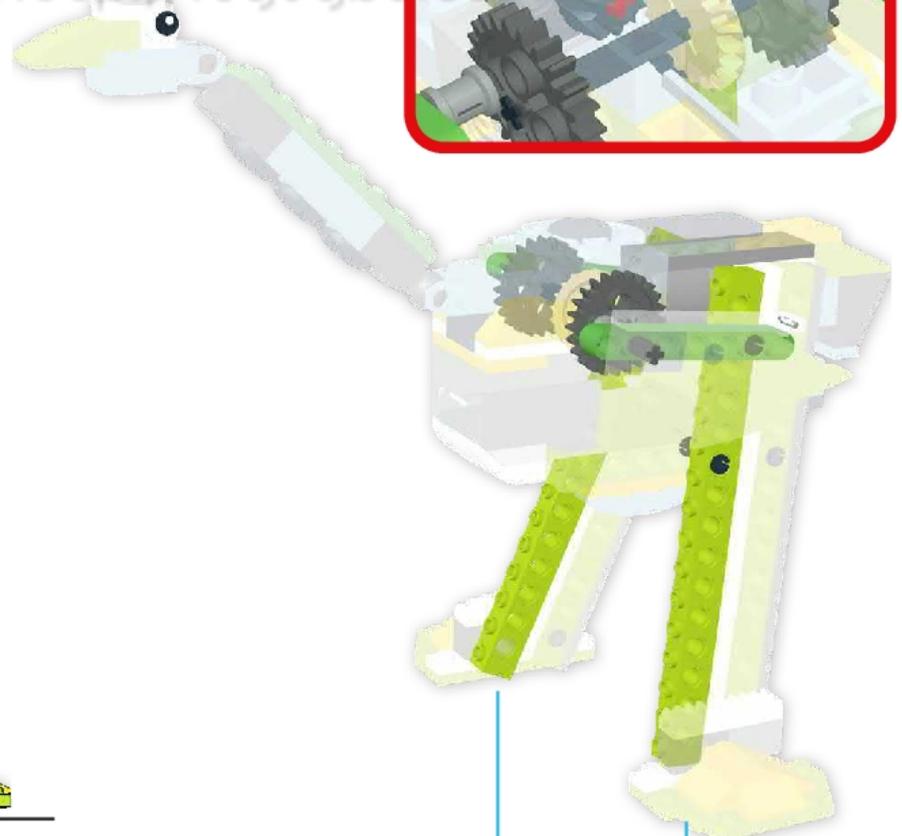
Design features

- Your **American rhea** uses the motor to drive the two legs.
- Similar to the **inverted slider-crank linkage** used in your penguin, a **Chebyshev's lambda linkage** allows the walking motion of your prototype. You will see in detail this linkage in the next chapters since you will be using it a lot to make different walking robots.
- Can you identify the **bevel gears** and the **Chebyshev's lambda linkage**?
- Can you identify the **driver gear** and the **follower gear** in the bevel gear mechanism?
- Are the two legs in an **out-phase motion**? You can check this by the position of the legs. One leg should be in the opposite direction of the other leg.

Gearing down mechanism
using bevel gears



Out-phase motion



Chebyshev's lambda linkage

Program phase: Start on key press



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- In this section, you will explore the use of the **keys** from your **keyboard** to make your American rhea move forward and stop.
- The **program idea** consists of moving forward your American rhea when you press the key “F” and stopping it by pressing the key “S.”
- In a more detailed way, your American rhea will move forward if you press the key “F,” and it will keep moving forward until you press the key “S.” If the key “S” is pressed, your American rhea will stop, and it will remain like that until you press again the key “F” to change its state and make it moving forward again.

Flowchart



Program 1

Program 2

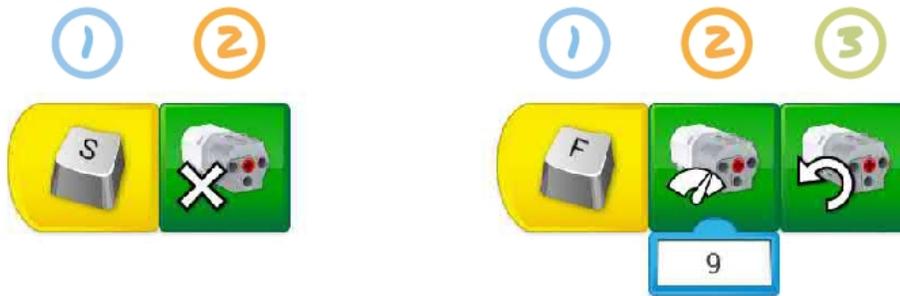
In this case, you have two programs running simultaneously. Since you can press a key at any moment, the two programs must be always ready to execute!



Parallel programming

- Parallel programming refers to when **more than one program** (multiple programs) is **running simultaneously**.
- Since a key can be pressed at any moment, the two programs must run at the same time, and depending on which key is pressed, only **one of them** will be executed at that moment.

• Given the flowchart, you have to develop **two programs**:



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Start on key press blocks

- In this opportunity, you are using a different block to start your program: **start on key press block**.
- Be careful when using this block; remember that it is case sensitive, meaning that if you set it up to execute when you press “F,” if you press “f,” the program will not be executed.

• Which of **these blocks** will make your American rhea **go forward**?



• You will find out the answer to this question on the **test phase**!

Test phase: Condition – action

• Remember to verify the **communication** between your WeDo software and the WeDo Hub before you start testing your prototype.

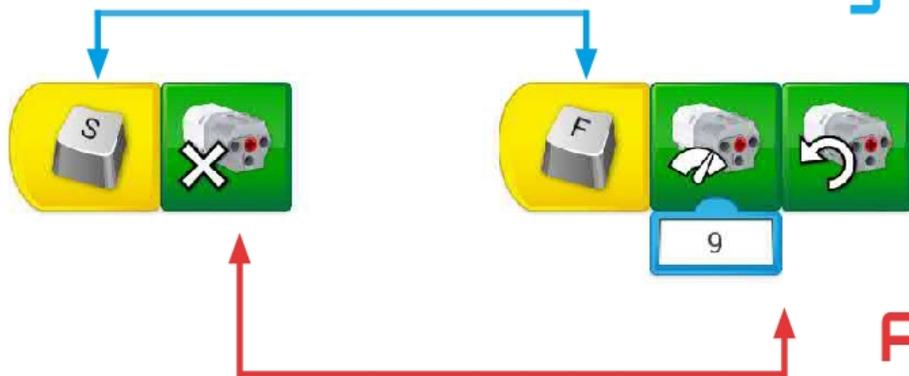
TEST 1: Finding the right motor direction

• Identify in which direction your motor has to rotate to make your American rhea move forward and backward. Once you identify which block to use, change your program accordingly. Can your American rhea walk backward?

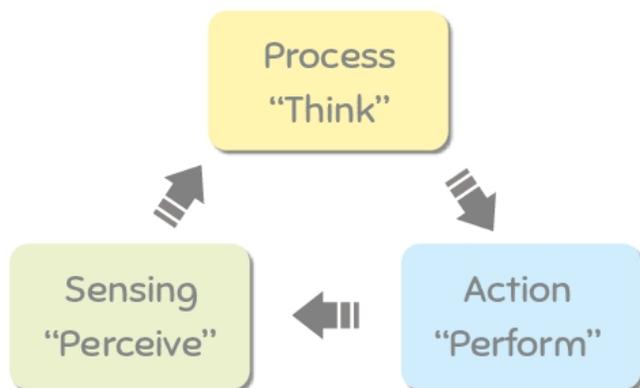
TEST 2: Condition – action

• Test your prototype by executing the program developed in the **program phase** by pressing the two different keys: “F” and “S.”

Conditions (sensing)



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Perceive – think – perform

- The keys on your keyboard are used as sensors, so your robot will perform an action depending on which key has been pressed (**condition**).
- The "think" process involves the **instructions** (programming blocks) to perform depending on the condition (**sensing**).
- Based on which instruction was sent, your prototype will **perform an action**.

Document & share phase

- Remember to collect all your **notes**, **videos**, and **photos** to report your **findings and results**.
- Record a video of your American rhea performing the three different actions depending on which key you have pressed.
- Report your findings and results from the **two tests** performed in the test phase.

Enhancing the experience

- **Build:** You can try building different legs for your American rhea and see if it can walk.
- **Programming:** Program other actions when other keys from your keyboard are pressed.

