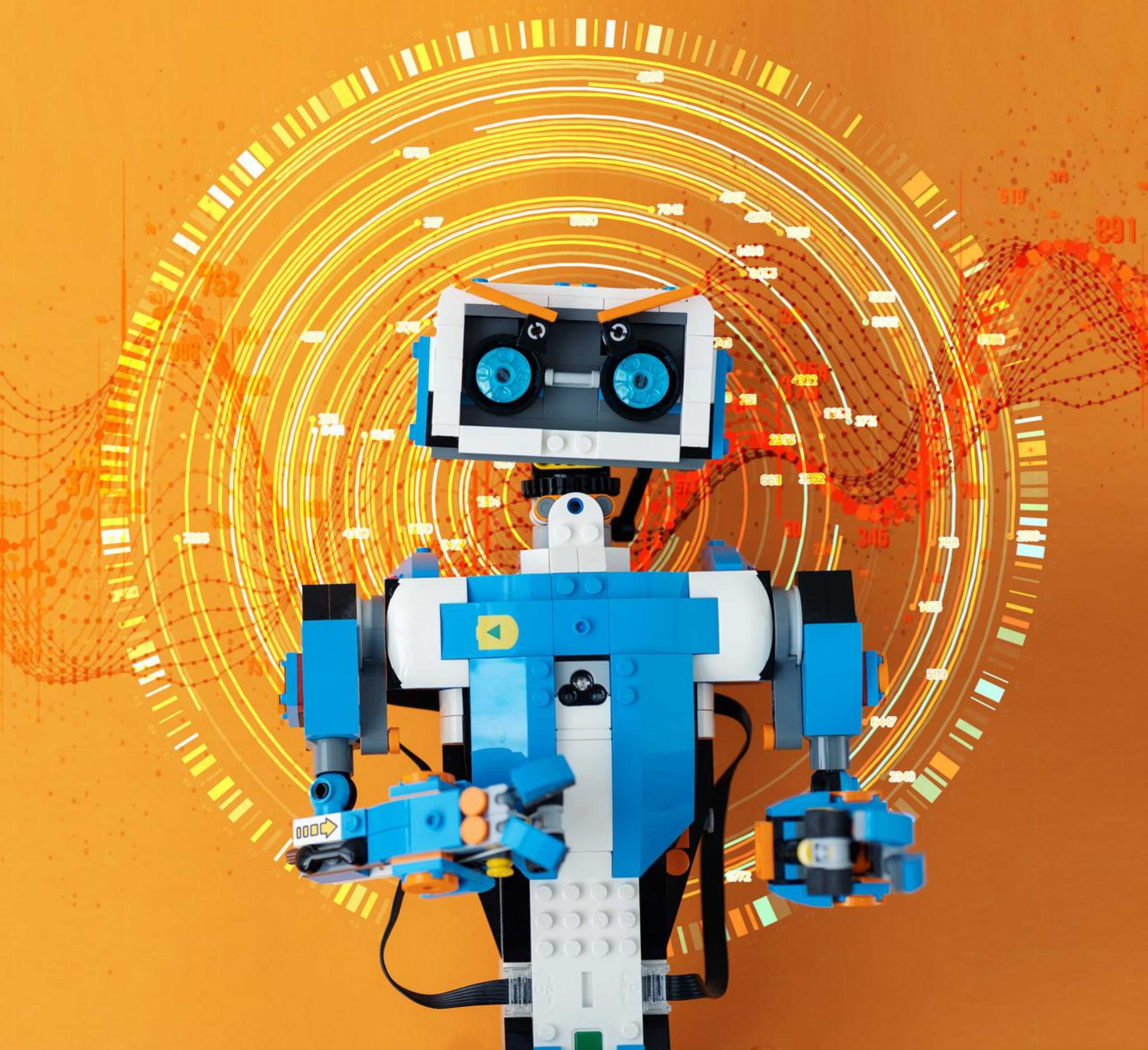
MISSIONS

w/LEGO® Robotics



For information about this title or to order other books and/or electronic media, contact the publisher: Arbotics LLC, contact@databot.us.com, databot.us.com

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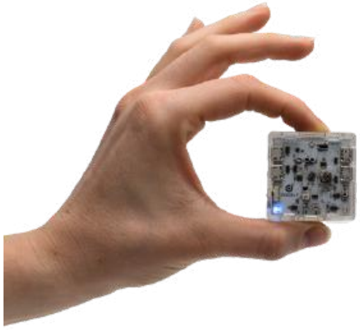
Introduction

Welcome: Meet databot™

databot™ is a disruptive STEAM EdTech device combining powerful tools for exploring science, math, coding, IoT, AI, cybersecurity, data science, design engineering challenges, and technology. This one device simplifies training and support in educational organizations while facilitating cross-disciplinary integration through its remarkable versatility.

Imagine training educators on one device used across grade levels and disciplines. databot™ brings data to life for students just learning to explore science, for advanced students exploring chemistry, life science, physics, and earth science, for technology and STEAM students to explore coding, IOT, and machine learning, or for math educators to enliven math concepts with real world applications. Originally designed for providing a scalable, sensible solution for organizations seeking a solution to a very complex problem - implementing STEAM education - databot™ provides a remarkable one-stop option for organizations seeking to maximize their educational technology spending.

Exploring the relationship between distance and light intensity with databot™.



Tiny but mighty, this one device can be used across multiple departments and programs.

- **STEAM simplified**: databot™ is a tiny device that fits in the palm of any student making it an ideal companion for exploration STEAM anywhere.
- **Sensor Science for All**: Equipped with a wide array of sensors databot™ opens up a universe of possibilities for experimentation and analysis.
- **Friendly Hardware**: Non-threatening, inexpensive, friendly, easily stored and inventoried, elegant, and incredibly simple to use by beginners and advanced users in their STEAM skills.

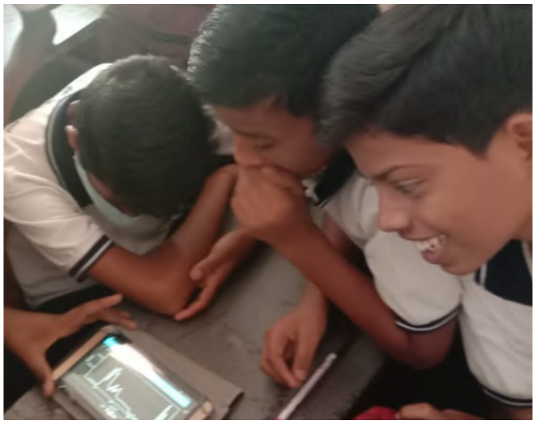
databot™ has been designed to simplify STEAM education and broaden its appeal to organizations facing complex training and scaling needs. Out of the box databot™ connects to the free App Vizeey™ for easy experiment setup, data collection, visualization, analysis and export. Once educators and students are comfortable with this friendly solution there are many additional opportunities. Beyond Vizeey™ there are a multitude of options for coding, IOT, advanced data analysis, machine learning, and more. databot™ is the ultimate low floor, high ceiling STEAM education tool!

The databot™ Mission

"We create technology and brilliant activities that empower students everywhere to think deeply, explore with passion, and solve our planetary scale challenges."

databot™ was created to solve a problem encountered by organizations trying to implement and scale STEM education solutions. Attempting to deploy a full scale STEM lab complete with robotics, 3D printers, and more can be an overwhelming task for educators when they are faced with loads of new equipment, technical training, and content training in addition to a radical pedagogical change.

databot™ provides an approachable, friendly platform for implementing new pedagogical methods across a wide variety of topics without the overwhelming feelings of facing "too much gear."



"Students in India exploring sensor-based science concepts with databot™ & Vizeey™.

STEAM Applications

"Our kids are going crazy with this thing - mounting it on drones, integrating it with LEGO, launching it on rockets. We had no idea where this could go!"

AI and Machine Learning

A STEM educator demonstrating gesture recognition with databot™, OpenCV, and Python.

The databot™ mission supports a wide variety of educational experiences - we have broken them down into four distinct areas of learning:

<u>Science, Technology, Engineering, Arts, & Math (STEAM)</u>
The fundamental underpinnings of our society are supported by technology, the sciences, and math. Creativity and innovation is stimulated by our natural inclination to explore the arts. Exploring and understanding these topics are key to building citizens literate in how the world works. databot™ supports STEAM initiatives through an ability to facilitate learning experiences across all the science domains as well as provides physical computing and technology opportunities

<u>Artificial Intelligence and Machine Learning</u>
There can be no doubt that the evolution of computing power and artificial intelligence research has the potential to ultimately pose an existential threat to humanity. For this reason, we emphasize the development of educational materials including hardware, software, and curriculum that will educate students on how artificial intelligence works, the associated ethics that need to be instilled, and a fundamental understanding of related hardware issues such as machine learning and quantum computing.

<u>Planetary Health & Environmental Awareness</u>

It has become obvious that planetary scale changes need to happen in order to alter the path of destruction humanity has taken. Never before has an awareness of environment and planetary health been more important than it is today, and for this reason we emphasize the development of extraordinary learning experiences for students to understand and interact with the data that tells the story of our planet's well being. Just like we take our temperature to check for a fever, and we trust that data when we see it, students need to understand the meaning behind the numbers and recognize the reality behind the data. By educating children around the planet to see and understand planetary health data, we can collectively raise the needed awareness to heal the planet.

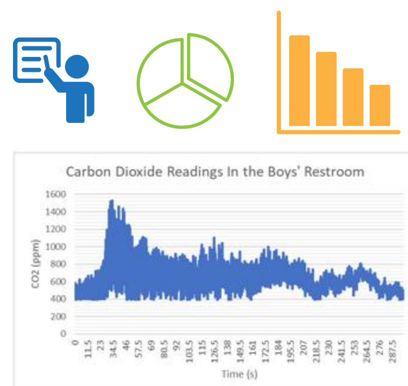
Environmental Awareness

Students exploring ultraviolet radiation, the UV index, and the impact of UV on health.

<u>Data Literacy, Data Science, and Critical Thinking</u>

It is the age of data with data science being one of the fastest growing and highest paying new career segments. Data surrounds us and envelopes us every second of every day of our existence. It's in the air we breathe and in the movement of our bodies as we walk, run or leap. It's in the sunlight on our face, the breeze that lifts our kite and the clouds that float through a data rich blue sky. It's also in the loyalty card we use at the grocery store, the cookies that follow us on our Internet travels, the traffic stop camera tracking us at the intersection, the news we read and the television shows we watch.

The ability to read, interpret and understand data has never been more important. How do we inspire a new generation of conscientious global citizens to be passionate about understanding data and how it impacts our daily lives?



Data Science

Students in Anaheim conducted a campus wide CO2 study using databot™ to better understand how various conditions can impact indoor air quality.

In conclusion, the social mission of databot is to develop solutions that address the above educational objectives and make them available to all students, everywhere on the planet. The very fate of our planet and species depends on students understanding the data we share, how it is gathered, interpreted, and verified.

"A true teacher is not the one with the most knowledge, but one who causes the most others to have knowledge."

- Neal Donald Walsch

Why is Sensor Based Science Important?

Reasons to Expose Students to Sensors and Data Collection

Using sensors for learning provides important benefits for students including meeting a variety of educational standards required in math, science, technology, engineering, and computer science standards frameworks.

Hands-on and Experiential Learning

Sensors allow students to engage in hands-on learning experiences, enabling them to interact directly with the physical world. This experiential learning approach helps students develop a deeper understanding of scientific concepts and principles by observing real-time data and making connections between theory and practice.

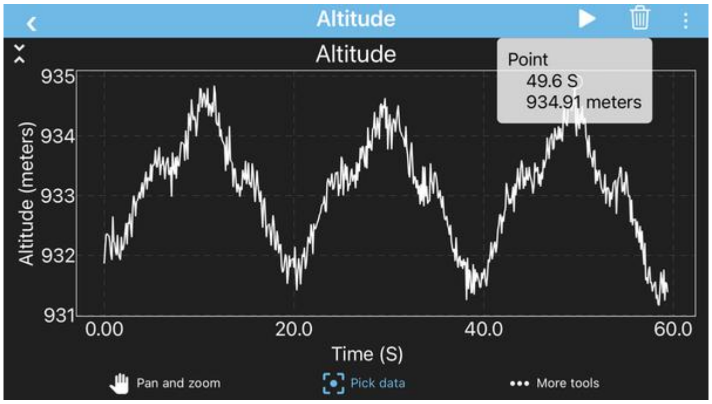
A student gathers live data as she changes altitude by running up and down stairs. The relationship between air pressure and altitude becomes highly relevant as students physically interact with scientific data.

Data Collection and Analysis

Sensors facilitate the collection of accurate and precise data in various fields such as physics, biology, chemistry, and environmental science. Students can use these data sets to analyze patterns, identify trends, and draw conclusions. This process encourages critical thinking, problem-solving, and the development of analytical skills.

Real-World Applications

By utilizing sensors, students can explore real-world applications of scientific concepts. For example, they can measure environmental factors like temperature, humidity, and air quality to understand how they impact ecosystems or human health. This practical approach helps students appreciate the relevance of their learning and fosters a stronger connection between classroom knowledge and the world around them.



Concepts of calibration, accuracy, and data analysis have direct connections to hundreds of real world applications and careers.

Why is Sensor Based Science Important?

Exploring sound intensity.

<u>Engagement and Motivation</u>

Incorporating sensors into the learning process can increase student engagement and motivation. Sensors provide immediate feedback and visual representations of data, making learning more interactive and enjoyable.

Students are more likely to be actively involved in their studies when they can see tangible results and have a sense of ownership over their learning process.

Environmental monitoring as a team.

<u>Collaboration and Teamwork</u>

Sensor-based learning often encourages collaborative work among students. They can design experiments together, collect data as a team, and analyze the results collectively. This collaborative approach fosters communication, cooperation, and teamwork skills, which are essential in many aspects of life beyond the classroom.

<u>STEAM Education Enhancement</u>

Sensors play a vital role in enhancing STEAM (Science, Technology, Engineering, and Mathematics) education. They enable students to explore scientific phenomena, conduct experiments, and engage in engineering design challenges. By using sensors, students can gain practical skills and a deeper understanding of STEAM subjects, preparing them for future careers in these fields.

Students gather real-time data during catapult launches to create a quadratic function modeling the databot™ flight trajectory.

In summary, sensors provide a powerful tool for students to engage in hands-on learning, collect and analyze data, explore real-world applications, enhance motivation, foster collaboration, and strengthen STEM education. By incorporating sensors into the learning process, students can develop critical skills and a deeper appreciation for the subjects they are studying.

Getting Started

About Missions with LEGO® Robotics

LEGO® Robotics is one of the most popular STEM activities for students and technology educators around the world. databot™ Missions with LEGO® Robotics provides STEM educators and students with the unique opportunity to blend real-world data collection challenges with engineering design challenges. The result are some very exciting creations that introduce students to a wide variety of real-world career scenarios ranging from sports science to cybersecurity! The databot™ curriculum team is excited to present this set of missions for you and your students to explore. We are already working on ideas for volume II so stand by!

Preparing for Your Mission Experience

databot™ is tough, lightweight, easily stored and shipped, and comes with minimal parts to keep track of and inventory. This tiny device includes a wide variety of sensors for gathering data on acceleration, air pressure, altitude, ambient light, CO_2, color, gesture, rotational motion (gyroscope), humidity, magnetism, proximity (time of flight), sound, temperature, UV, and volatile organic compounds. This makes it a highly versatile STEM education tool useful for teaching a variety of topics spanning chemistry, life science, physics, earth science, technology, coding, and more. In order to prepare for your Mission Experience you will want to do the following:

- Review the databot™ Quick Start Guide (5 pages), which explains the device and its operation in detail.

  databot™ — https://databot.us.com/starters-databot/

- Review the Vizeey Quick Start Guide (4 pages) to understand the functions of the data visualization app.

  vizeey™ — https://databot.us.com/starters-vizeey

- Review the MicroBlocks Getting Started Guide. The final Mission, CO_2 Detector, challenges students to program two devices to communicate with one another and uses two coding languages - MicroBlocks® for databot and the regular Spike Prime app for your LEGO® Hub.

  microBlocks® Small, Fast, Human Friendly — https://databot.us.com/mbstart

Good luck to you and your students as you venture into the world of databot™ Missions. Contact databot™ for support at any time at contact@databot.us.com. We look forward to hearing about your adventures!

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Missions w/LEGO ® Robotics

Grade: 4 & Up
Time: 60 minutes +
Student Guide

Math, Physics,
Technology, STEM,

Putter Perfection

Mission: Putter Perfection

w/LEGO® Robotics

Grades: 4 & Up
Time: 60+ Minutes
Subject: Math, Physics, Technology
Topics: **Gravity, Force, Friction, Accelerometer**

Overview

Golf is a challenging sport that requires skill, patience, and perseverance. A professional golfer is facing a crisis and needs your help! Your mission is to provide her with detailed scientific and engineering data to improve her performance in putting. Using databot™, you will measure putter impact **force** with an **accelerometer** and explore how the swing angle and motor speed affect this **force**.

Background

Your team has been hired as **biomechanical** engineers by a professional golfer experiencing a career slump - her putting game is off! You will help her by demonstrating how to deliver perfect putts to a target 6' away. Do this by adjusting the **force** of impact from LEGO® motor speed and swing angle. Work as a team. The data scientist will evaluate each round of code and the Programmer will adjust the **force** accordingly until the putting is "perfection." Two **forces** that affect a golf ball are **gravity** and **friction.** Putting combines **mass** (the club head) and **acceleration** (the swing) to deliver a **force** to the ball to overcome **gravity** and **friction**.

Important Terms

Acceleration: The rate of change in speed or direction. An object moving at a constant speed and direction has zero **acceleration**.

Accelerometer: A sensor that detects **acceleration -** changes in speed and direction.

Biomechanics: The study of the mechanical principles of living organisms, particularly their movement and structure.

Force: When entities collide creating a large force in short period of time and can cause objects to change direction and speed.

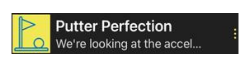
Friction: The **force** that opposes motion between two surfaces that are in contact with each other.

Gravity: A universal **force** of attraction from all objects with **mass**.

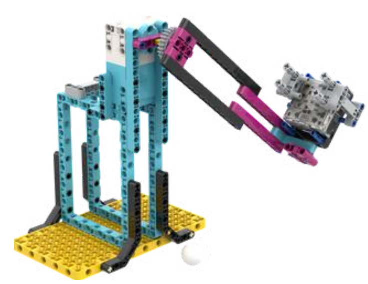
Mass: An object's inertia, the **acceleration** required to move it, defines its **mass**. **Force** is defined in a formula, F=ma, so more **mass** = more **force**!

What You Will Need/Prep

- databot™ 2.0 & Vizeey™
- IOS/Android Smart Device
- Read the Vizeey™ Quick Start Guide and install the Vizeey™ app.
- Use Vizeey™ to scan the QR Code to load the Missions w/ LEGO® Robotics collection.
  - You only need to do this once.

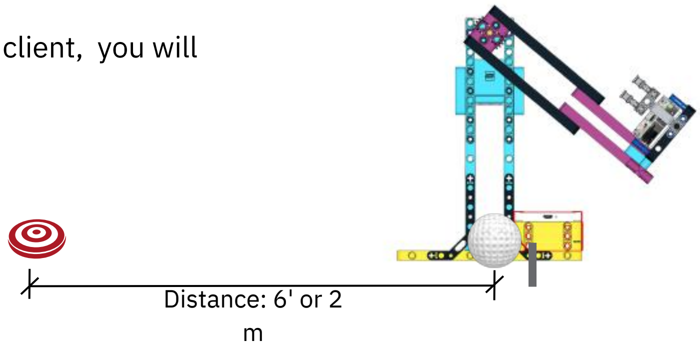


- LEGO® Education SPIKE™ Prime
- Use the included plans & build "Putter Perfection" or use your own design!
- Golf ball (or similar)



Set-Up: The Build!

To properly demonstrate the physics of putter action for your client, you will need to set-up a controlled testing environment.

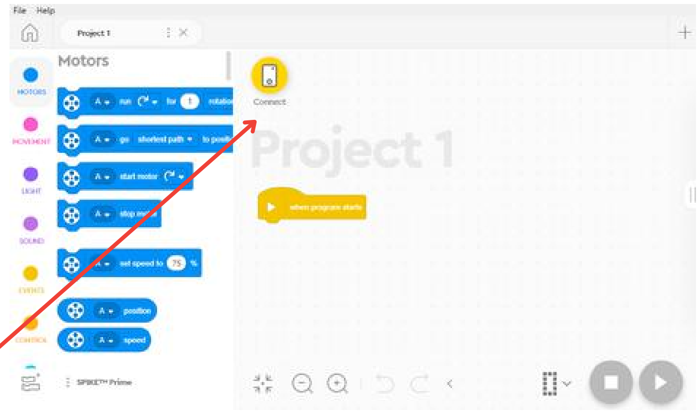


- Identify a consistent surface for the ball to roll on such as carpet, a yoga mat, etc. A hardwood or tile floor is not recommended as the ball will have considerably less **friction** with the surface and can travel just due to variations in the floor surface.
- Measure a space for a putting green 6' (2 meters) long X 2' (60 cm) wide.
- Create a visible target that can be taped or secured to the playing field exactly 6 feet or 2 meters from the putter. The target should not impede the ball's travel so make it as flat as possible and consistent with the rest of the playing surface.
- Build "Putter Perfection" using the build plans at the end of this mission and set it up appropriately as shown in the above diagram. Add databot™ to the build and prepare for gathering impact force data. Give yourself plenty of room to code and practice as a team.
- Once your machine is built and the putting area is prepared move on to the coding setup!

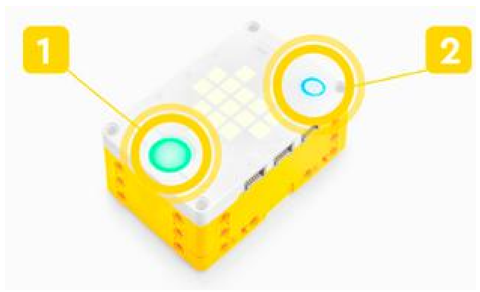
Set-Up: LEGO® Coding

To program the LEGO® Hub use the LEGO® Education SPIKE™ app on a smart device or online. All Mission instructions are done using the online environment. https://spike.legoeducation.com/

- Launch the SPIKE app
- Select SPIKE Prime
- Click on "New Project"
- Select the Word Blocks option
- Choose CREATE (this creates a new program as shown)
- To connect the LEGO® Hub to the program and click on "Connect" and follow the steps.



Interface of LEGO® Education SPIKE™ Prime



1. This button activates the LEGO® Hub.
2. This button turns on the Bluetooth and connects the Hub to the computer.

Coding: Putter Perfection

Angling for the Win

In this mission you will use code to modify the **force** delivered by your machine with each putt. The ball has **mass** and requires **force** to move it. There are two things that modify the force, "strike angle" and "motor speed." Follow the steps below to learn how to modify your impact **force** by adjusting the strike angle!

Confirm your motor is connected to port A and set the motor to position 0.

- Open SPIKE™ 2 App (or whatever version you are using) the code should be similar.
- Start your program using the Setup Block: 

- Add the Position Block:
  - This block will put your motor in position 0 

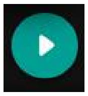
- Add the Motor Block:
  - Set the block to 90 degrees which raises the "putter." 

- Add a wait Block:
  - Set to pause for a second before your strike. 

- Add a Motor Block:
  - This action sets the second motor in the opposite direction by 90 degrees - hitting the ball! 

Striker Code Part 1: Strike Angle only.

- Test this code now by setting your first golf ball up and pressing the start command in your app. Each time you wish to execute your code, simply press this start command.
- Observe the putt distance. Now modify your code for a lower strike angle of 75 degrees and repeat the trial. Does the ball travel a farther distance or lesser?   This is one coding tool for changing the distance of the putt. Let's look at a second method.



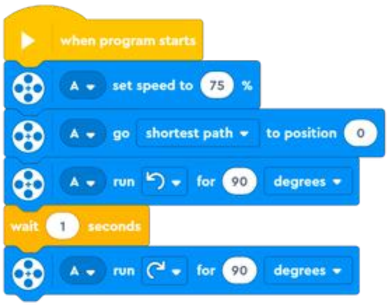
Start Command

Speeding to Victory

The second method of coding that can change the **force** of impact is the "Set Speed" block. This will modify the speed with which the motor executes the swing. For example, if you set the motor speed to 100% and the swing angle for 90 degrees the **force** of impact will be greater than setting the motor speed to 50% and 90 degrees. Using these two variables, motor speed and strike angle, you now have a lot of control over the **force** you deliver.

- Add this block that allows you to change the speed to the top of your code stack as shown. By placing it at the top of the stack, it sets the speed for the motor in any actions that follow this block. 

- Test this code by leaving the strike angle at 90% and doing a putt at 100% motor speed and one at 50%. Observe the difference in the distance traveled by the ball.



Striker Code Part 2: Adjust angle strike and strike speed.

Congratulations! You are now ready to proceed to the next phase of the mission in which you will collect impact **force** data that will help you identify the "Perfect Putt."

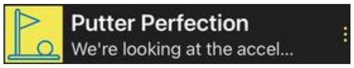
Mission: Putter Perfection

Your mission is to use the power of data science to build a "perfect putter" machine for instructing your client on the various **forces** contributing to her putting game. You will accomplish this as a team in which one team member is the data scientist and one is the Programmer. Using the "Putter Perfection" experiment in Vizeey™ the Data Scientist will use the accelerometer to measure the impact **force** applied to the ball. Based on the data provided the Programmer will modify the Spike Prime Code to change both the speed and angle of the strike which will in turn change the putt distance. Working together your team will create a solution capable of executing a "perfect" putt of 6' each time that will serve as a great training aid for your golfer client.

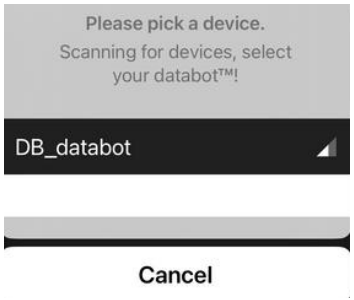
Collecting the Data: First Steps

Begin your experimentation with impact **force** by collecting initial data with test strikes and setting up a data table that will help you clearly and logically organize your data. Done properly, this data table will ultimately provide you the answer you seek in this challenge.

- Open the Vizeey™ app on your smart device.
- Turn on databot™ that is secured to the striker arm of your machine.
- Tap on *Putter Perfection* in Vizeey™ to load the experiment.
- You will be prompted to connect to databot™.
  - *Hint- if there is more than one databot™ in use, the one closest to you will be in blue!*
  - *A solid blue light on databot™ means you are connected.*
- Use these icons at the top of the screen in Vizeey to start and to pause experiments.
- Use the trash can icon to clear your dataset after each run.



Tap on Putter Perfection



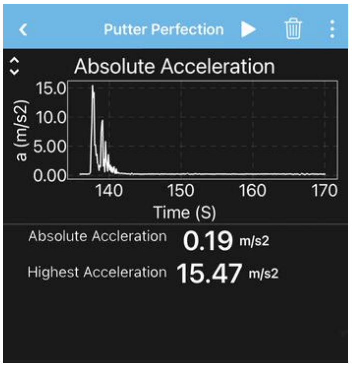
Connect to databot™

Let's try it!
- Data Scientist: Start your experiment using:
- Programmer: Hit the Run button to execute a trial putt.
- Data Scientist: Pause the experiment using:

Observe the data and note the values for Absolute **Acceleration** and Highest **Acceleration**. The **Absolute Acceleration** is the live value that will display while the experiment is running. The Highest **Acceleration** is the highest value recorded during the run.

Now try several more sample runs to get a feel for the data you will be collecting and analyzing.

- Programmer: Change the motor speed or strike angle for each sample run to modify the impact **force**.
- Data Scientist: Clear the dataset and start a fresh experiment for each sample run.



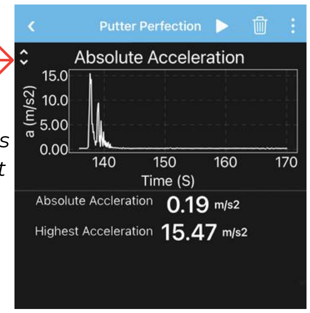
Example of data you will see from a sample putt!

- Team: Note the distance the ball travels for each trial in preparation for your next steps. Are you in the neighborhood of a 6' long putt yet?

Collecting the Data: Going Deeper

The physics of **acceleration** and impact **force** are quite complex so it is important to be able to look at the data you are collecting more closely. You can do this in Vizeey™ by opening your data sample for closer inspection by tapping on the graph or the "toggle" in the upper left hand corner.

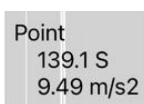
The zoom toggle opens your dataset for a closer look!

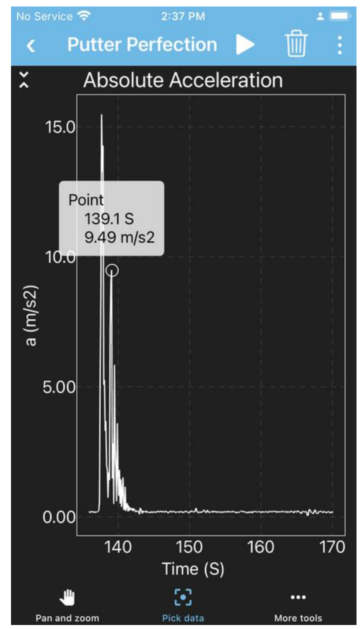


Once you open your dataset for a closer look, you will note these icons at the bottom of the screen.

- Pan and zoom allows you to press and hold and move the data set back and forth or pinch to zoom in and out.
- Pick data allows you to select a specific data point to see its value in detail.
- "More tools" has additional tools for exploring your data and is also there for exporting this dataset to save and explore further if desired.

Team: Collect another sample and this time open the dataset in the zoom mode. Use the "pan and zoom" and the "pick data" tools to look through your dataset in more detail. You will notice your graph shows two distinct spikes in **acceleration**. Use the "pick data" tool to select the highest and second highest data points in the set and you will see a display similar to this:





Sample full screen graph

There are two values displayed. The first is the time in seconds since you started the program, and the second is the **acceleration** recorded. In this experiment:

- The highest **acceleration** is the backswing when your putter arm swings back into position.
- The second spike after the backswing is the **impact force**. This is the abrupt change in speed when databot™ strikes the ball.

Collecting the Data: Organization

You are now ready to do some serious data science! Using databot™ and Vizeey™ you will collect data from a series of putts and use this to refine the code! Look at the data table example to the right. Your next steps are to record your data, organize it into this table format, and determine the perfect machine settings for producing the "perfect putt."

Test Run	Surface	Angle of the motor	Power of the motor	Acceleration at impact, m/sec2	Maximum accelaration, m/sec2	Distance
1	Yoga Mat, Rubbery with some texture	75 / 75	100%	9.49	15.47	60"
2	Yoga Mat, Rubbery with some texture	75 / 75	100%	6.28	19.34	54"
3	Yoga Mat, Rubbery with some texture	75 / 75	100%	10.88	15.72	62"

As a team create a plan for systematically running tests and collecting data that will guide your coding solution to deliver the perfect putt consistently. Commence testing and work together to refine your results. As you run each test and fill in the table consider the following:

- Are there some inconsistencies?
- What could cause a difference in data in some of the trials?
- Can you improve the construction of your machine to work more consistently?
- Pay attention to the surface upon which the experiment is performed as **friction** will impact your results.
- Even the ball you use may affect the results so be observant and creative.

Perfect Putter Data Table (use a notepad for more tests if necessary)

Test Run	Surface	Motor Angle	Motor Power	Acceleration at Impact, m/sec2	Maximum Acceleration, m/sec2	Distance
1						
2						
3						
4						
5						

Analysis

Analyzing the data you have gathered is a critical part of Data Science. Use the following table to guide and document your experience. Use a notebook to expand your analysis and documentation.

Did you have inconsistent data results? If yes, what do you. think were contributing factors?	
What patterns in the data were consistent as you changed the force and angle of strike?	
Are you able to consistently repeat your results after multiple attempts? If no, what do you think will work?	

Communication and Presentation

Upon the conclusion of your work, prepare a presentation for your golf pro client and use your data and experience to clearly explain the many variables and issues impacting her putting game. Encourage her to methodically work through these variables in her putting until she attains perfection.

Challenge

Go further by tackling the following challenges!

Fear No Friction

Once you have your machine working consistently expand your solution to accommodate three different surfaces each with a different coefficient of **friction**. For example a rubber mat, artificial putting grass, and carpet will all affect the ball differently. Save your coding settings for each surface and store them as individual programs on your LEGO™ Hub such that you can easily change settings for each surface.

Mass Master

You recall the formula for **Force** is F=ma or **Force** = **mass** X **acceleration**. Find balls that have a different mass than your original test golf ball. Use a scale if you have one and try to find balls that are similar in size and surface and test your code with these new balls. Can you adjust your code easily to accommodate the **force** required to move a larger or smaller **mass**? Do you see patterns that will enable you to predict how much **force** you need based on the **mass** of your ball?

Career Connection

Sports science is a field that applies scientific principles to improve athletic performance and prevent injuries. Engineers and scientists may use a variety of tools and techniques to evaluate an athlete's performance, including **biomechanical** analysis, physiological testing, and advanced imaging technologies.
Some specific job titles within sports science that may involve working with professional athletes include: **biomechanical** engineer, sports physiologist, sports nutritionist, exercise physiologist.

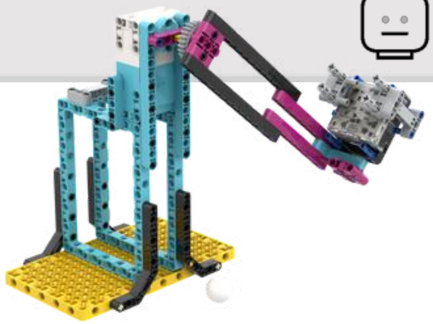
Biomechanical Engineer: this type of engineer uses principles of mechanics, physics, and engineering to study the movements of athletes and analyze how they can improve their form and technique.

Real World Examples

The real world business applications of sports science are vast and many entrepreneurs and companies focus their time on designing the latest and greatest training aids for sports enthusiasts looking to improve. In the sport of golf, hundreds of training aids have been developed by sports scientists that range from apps and wearable devices to full blown virtual reality trainers that help golfers visualize their swing in an effort to improve their game.
On the Internet, use a browser and search for the term "golf training aids" and take a look at the remarkable variety of products available. As a **biomechanical** engineer or sports scientist you just might invent the next big thing in golf! Awesome!

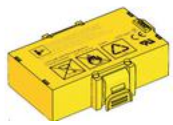
Putter Perfection

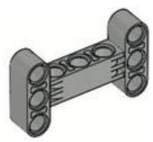
Build Plan



Parts List

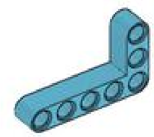

1x LEGO Yellow Hub (53444)


1x LEGO Battery (55422)

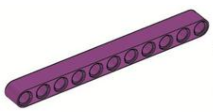

3x Beam I-frame 3x5 (14720)


1x Angled gear (46372)

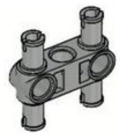

4x Black Beam (32009)

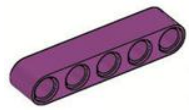

3x Medium Azure (32526)


4x 2m fric. snap (32054)


2x Technic 11m beam (32525)


1x Biscuit 1x3x3 (39793)

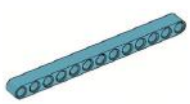

2x Beam 3 m (48989)


1x Technic 5m beam (32316)


1x Cross axle 3m (4519)


50x Technic Pin (2780)

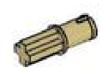

1x Technic frame 5x7 (64179)


2x Technic 13m beam (41239)

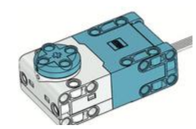

12x Blue Long Pin (6558)


2x Technic frame 11x15 (39790)


2x Technic 15m beam (32278)


4x Tan Pin (6562)


1x Panel 11x19 (39369)


1x Large Motor (54675)

Build Instructions

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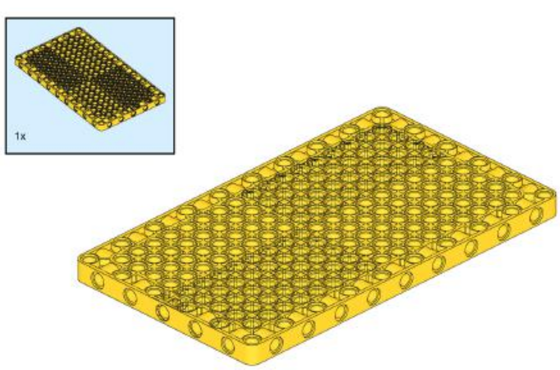

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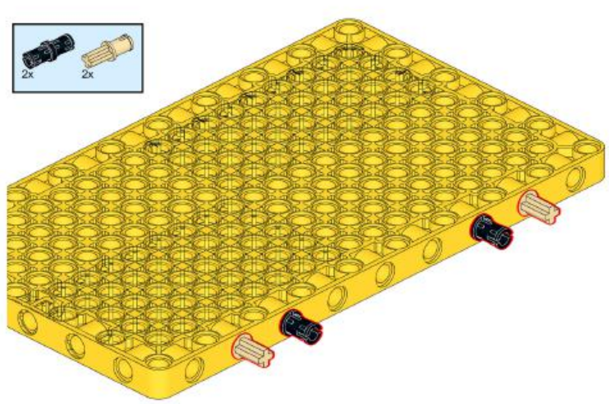
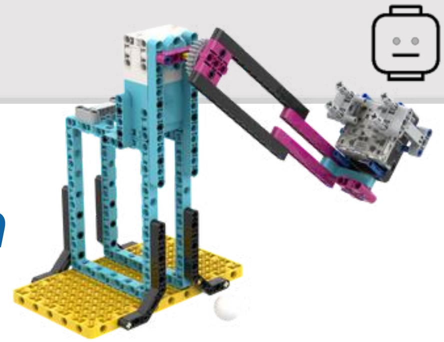


Putter Perfection



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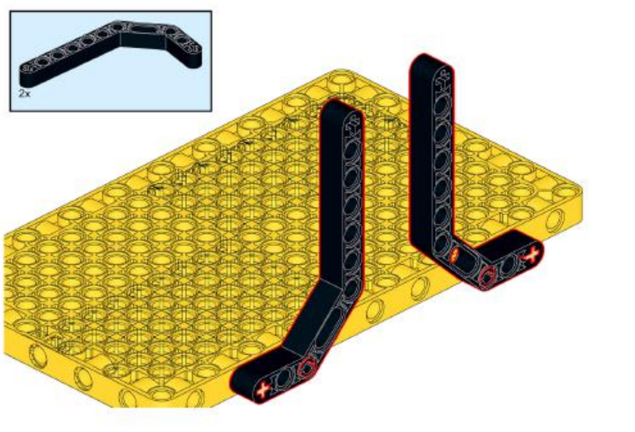

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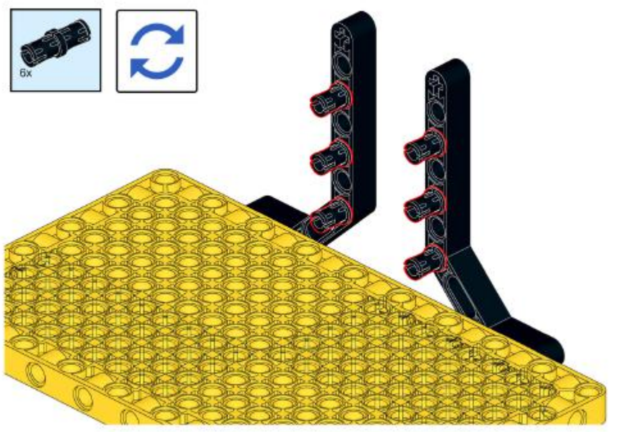

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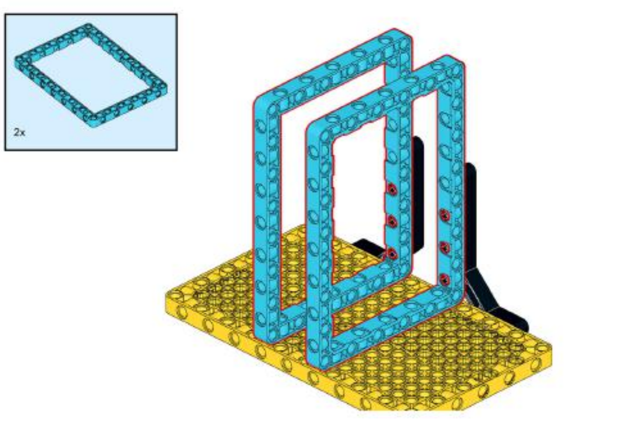

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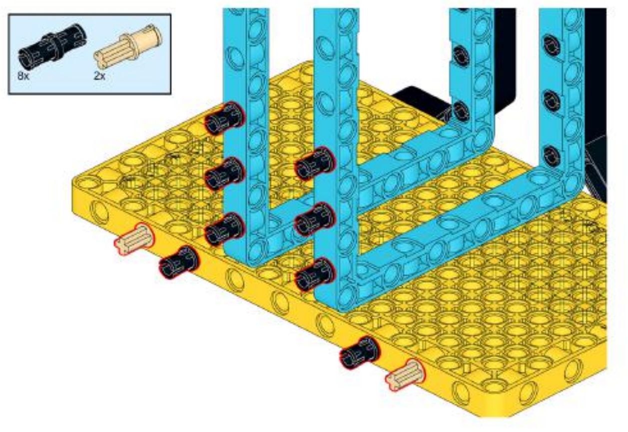

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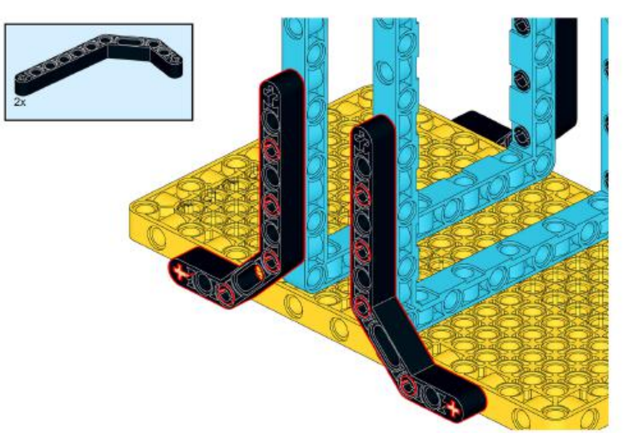

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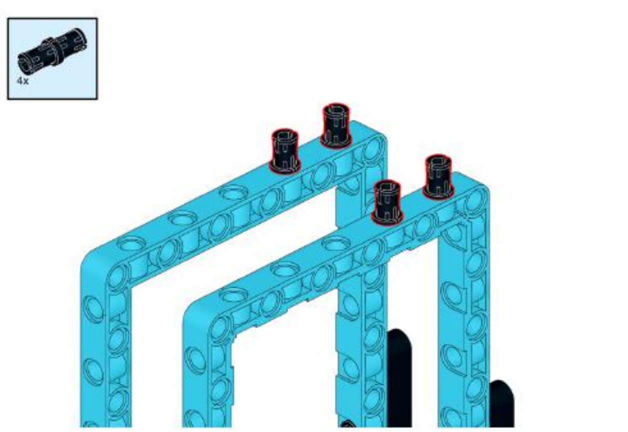

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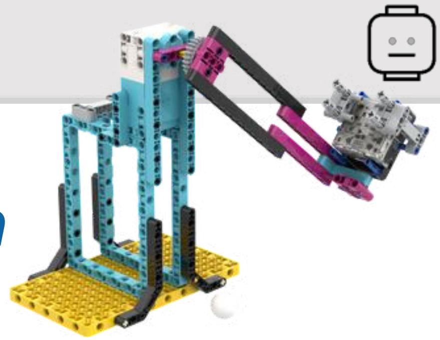

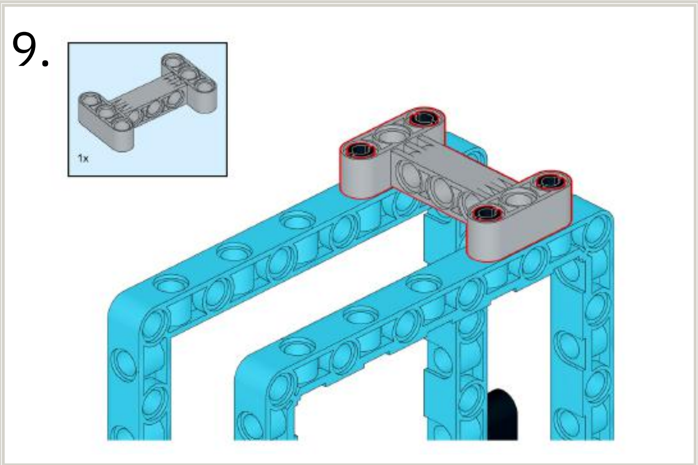

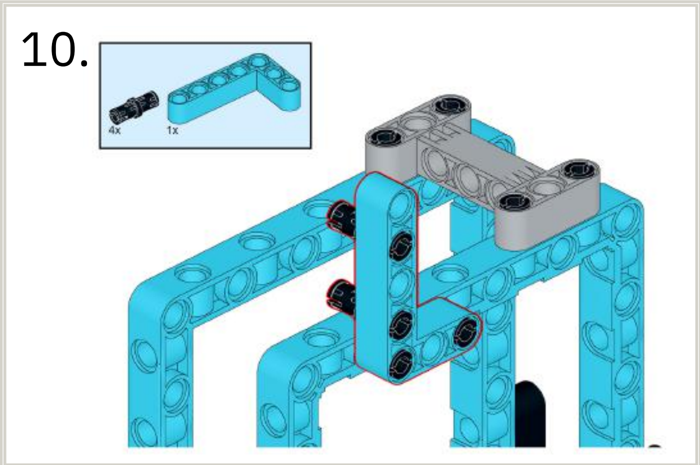

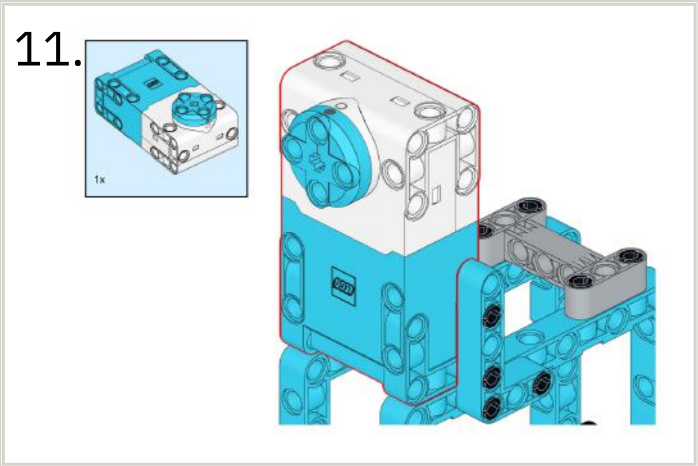

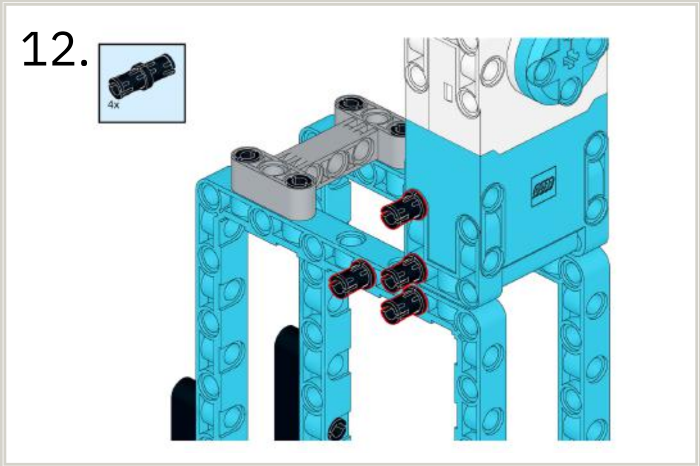

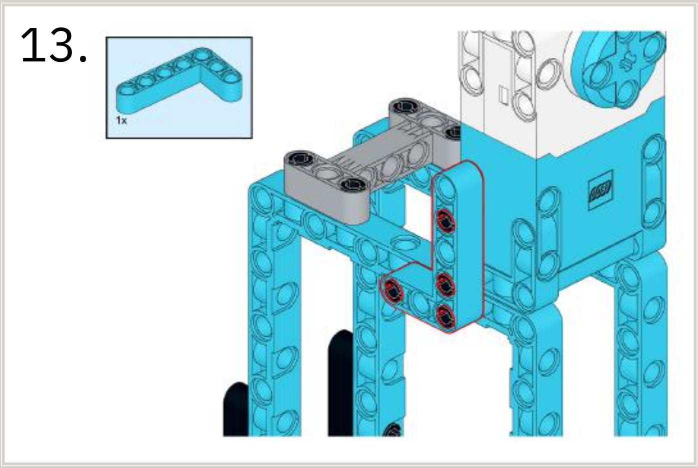

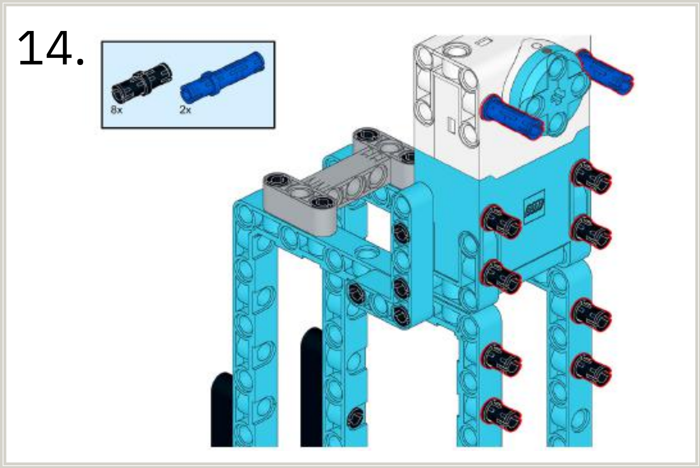

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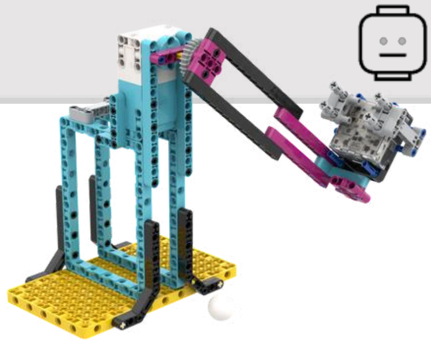

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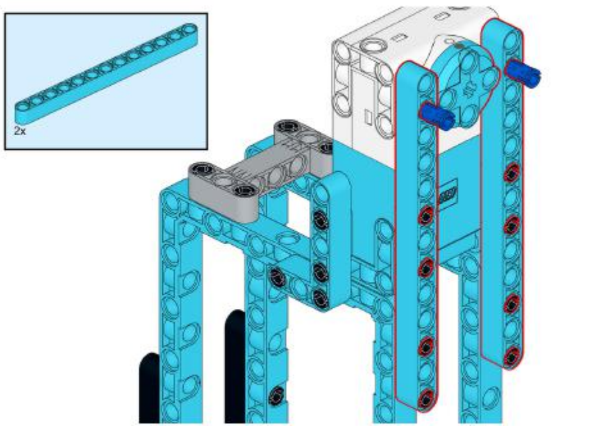

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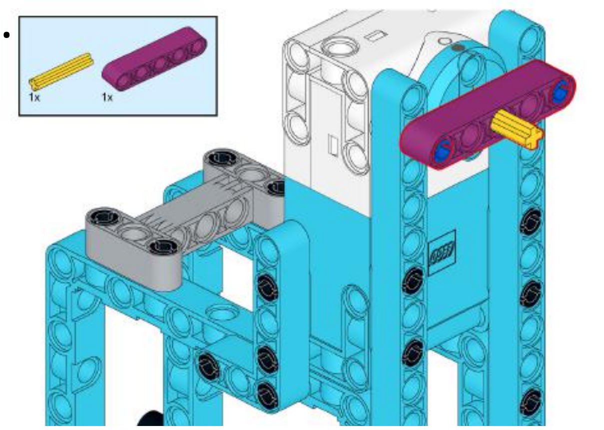

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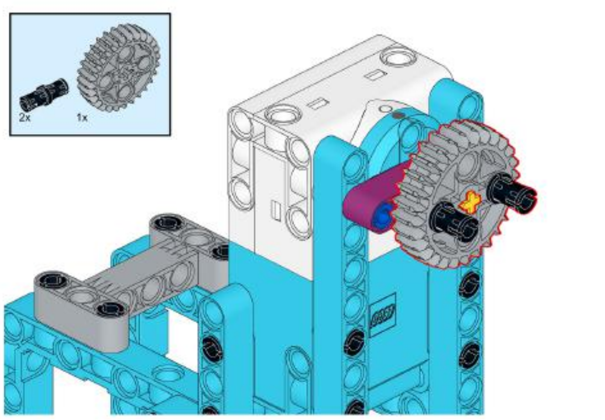

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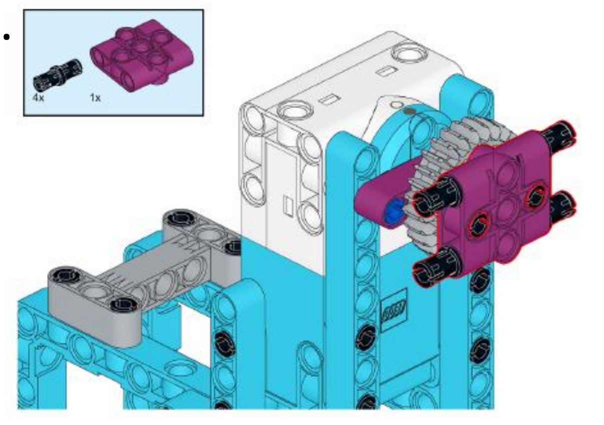

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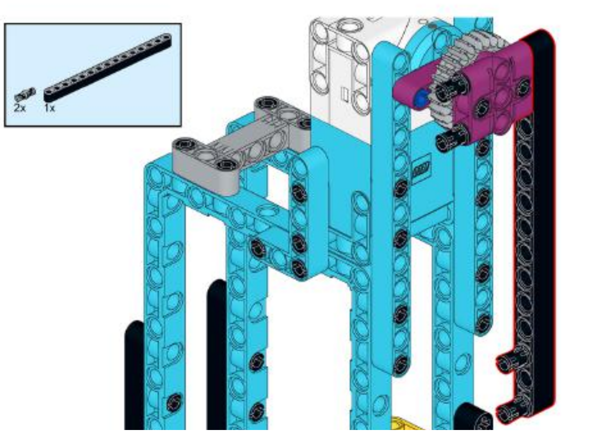

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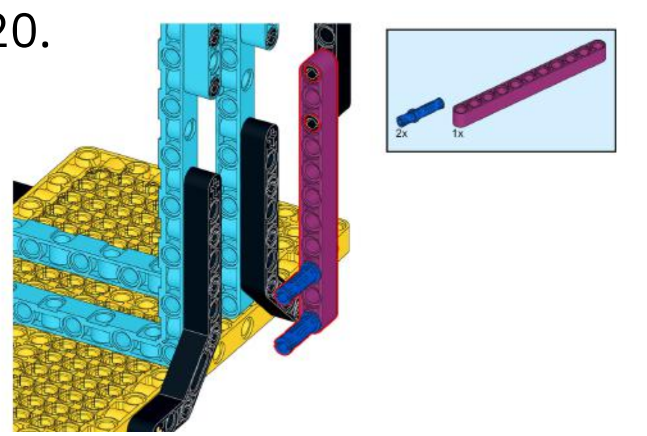

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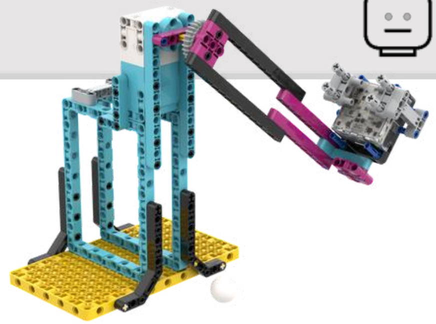

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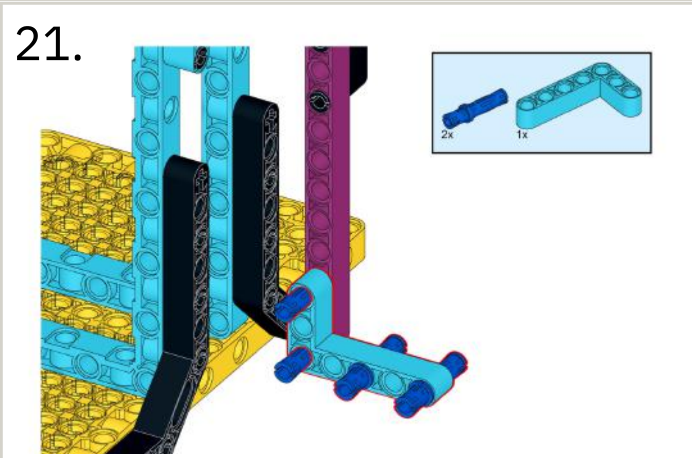

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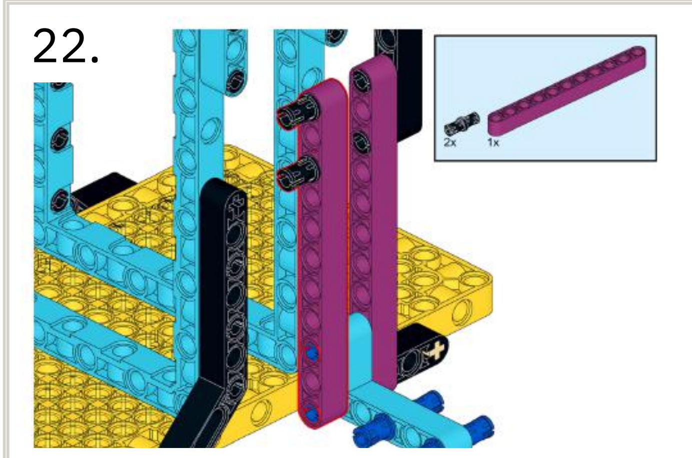

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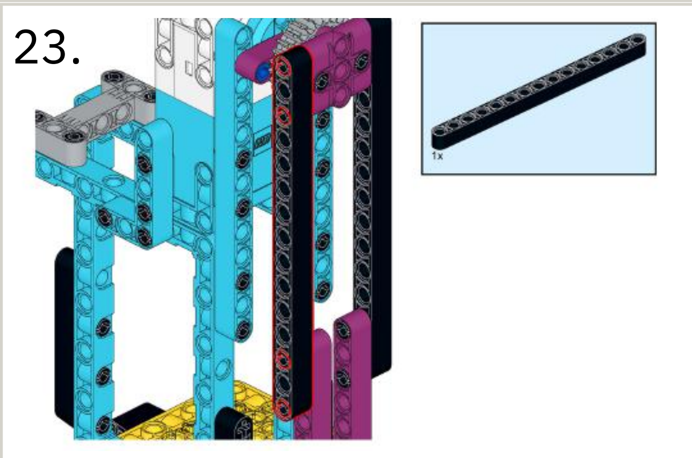

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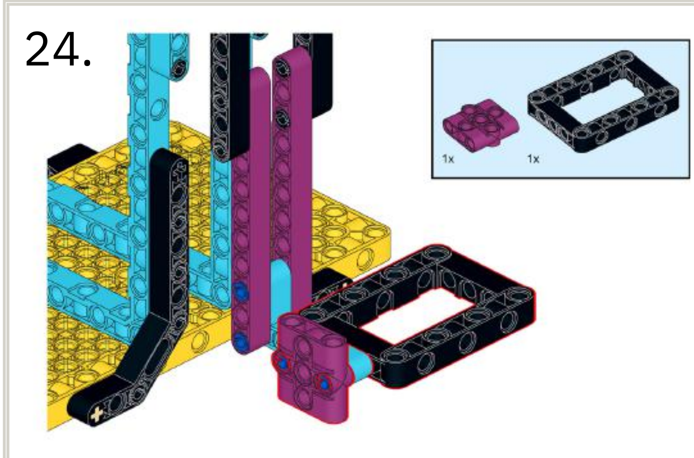

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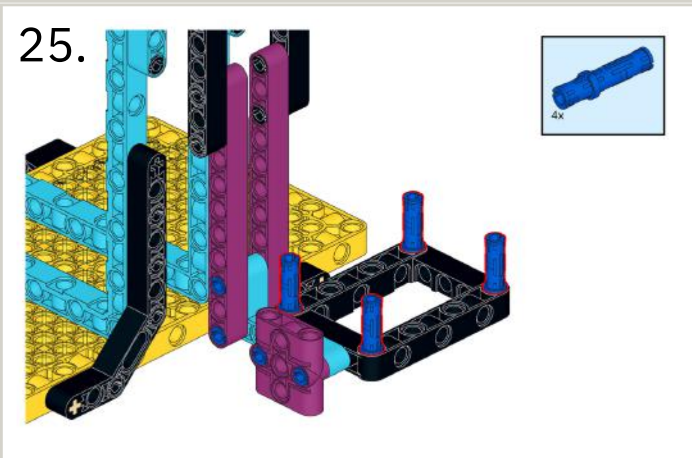

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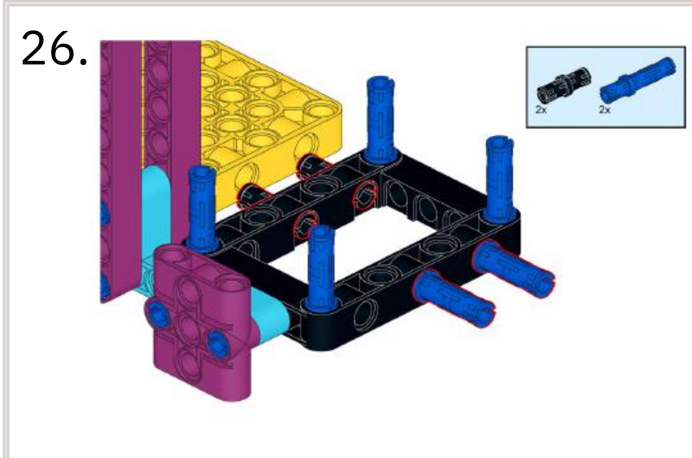

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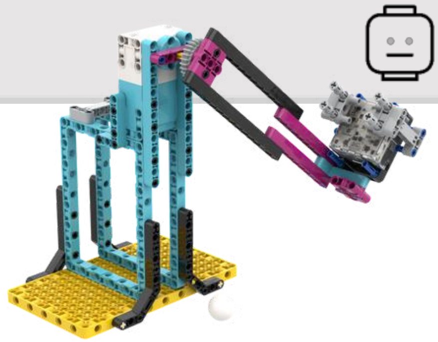

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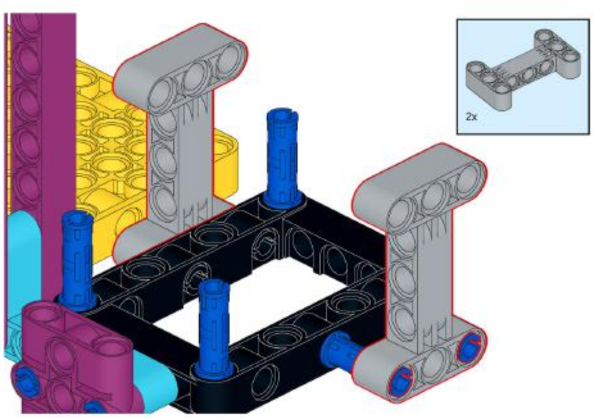

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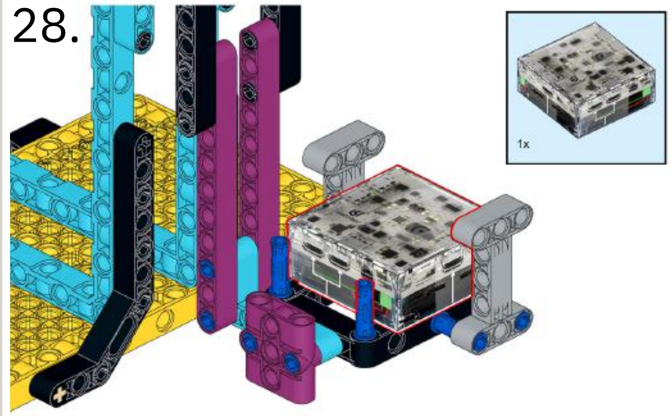

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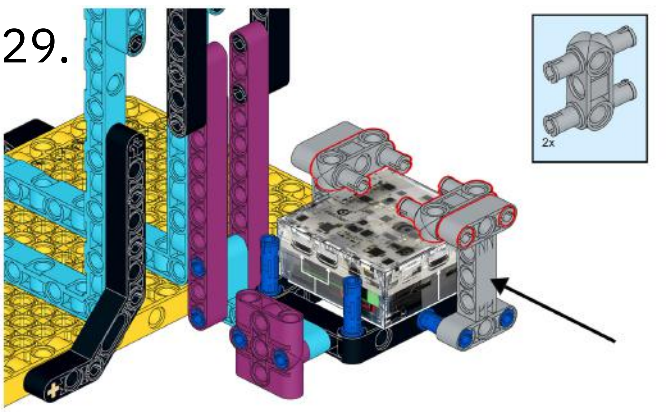

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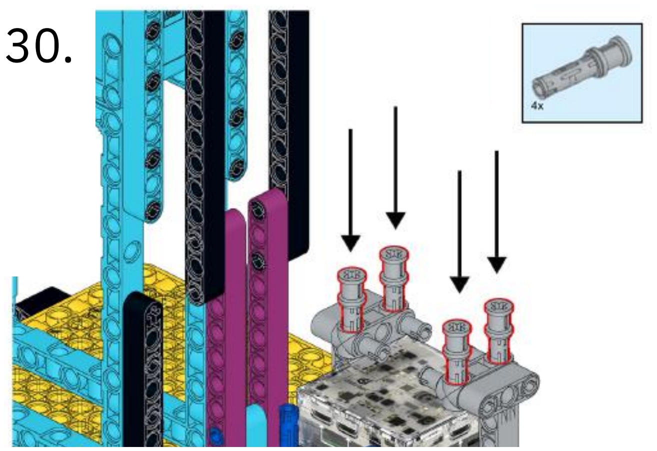

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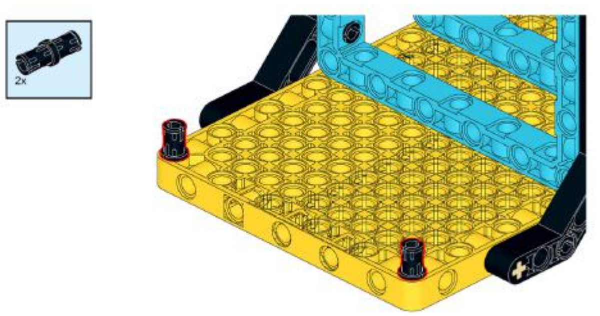

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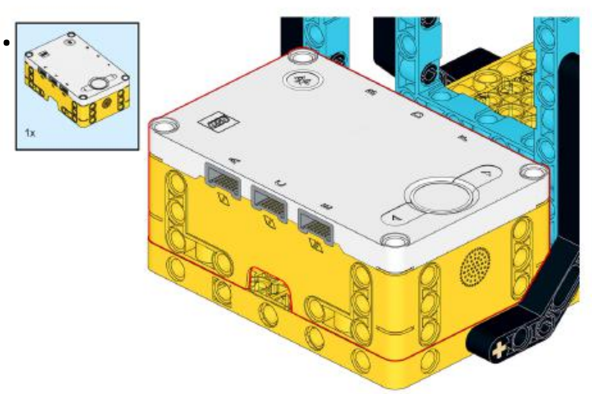

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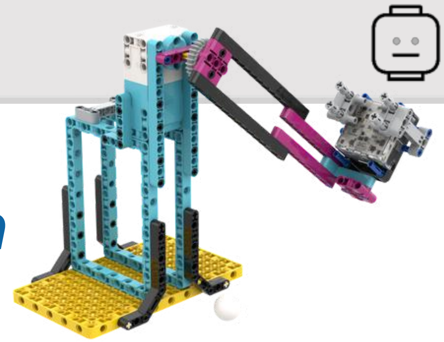
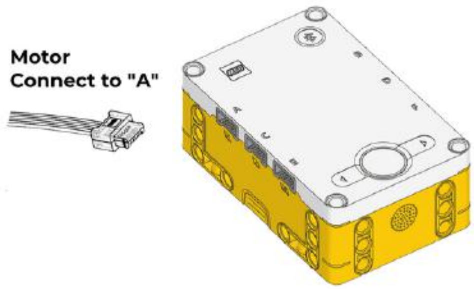
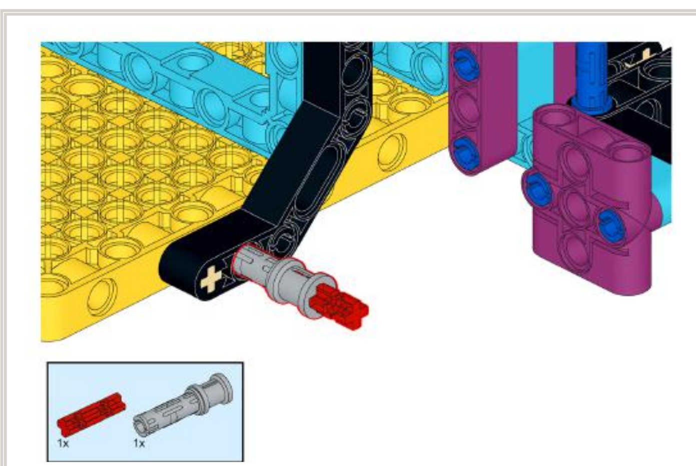


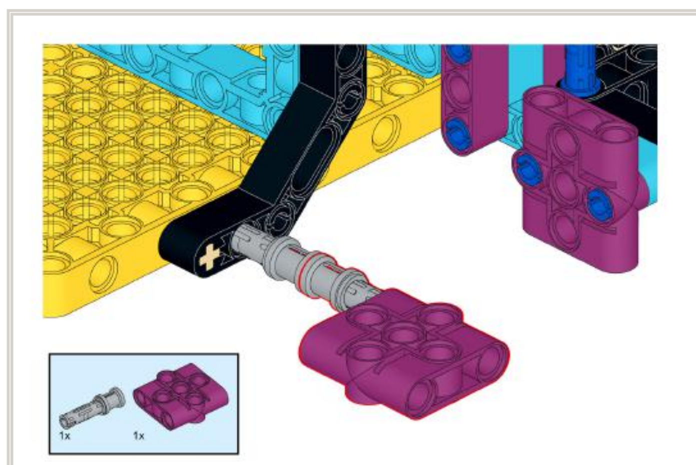


**After you finish building the model, don't forget to connect the motor to the block. In this mission, we connect it to Port A.*

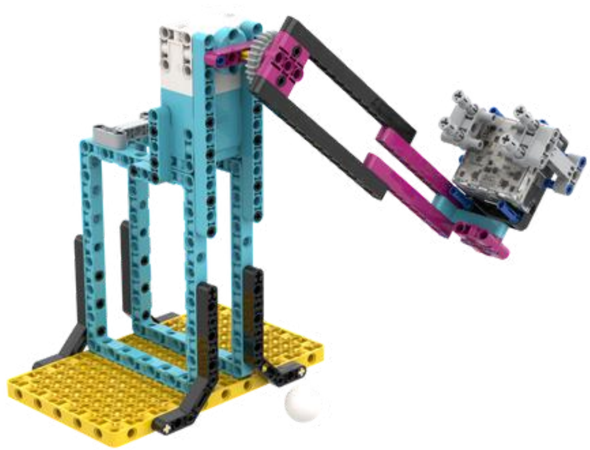
Tips for Perfect Putter

- Make changes as you see fit that will improve the design!
- Experiment and create.
- Devise a method to
  - weigh your base plate down - the force of the swing will move the base.
  - to hold the ball in place in the same starting position for each strike.
- Set your motor to the zero position before each start.





Finished Putter



Putter Perfection
A databot™ Mission w/ LEGO® Robotics

Standards & Alignment

NGSS Standards

- Motion and Stability (MS-PS2-2)
- Engineering Design (MS-ETS1-2) (MS-ETS1-3)

Science and Engineering Practices

- 2nd Practice: Developing and Using Models
- 3rd Practice: Planning and Carrying Out Investigations
- 4th Practice: Analyzing and Interpreting Data
- 5th Practice: Using Mathematics and Computational Thinking
- 6th Practice: Constructing Explanations and Designing Solutions

ISTE Standards

- 1.1 Empowered Learner (1.1.d)
- 1.3 Knowledge Constructor (1.3.c)
- 1.5 Computational Thinker (1.5.b)
- 1.6 Creative Communicator (1.6.c)
- 1.7 Global Collaborator (1.7.b) (1.7.c) (1.7.d)

Disciplinary Core Ideas

- Forces and Motion
- Definitions of Energy
- Defining and Delimiting Engineering Problems (ETS1.A)
- Developing Possible Solutions (ETS1.B)

Crosscutting Concepts

- Patterns
- Cause and Effect
- Scale, Proportion, and Quantity
- Energy and Matter
- Structure and Function
- Stability and Change

TEKS -Texas Essential Knowledge and SkillsElementary Process TEKS

Elementary Process TEKS

- 5.2B Scientific investigation and Reasoning: Ask well defined questions
- 5.2C Scientific investigation and Reasoning: Collect and record information

Elementary Level Content TEKS

- 3.6B Force, Motion and Energy: Demonstrate how position and motion can be changed
- 5.6D Force, Motion and Energy: Test the effect of force on an object

Middle School Process TEKS

- 6.2C Scientific investigation and Reasoning: Collect and record data
- 7.2E Scientific investigation and Reasoning: Analyze data to formulate reasonable explanations

Middle School Level Content TEKS

- 6.8B Force, Motion and Energy: Identify and describe changes in position
- 6.8C Force, Motion and Energy: Calculate average speed
- 6.8D Force, Motion and Energy: Measure and graph changes in motion
- 8.6C Force, Motion and energy: Investigate and describe applications of Newton’s three laws of motion

CBSE

- 9.2.2: Represent data using various types of graphs and charts
- 9.2.3: Interpret data represented in graphical form
- 11.3.3: Use data visualization tools to represent data graphically
- Math: Data Handling - Collection of data