2023-24

CODEAVOUR 5.0
INTERNATIONAL

Track 2 - AI Robo City Challenge
Rules and Regulations

Unleashing Power of AI and Robotics
for a Sustainable Future

Version 2.0, Date: 1st January 2024

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1. Introduction

Engage in a thrilling competition where robots powered by Artificial Intelligence (AI) navigate the cityscape, tackling real-world challenges and revolutionizing urban life. Showcase your expertise in AI, Robotics, Machine Learning (ML), and intelligent systems as you shape the future of smart cities and redefine the possibilities of urban living.

In the Codeavour 5.0 International, Track 2 the AI Robo City Challenge is a physical robotics competition. The participants will design and build their **Robot with Quarky** to complete the different object-placing missions.

In Track 2, the game field of AI Robo City Challenge, your robots will help install, repair, and manage the different tasks and challenges.

The robot can be **Autonomous** (programming the robot to follow a predetermined path using the line-following technique) or **Manually** (direct control of the robot using your device) controlled and must be Do-It-Yourself (DIY).

Codeavour International will help students develop their 21st Century skills and creativity in the following areas:

- Coding
- Robotics concept
- Engineering Skills
- Artificial Intelligence
- Strategies and Planning
- Real-world problem-solving

1.1. Eligibility Criteria for Registration

Follow these simple rules and make sure you meet the criteria to join the program. These include:

- Each team can have a maximum of three members and must have one mentor/coach/guardian.
- The age group for track 2 is as follows:
  - **Elementary:** 7-10 Years
  - **Junior:** 11-14 Years
  - **Senior:** 15-18 Years
- All the participants must meet the age group and team size criteria.

1.1.1. Team Registration

Complete your team registration to participate in the world's biggest AI, Coding, and Robotics fest.

To register for this competition, participants must visit the Codeavour 5.0 International website and complete the registration process:

Registration Link: https://codeavour.org/register/

1.1.2. Learning Resources

Participants can access training resources on the Codeavour 5.0 official website, which offers comprehensive material for learning Coding, AI, Machine Learning, and more.

LMS: https://codeavour.org/learning-resource/

1.1.3. General Rules and Regulations

Stick to the general rules and regulations for a smooth and enjoyable experience.

- The robot should be programmed using PictoBlox only. Participants can use any coding environment inside the PictoBlox.
- The participants must make a robot using the Quarky only.
- The mentor or coach's responsibility is limited to mentorship and guidance only, they should not be directly involved in making or controlling the robot. Any direct involvement will lead to the disqualification of the team.
- The Codeavour team will reveal surprise rules on the competition day for participating teams, ensuring an engaging and fair experience for all.

2. Game Arena and Specification

Game Field Size: 45 in x 93 in

● Path width: 15cm
● Width of black line: 1.5 cm
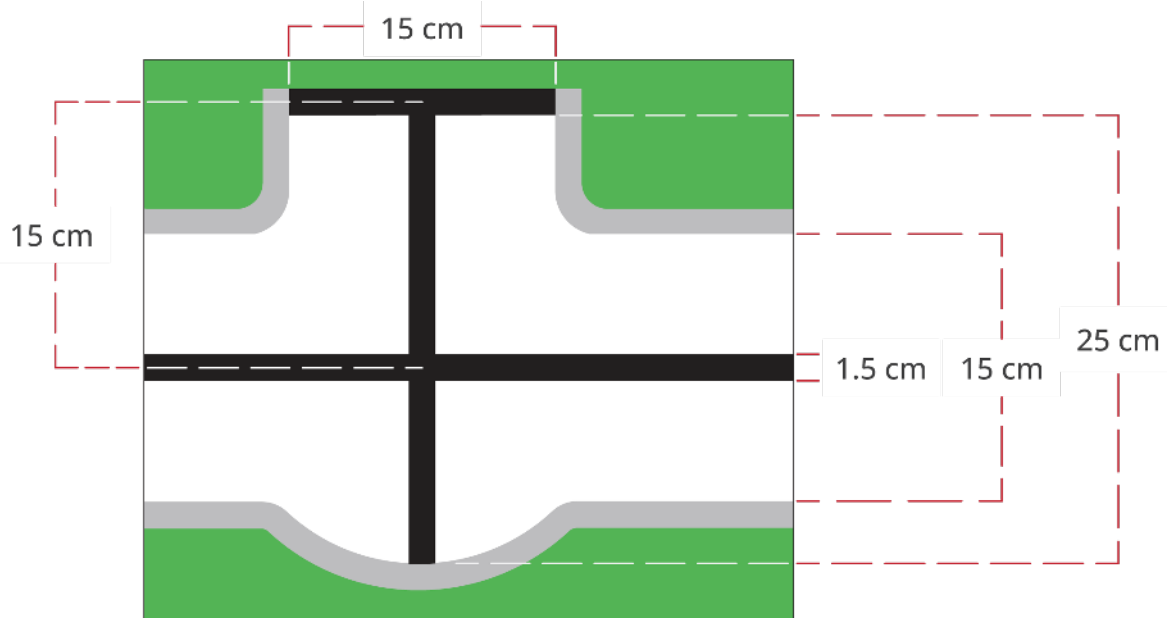
Pathway Dimensions

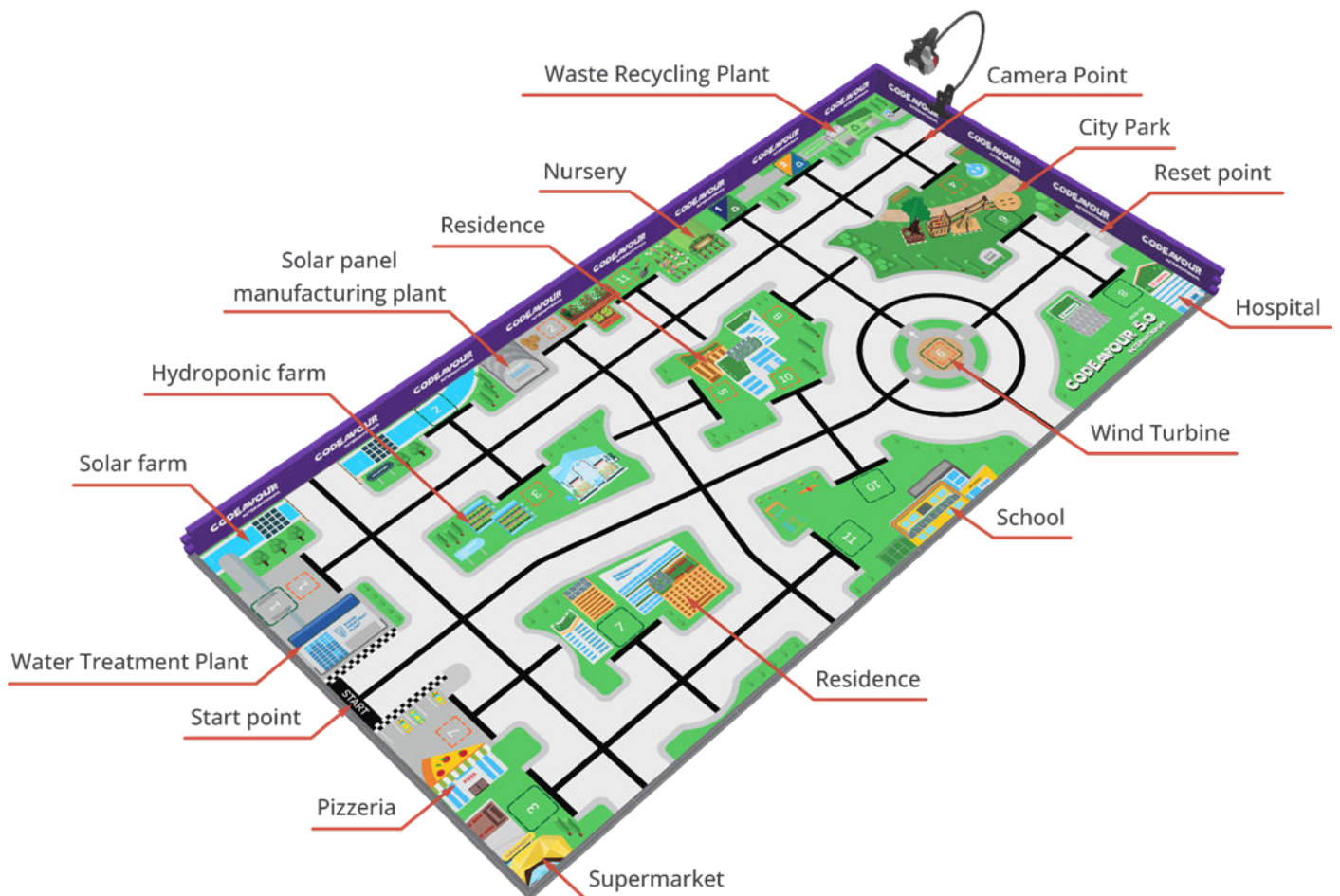The game field/arena is marked at various places with red outlines for pick-up and green outlines for drop locations. Initially, an object is placed on the red outlined area, and a robot will be responsible for moving it to the drop location.

Pick-up Point   **Drop Point**
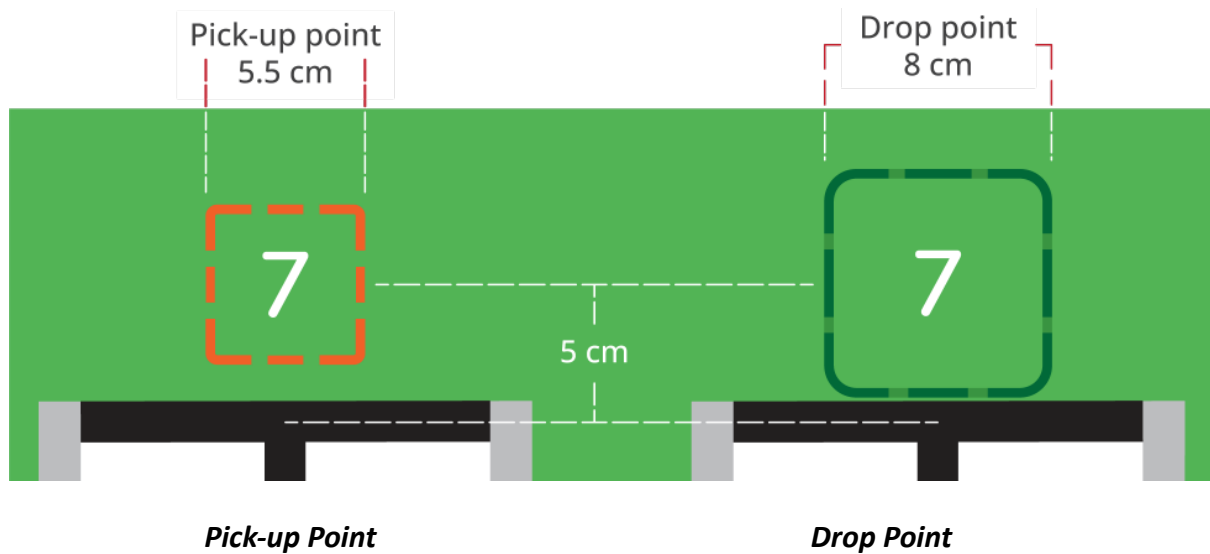
2.1. Arena for AI Robo City Challenge

2.2. Game Objects, Positioning, and Randomization

Various objects are placed inside the arena for the challenges; each element differs according to the specific challenge. The object's appearance will be different, but its size and shape will remain the same, as shown below:

2.2.1. Objects

Participants can use various methods to correctly position the object cubes, such as Pick and Place, Grab, Push Pull, and more.

1. Pipe Coupling

2. Solar Panel

3. Vegetables

4. Biodegradable Waste

5. Non-Biodegradable Waste

6. Wind Turbine

7. Pizza

8. Ambulance

9. Weight

10. Children

11. Plant

12. Waste Bin 1

13. Waste Bin 2

The "**Rescue Crane**" is a unique mechanism in the competition arena. This rescue crane has two sides: one side has a counterweight, and the other has a fireman rescuing a cat. The participating team's objective is to strategically remove the counterweight, allowing the fireman to get down safely, and rescue the cat from the tree.

Rescue Crane (Challenge 9)

2.3. Arena Set-up

- **Initial Configuration:** All objects and elements will be arranged on the arena according to the provided setup diagram.
  Note: Before the match, the judge may decide to randomly shuffle the cubes for activities 4 and 5.
- **Pickup Point:** The game field elements will be positioned at the Pickup point for teams to interact with during the competition.
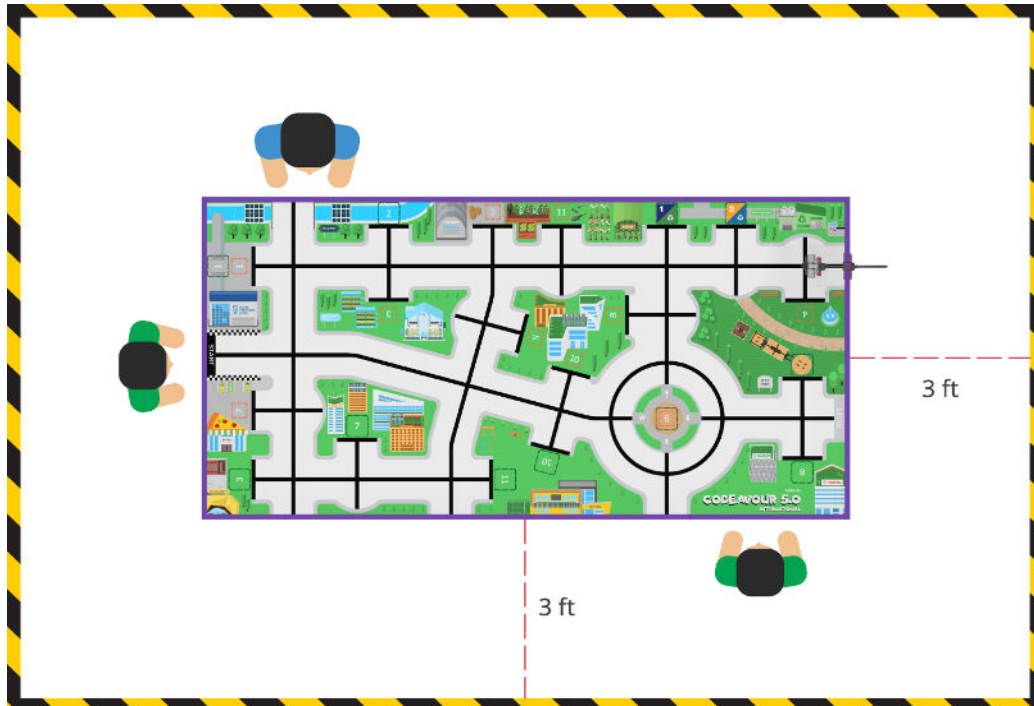

Initial Positions of Arena Objects (Elementary)

Initial Positions of Arena Objects (Junior/Senior)

- **Area:** The pit area will be marked with yellow and black floor marking tape.
- **Team Space:** Team members will have a designated area of 3 feet around the arena inside the pit for their activities and observations.
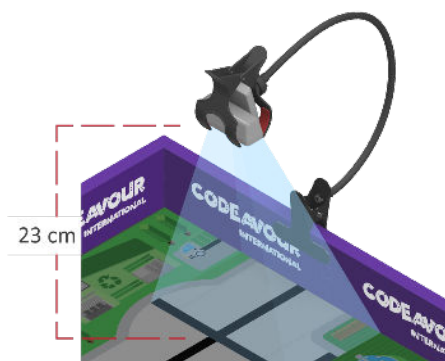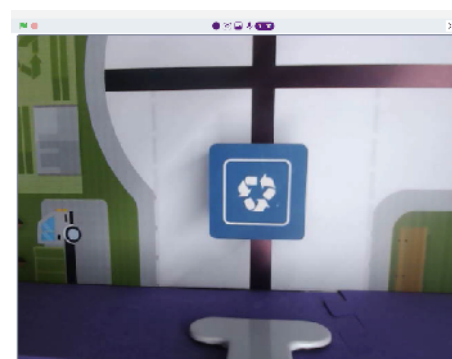

Arena Pit Area

2.3.1. Camera Set-up

A web camera will be placed at a distance of 23 cm from the arena for the AI-based challenges (challenges 4 and 5).

Note: The participant(s) must consult with the judge regarding the camera configuration. They are not permitted to handle or adjust the camera mount/camera before or during the match.

Camera Position

Camera Field of View

2.3.2. Camera Specification

Connection Type: Wired, USB 2.0   Capture Resolution:
Camera FOV: DFOV 95°   FHD (1920 x 1080)

3. Mission and Challenges

There are 11 challenges. Participants must complete as many as possible within 5 minutes. After time out, no incomplete task will be scored.

Participants can prepare the strategy and set their challenges in a sequence with the robot. To complete the challenges, participants can use Manual and/or Autonomous controlled robots as per the age groups:

- **Elementary:**
  The participants from the elementary age group can use a manual robot entirely for all the challenges. Opting for an autonomous robot in any challenge results in scoring advantages.

- **Junior/Senior:**
  The Junior and Senior participants can use Manual/Autonomous robots, with at least one challenge with an autonomous robot. You have the freedom to select your challenge on competition day. However, if you cannot independently complete the task, you will not earn points for that particular challenge.

  Note: Completing a challenge with autonomous robots is rewarded with double points compared to manual robots for that challenge. This strategic choice boosts a team's score significantly, offering a competitive advantage.

3.1. Challenges

Begin your championship journey with 11 exciting challenges to conquer.

3.1.1. Challenge 1: Water Treatment Plant Project

Water is essential for human survival, and it is crucial to ensure a steady supply of clean water for all individuals. In this challenge, there has been an unfortunate incident where the pipeline supplying water has been damaged at the water supply plant. The team is tasked with promptly identifying and repairing the damage, ensuring uninterrupted water flow to the residential areas.
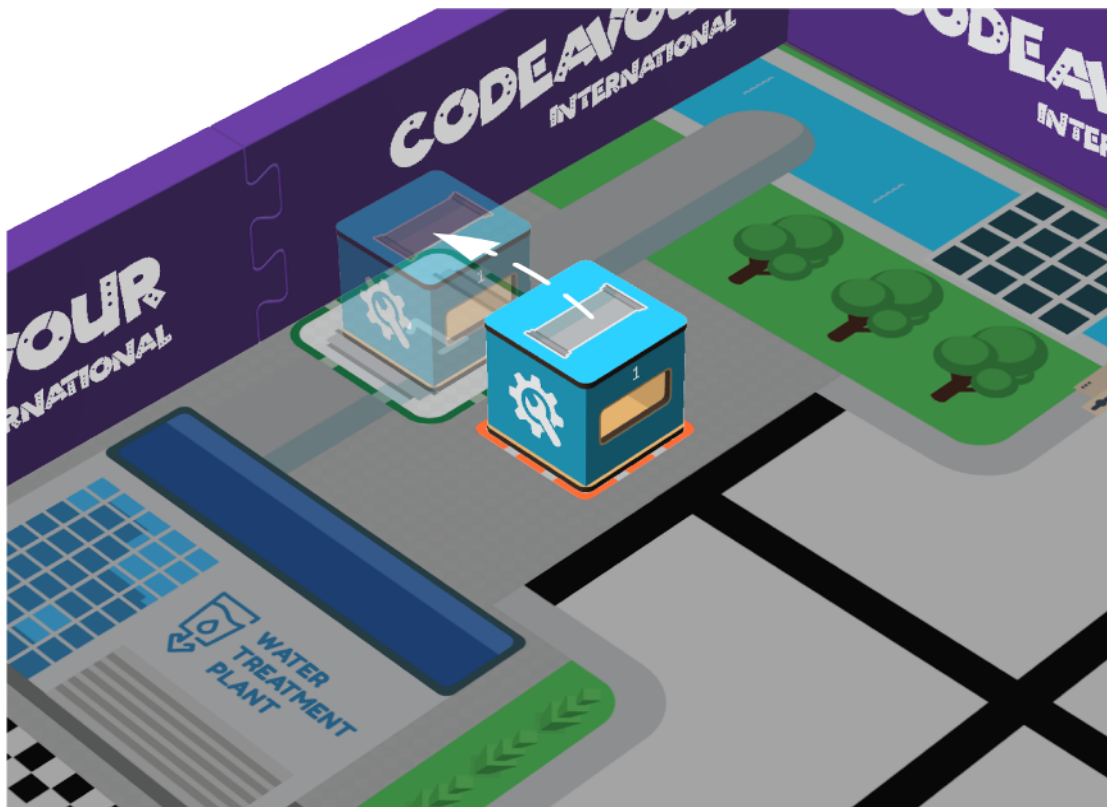
Challenge 1: Complete the Water Treatment Plant construction

3.1.2. Challenge 2: Canal Solar Power Project

Solar energy is a reliable renewable energy source that can help reduce our dependence on fossil fuels and tackle climate change. It is a crucial solution for sustainably meeting the growing global energy needs because it can be easily scaled up and cost-effective. The young innovator plans to use their robot to install solar panels over the river to make a positive impact.
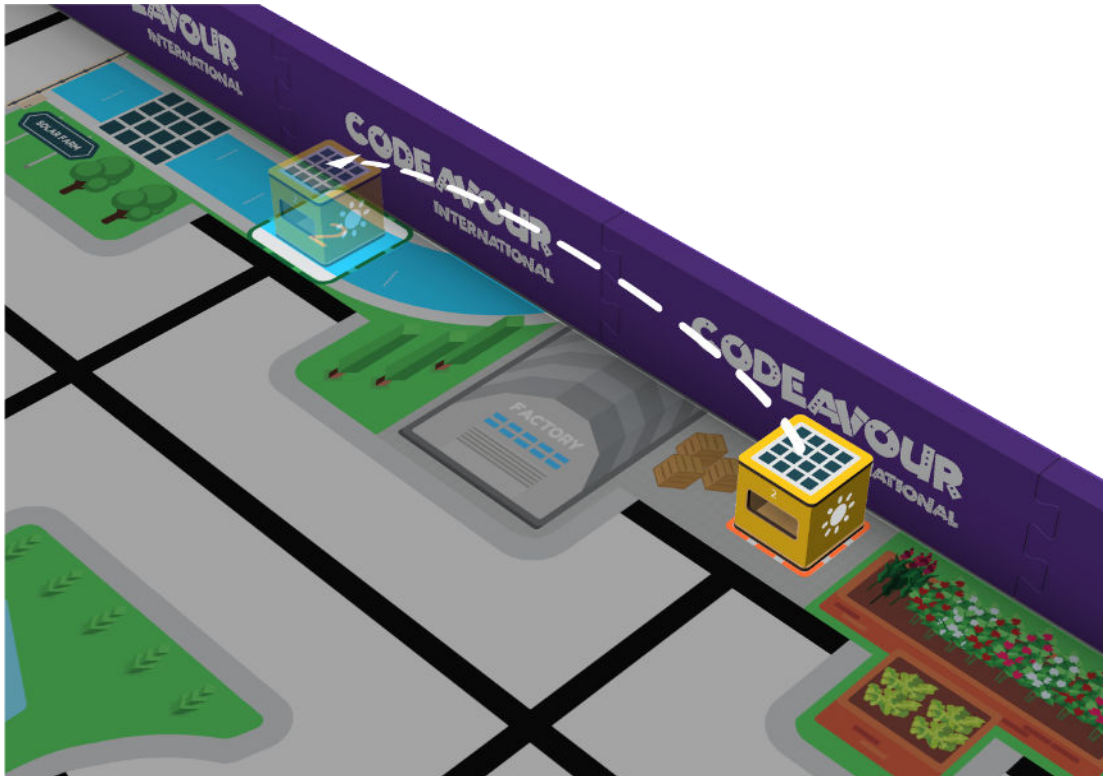
Challenge 2: Install solar panels on canal

3.1.3. Challenge 3: Hydroponic Farm Produce Supply

Hydroponics helps make urban farming more sustainable by increasing crop yields, conserving water, and eliminating the need for pesticides. This approach minimizes environmental harm and ensures food security in cities. The mission is to collect the vegetables from the farm and transport them to the store.
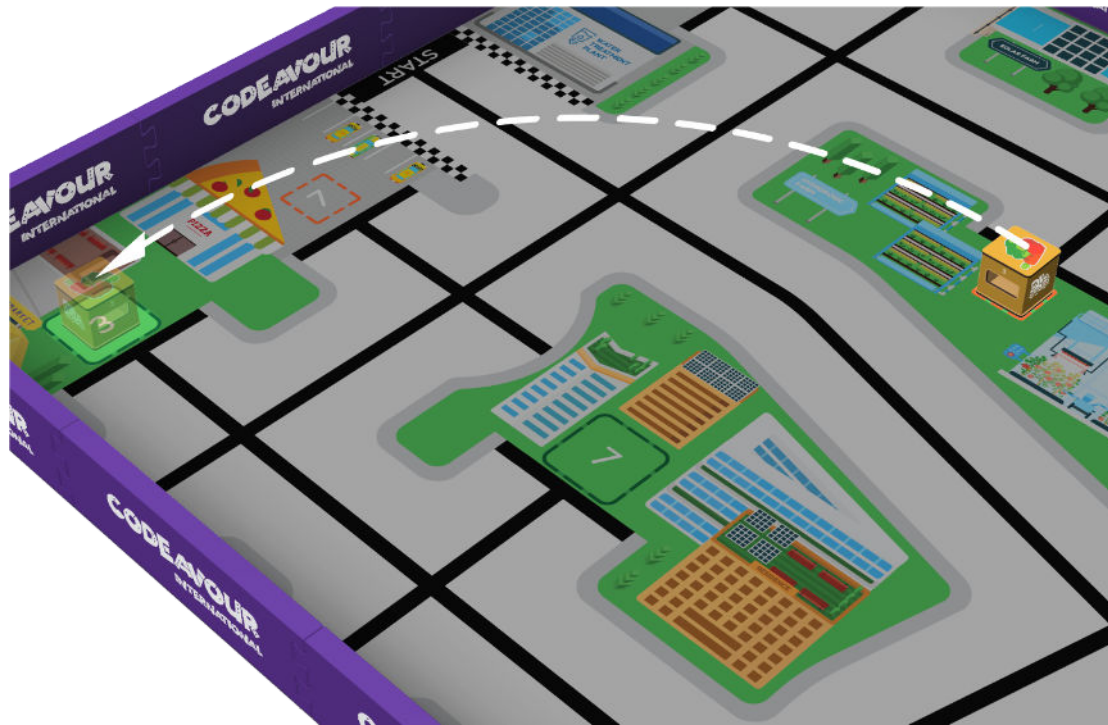
Challenge 3: Deliver Veggies to the Supermarket From a Hydroponics Farm

3.1.4. Challenge 4: Clean the Park

Keeping parks clean is essential in smart cities. Clean parks make the city a better place to live and visit because they are nice spots to relax and have fun. In Smart cities, clean parks also help care for the environment. In the mission, collect the waste from the City Park and identify whether it is biodegradable or non-biodegradable; dispose of it accordingly.

Conditions:

● One object will be randomly placed on Pickup point 4 (Biodegradable or Non-biodegradable).

● In this challenge, the **Junior/Senior** participants must use a Machine Learning environment to train the custom model with Biodegradable and Non-biodegradable waste images to identify the type of waste.

● **Elementary** participants can use the pre-trained model in the card recognition extension available in the PictoBlox (The color or number of the recognized card should be displayed on the Quarky display.)

Case 1

Non-biodegradable waste
(For Junior/Senior Age Group)

Case 2

Biodegradable waste
(For Junior/Senior Age Group)

Case 1

Waste bin 1
(For Elementary Age Group)

Case 2

Waste bin 2
(For Elementary Age Group)

Note:

1. Activities 4 and 5 have identical conditions.

2. For the card recognition, participants must display the output on Quirky as shown below-given images or they need to show the cube's name on PictoBlox Stage.

Non-biodegradable waste
(For Junior/Senior Age Group)

Biodegradable waste
(For Junior/Senior Age Group)
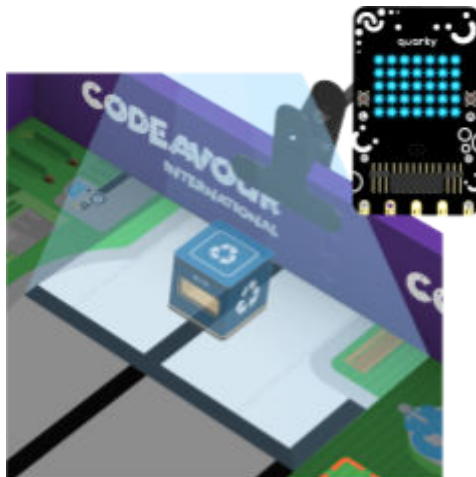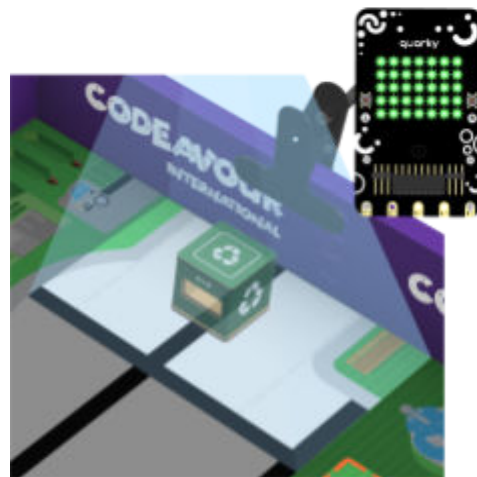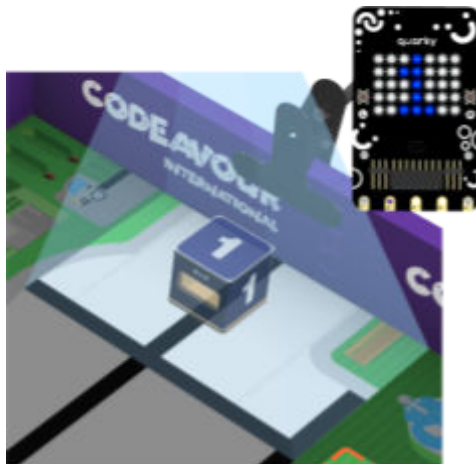

Waste Bin 1
(For Elementary Age Group)
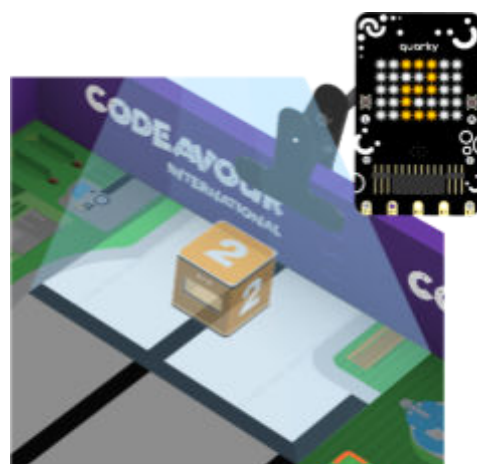
Waste Bin 2
(For Elementary Age Group)

3.1.5. Challenge 5: AI-powered Residential Waste Collection

Insufficient waste management infrastructure and systems lead to ineffective disposal and possible environmental pollution. Moreover, residents need more awareness and participation in separating and recycling waste to meet the city's sustainability goals. Collect the waste from the residence and identify whether it is biodegradable or non-biodegradable; dispose of it accordingly.

Conditions:

- One object will be randomly placed on Pickup point 5 (Biodegradable or Non-biodegradable).

- In this challenge, the **Junior/Senior** participants must use a Machine Learning environment to train the custom model with Biodegradable and Non-biodegradable waste images to identify the type of waste.

- **Elementary** participants can use the pre-trained model in the card recognition extension available in the PictoBlox (The color or number of the recognized card should be displayed on the Quarky display.)

Case 1

Non-biodegradable waste
(For Junior/Senior Age Group)

Case 2

Biodegradable waste
(For Junior/Senior Age Group)

Case 1

Waste Bin 1
(Biodegradable waste)
(Elementary Age Group)

Case 2

Waste Bin 2
*(Non-Biodegradable waste)*
(Elementary Age Group)

Note:

1. *Activities 4 and 5 have identical conditions.*

2. *For the card recognition, participants must display the output on Quirky as shown below-given images or they need to show the cube's name on PictoBlox Stage.*
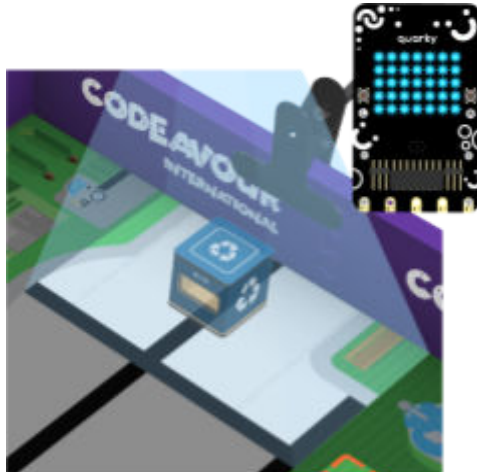
Non-biodegradable waste
(For Junior/Senior Age Group)

Biodegradable waste
(For Junior/Senior Age Group)
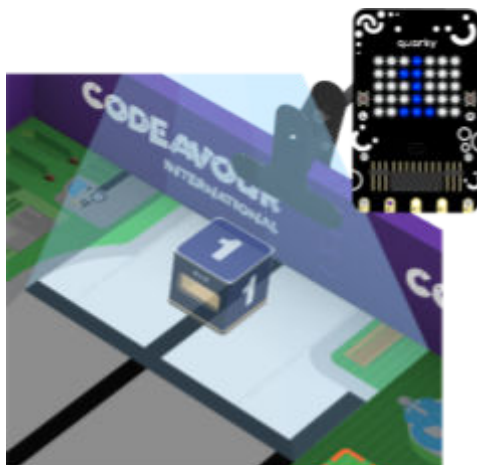
Waste Bin 1
(For Elementary Age Group)
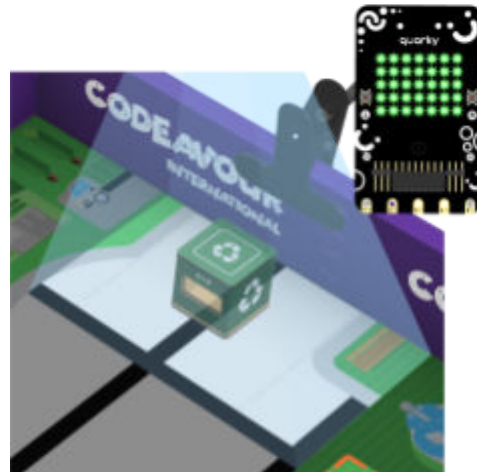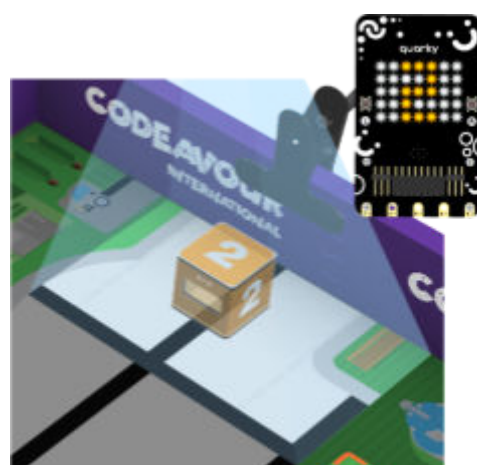

Waste Bin 2
(For Elementary Age Group)

3.1.6. Challenge 6: Redirect the Wind Turbine

Windmills and wind energy are crucial in smart cities as they enable us to harness electricity from the wind. It is essential to align the windmill with the direction of the wind flow to optimize energy generation.

The windmill will be initially placed randomly in any direction: South (S), East (E), or West (W). Participants' robots must change the windmill's position to face North (⇧) and align the North direction arrow with the windmill arrow.

Case 1
Object Direction East

Case 2
Object Direction South

Case 3
Object Direction West

Correct Direction "North"

3.1.7. Challenge 7: Smart Pizza Delivery

In the world of smart delivery robots for a smart and sustainable city, the Autonomous Food Delivery Bot is an intelligent robot designed to pick up pizzas from the outlet and deliver them directly to customers.
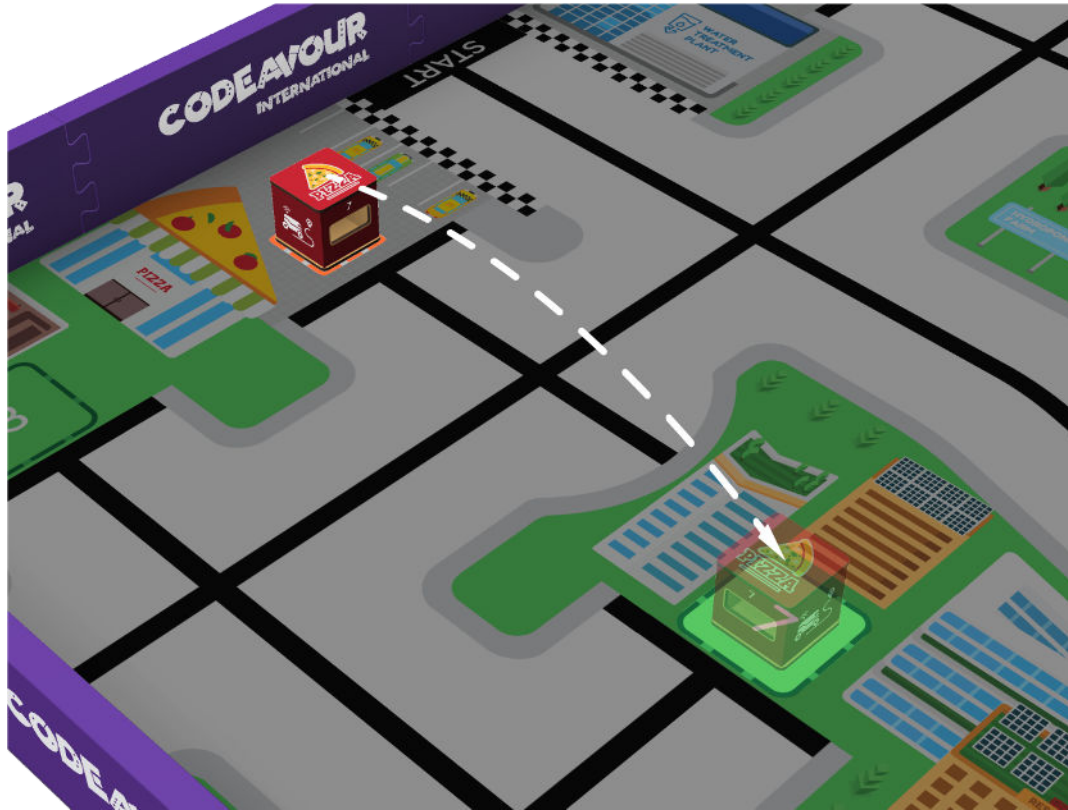
Challenge 7: Smart Pizza Delivery

3.1.8. Challenge 8: Autonomous Ambulance Service

The rapid development of autonomous driving technology leads to the proliferation of driverless vehicles. In healthcare, real-time traffic monitoring and optimized routes improve the efficiency of accessing the hospital. Here the call is to get the patient to the hospital quickly and safely.

Challenge 8: Get the patient to the hospital quick and safe

3.1.9. Challenge 9: Rescue the Cat

A curious cat has climbed up a tree but cannot return. The mission is to design and program a robot to rescue this stuck cat safely. The rescue team has a crane ready to help a cat stuck in a tree. Participants must remove the crane's counterweight and safely lower the cat to the ground to complete the rescue mission.

Rescue Crane Initial Position
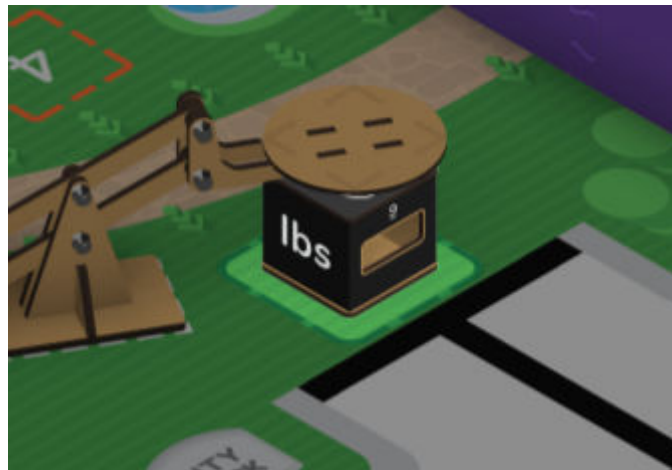
Rescue Crane Final Position

3.1.10. Challenge 10: Road Safety Robot

A busy road filled with traffic and a group of kids desperately trying to cross to the other side. Your mission is to help them and ensure their safe passage across this challenging road.
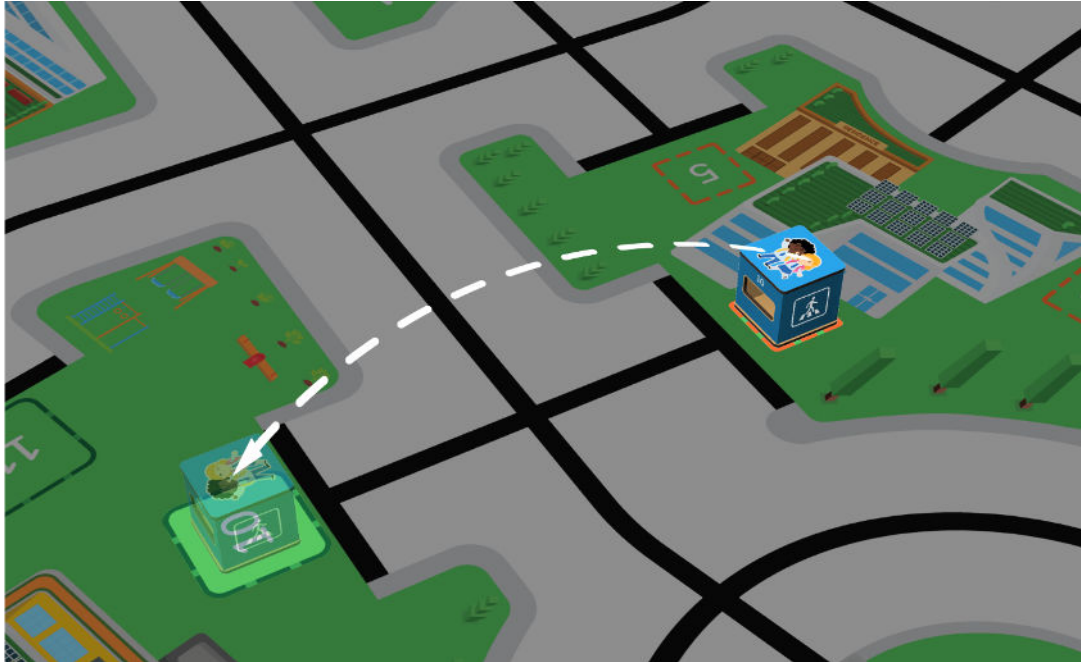
Challenge 10: Help the Kids Cross the Street to Get to the School

3.1.11. Challenge 11: Green City Project

The robots are not just machines; they are eco-warriors. In the mission, the robot will pick the tree and take it to the park for the plantation. Let us plant trees for a green and better world.

Challenge 11: Smart Tree-Planting robot planting a tree

4. Robot Material and Regulations

All the hardware brought by the team to the competition, viz the robot, accessories, and other attachments for the robot, are specified below. The entire robot must be designed as per the mentioned guidelines:

- **Hardware/Microcontroller:** Quarky Board (Max qty:1; No other microcontroller is permitted).
- **Programming Software:** PictoBlox (Participants can use different environments available in PictoBlox).
- **Power Supply:** Battery Operated with a maximum allowed Voltage of 5 Volts between any two terminals.
- **Add on Board:** Quarky Expansion Board (Max qty:1).
- **Robot size:** 20x20x20cm LBH (maximum).
- **Maximum Weight:** 1.5 kg.
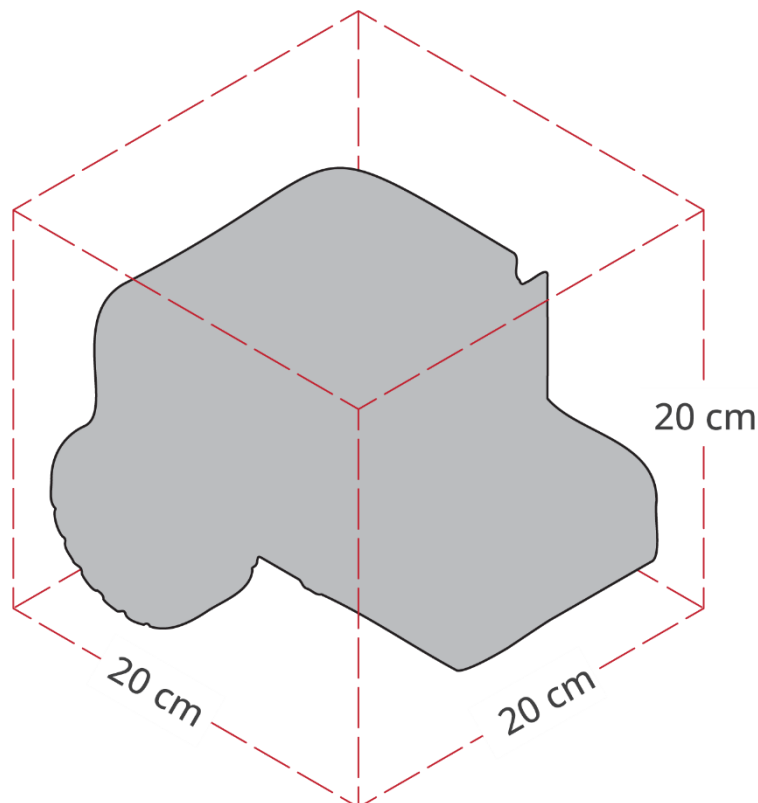
- **Add-on Parts:** Participants are free to choose the additional construction components as per their robot design (3D printed parts, Laser cut MDF parts, Lego components, Ice Cream sticks, and more).
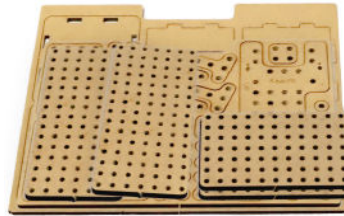
Lego pieces   *MDF parts*   *4 Pin IR sensor*
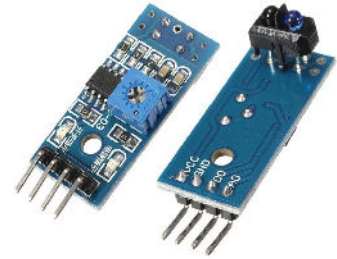
Note:
1. *You can use any sensors compatible with Quirky.*
2. *DC Motors up to maximum 150 RPM are allowed.*

The team must bring all the necessary components and tools, as no material will be provided at the venue by the organizers. This includes extra batteries, power extension cords, a soldering kit, glue, fasteners, etc.

The Robot design must not damage the game field or any of the articles in the game field in any way.

- **No exposed sharp edges:** The entire design of a robot must not have sharp edges that may harm the game field or the people around it.

- **No hazardous materials:** The Robot parts shall not be made with hazardous materials.

5. Before the Competition Round

- The robots must be fully assembled in advance before the commencement of the round.
- The participants **must verify** their robot (Quarky) & PictoBlox code by the designated Codeavour robot verification team to ensure it meets the specified requirements at a physical venue.
- Participating teams will know the time slot and game field table before the competition round.
- Before the competition round, the teams will get 10 minutes to test and set up their robots in the allotted practice arena.

Each team will receive one red card and two blue cards before the competition round and two yellow cards upon unlocking the cards by completing specific challenges;

- Participants can get a Yellow Card by completing challenge 4 or 5. Another Yellow Card will be awarded upon successful completion of challenge 6.
- Upon entering the challenge, participating teams will be equipped with Red and Blue cards.

Yellow Card (For Foul Exemptions): The team can redeem the Yellow Card to avoid negative scoring associated with that specific foul. This redemption acts as a foul exception, allowing the team to nullify the penalty and maintain their current score for that challenge.
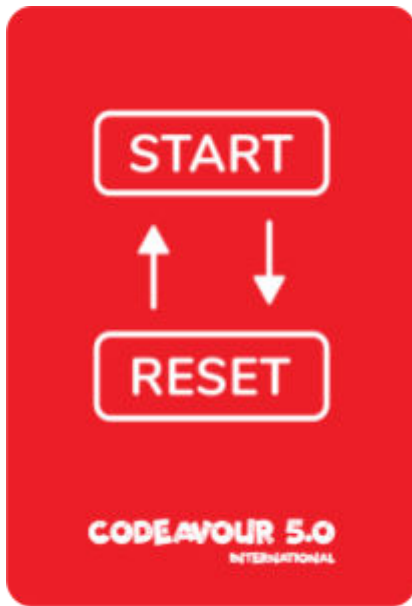
Teams must use their Yellow Cards judiciously, as they have only two chances to waive off negative scoring due to fouls. Making strategic decisions about when to redeem these cards can significantly impact a team's overall standing in the competition.

Yellow Card (2X)

Note:

- *The use of the Yellow Card to adjust/place the object at the drop point is not permitted.*

Red Card (1)

Red Card (Teleport Card): This card enables teams to deploy a teleportation strategy. Using the Red Card allows the team's robot to instantly teleport between predefined Starting / Reset points on the competition field. This strategic move can help teams swiftly change their robot's position.

Blue Card (Switch Manual/Autonomous Mode): The Blue Card allows teams to switch their robot's operational mode seamlessly. Teams can switch their robot between autonomous and manual control only once using this card. This flexibility is crucial for adapting to various challenges during the competition. Autonomous mode allows pre-programmed actions, while manual mode lets teams control their robot in real-time.

Blue Card (2X)

Note:

- *Teams can only use the red card while their robot is in the start or reset regions.*

6. During the Competition Round

- 2 minutes will be given to a team for the calibration before starting the challenge.

6.1. Do's

- Only team members are allowed near the competition (pit) area.
- The team is responsible for picking up their robot immediately on time out.
- The robot must start from the starting point, and the team will have a chance to teleport the robot to reset point using a Red Card.
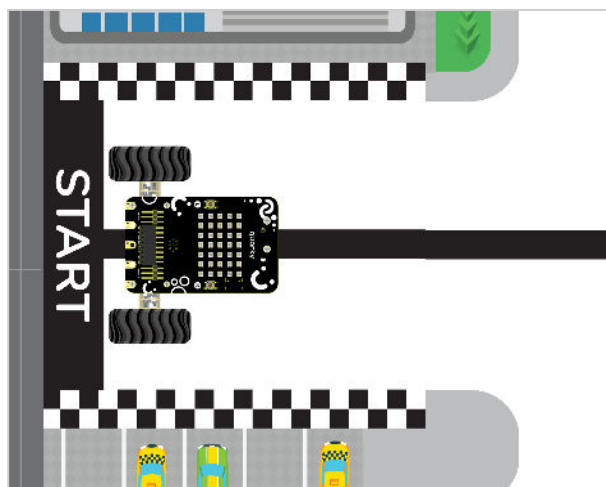
Robot Initial Position

- Robots must adhere to the specified path when approaching objects.

Correct Way to Approach Objects

- During a challenge attempted as an autonomous challenge:
  - The team should code in the way that intersections are defined. The running code should automatically switch to the code for the next challenge and be toggled when using the L and R buttons in the event of a foul or reset.
  - The team is not permitted to touch the gadget connected to the robot when it is in autonomous mode.
  - In the case of an error, such as losing an object, when conducting an autonomous task, the participants can decide either
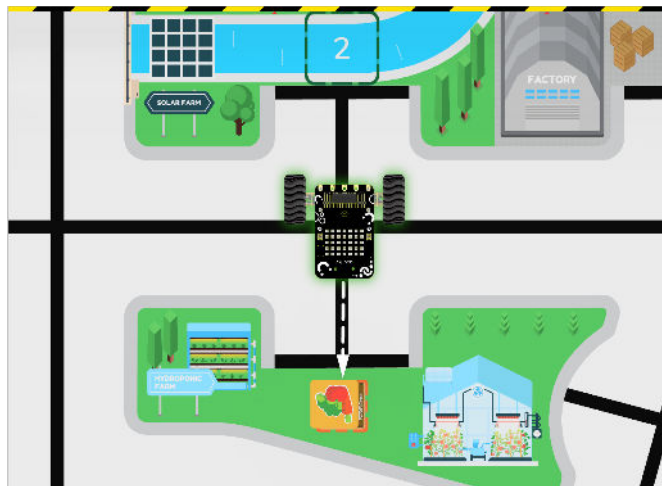   - To continue toward the next task

      OR
    - Exercise a foul to reposition their robot to one of the intersections, with the reinstating of that challenge's game object (ref. Fouls) to its original position by the referee.
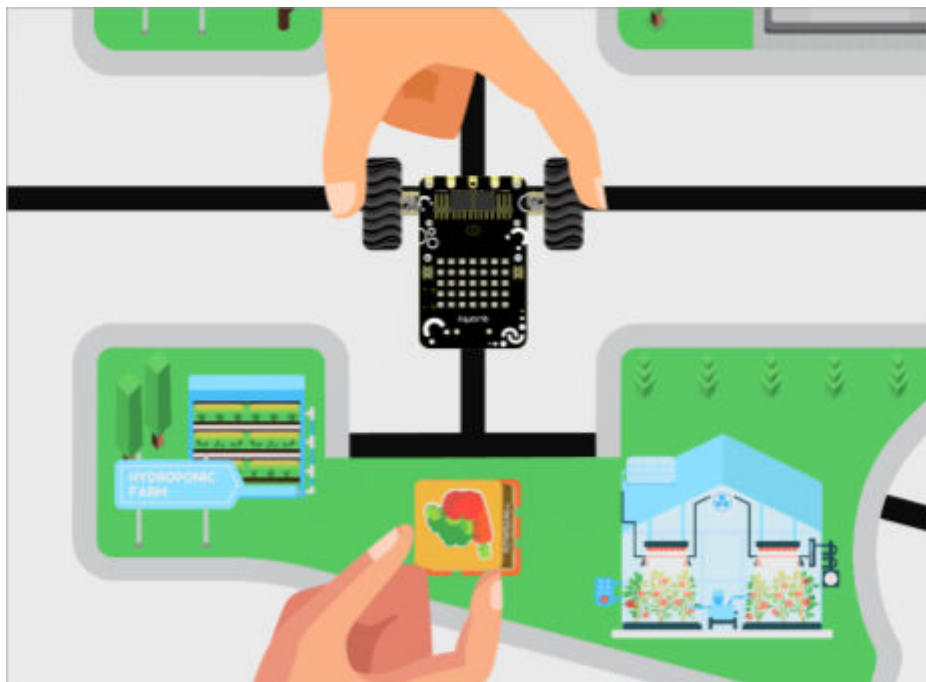
Repositioning Robot and Object

6.2. Don'ts

- It is forbidden to touch the robot during the challenge. In case of any technical issues with the robot, the team is permitted to make minor changes/fixes to the robot at the expense of foul.
- Mentors/coaches/teachers/parents/guardians are not allowed inside the Pit area.
- Do not cause any damage to the competition field, arena, or any of the given equipment, as this may result in disqualification.
- Approaching the object directly over other buildings or areas is strictly prohibited.
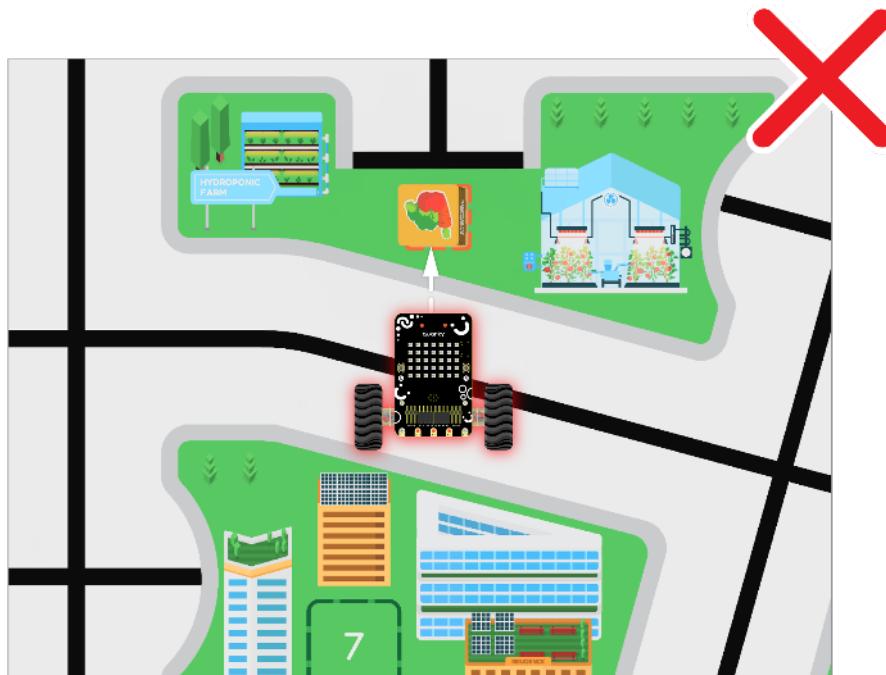
Incorrect Way to Approach Objects

7. Evaluation and Scoring

- Team submission should abide by the participation and submission guidelines; non-adherence to them will result in disqualification.

- The team must submit photos, videos, and detailed information about the robot on the Codeavour 5.0 submission portal.

During the competition (physical mode) the score will be given as per the following criteria:

- **Full Points**: You will get full points if the object is inside the placement area or positioned on the green line.
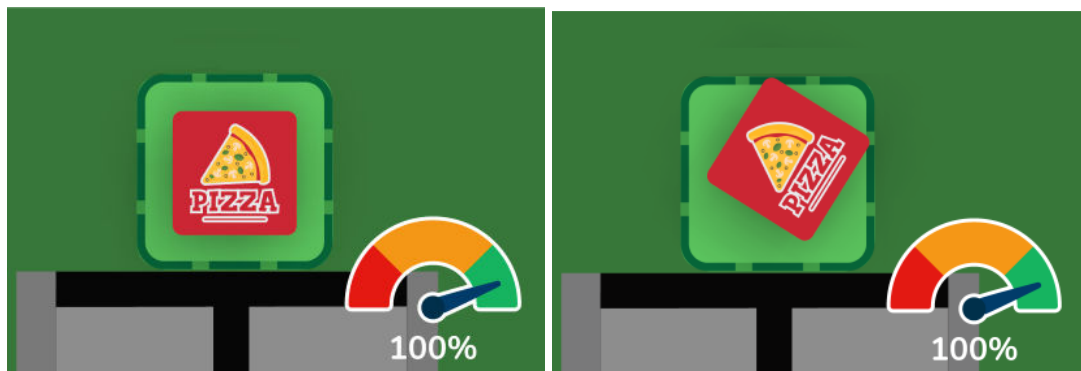
Full Points

- **Half Points**: Only half points will be given if the object is touching the green outline of the placement area in any way.
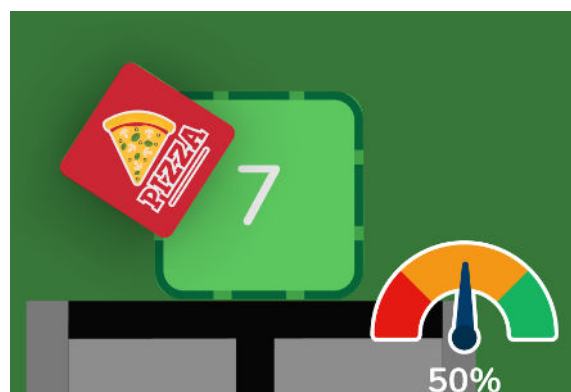
Half Points

- **No Points**: Zero points will be considered if the object is placed entirely outside the designated area.
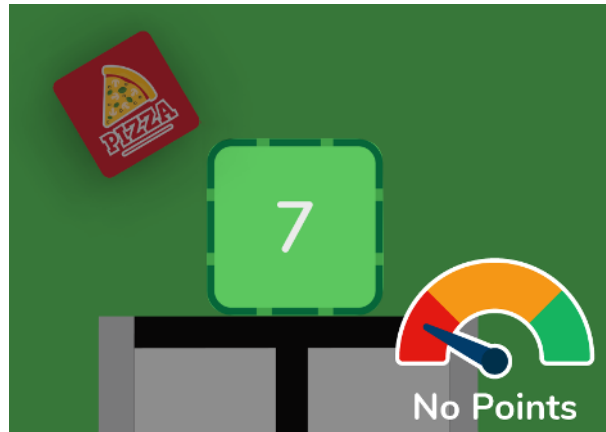
No Points

- For each foul, negative five (-5) points will be considered, and it will be deducted from the total score.
- A foul will be called if the robot leaves the allocated track or if any portion of the robot is not on the black line of the white track.

Path Deviation

Page 35
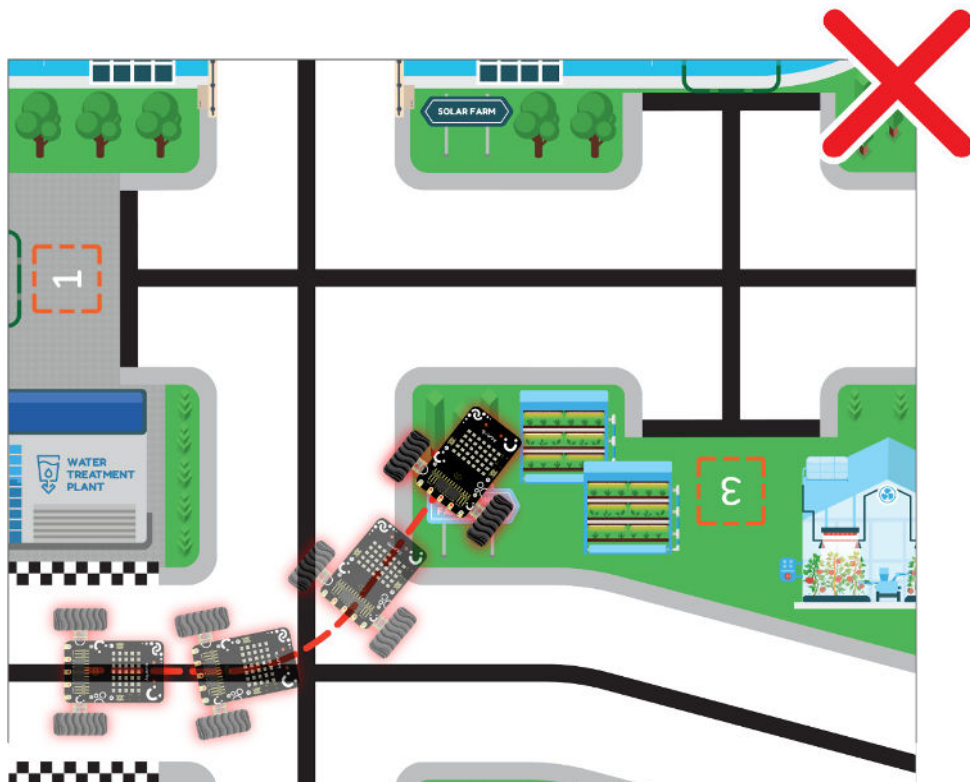
- If a team member touches the robot directly during the challenge without instruction from the referee.
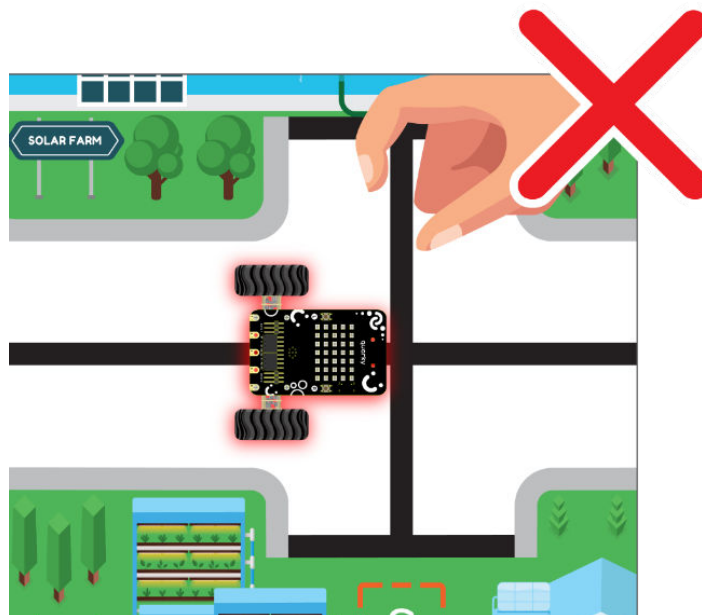
Participant's Touch

8. Score Sheet For Track 2 - Codeavour 5.0 International

Scoring Sheet Track 2	
Team Name:	Age Group:
Team Number:	Table Number:
Referee Name:	Robot Inspection:
Activity Sequence:	Autonomous Challenge: ☐
Windmill Position: East ☐ South ☐ West ☐	Yellow Card ☐☐ Red Card ☐ Blue Card ☐

Sr. No.	Challenges	Activity Points					Total Secured Points
		Manual		Autonomous		Fouls (-5)	
		Full Score	Half Score	Full Score	Half Score		
1	Complete the water treatment plant	10	5	20	10	○○○○○ ○○○○○	
2	Solar panel installation	10	5	20	10	○○○○○ ○○○○○	
3	Deliver veggies to the supermarket from hydroponics farm	20	10	40	20	○○○○○ ○○○○○	
4	AI-powered residential waste collection	30	15	60	30	○○○○○ ○○○○○	
5	Clean the park	30	15	60	30	○○○○○ ○○○○○	
6	Redirect the wind turbine	30	15	60	30	○○○○○ ○○○○○	
7	Smart pizza delivery	10	5	20	10	○○○○○ ○○○○○	

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8	House-to-hospital patient transfer	20	10	40	20	○○○○○ ○○○○○	
9	Rescue the cat stuck on the tree	10	5	20	10	○○○○○ ○○○○○	
10	Help the kids cross the street to get to school	10	5	20	10	○○○○○ ○○○○○	
11	Greener city (tree plantation)	20	10	40	20	○○○○○ ○○○○○	
	Maximum Point/Total	**200**		**400**			

9. Glossary

Glossary	
Game Field	The area within the competition arena where the robots perform the challenges and tasks.
Object Placing Missions	Specific tasks that robots need to accomplish include placing objects in designated areas or moving objects from one location to another.
Challenge	A specific task or problem that participants need to solve using their robots within a limited time frame.
Game Objects	Physical items are placed inside the arena that robots interact with during the challenges.
Pick and Place	A method of robot manipulation where the robot picks up an object from one location and places it in another.
Grab	A method of robot manipulation where the robot uses a gripping mechanism to hold and move objects.
Push Pull	A method of robot manipulation where the robot applies force to objects to push or pull them to desired locations.
Hydroponics	A method of growing plants without soil, using nutrient-rich water solutions to deliver nutrients directly to the plant roots.
Machine Learning Environment	A platform or framework where machine learning models are trained and tested using datasets.
Smart Delivery Robots	Robots designed for delivering goods or services autonomously are often used in the context of smart cities for efficient and sustainable deliveries.

Robot Verification Team	A team is responsible for ensuring that robots meet the specified requirements and guidelines before the competition.
Referee	An official is responsible for overseeing and judging the competition, ensuring fair play and adherence to the rules.
Table Number	A unique identifier is assigned to each competition table or area where teams perform their challenges.
Starting Point/Reset Point	Designated locations on the competition field from where the robots begin or can be reset during challenges.
Scoring Sheet	A document used to record each team's scores and performance during the competition.
Calibration	The process of adjusting and fine-tuning the robot's sensors and movements to ensure accuracy during challenges.
Yellow Card	Teams can redeem a penalty card to nullify negative scoring associated with specific fouls.
Red Card	A card enabling teleportation strategy, allowing teams to move their robot instantly between predefined points on the field.
Blue Card	A card that allows teams to switch their robot between manual and autonomous mode during challenges.
Foul Exemptions	Instances where teams can avoid penalties by redeeming yellow cards strategically.
Quarky Expansion Board	An additional board can be attached to the Quarky microcontroller to extend its capabilities.
Practice Arena	An allocated space where teams can test and set up their robots before the competition round.

Biodegradable	Materials capable of decomposing naturally and returning to the environment without causing harm.
Non-Biodegradable	Materials that do not decompose naturally can harm the environment if not disposed of properly.
Mentors/Coaches /Teachers/Parents /Guardians	Individuals not allowed in the competition area are not directly involved in robot control or manipulation.
AI (Artificial Intelligence)	The simulation of human intelligence processes machines, especially computer systems, to perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation.
Autonomous Robot	A robot operates without human intervention, following a predetermined set of instructions or responding to its environment using sensors and algorithms.
Codeavour	The name of the international robotics competition is mentioned in the rule book.
DIY (Do-It-Yourself)	The practice of building, modifying, or repairing something without the direct aid of experts or professionals.
FHD (Full High Definition)	A display resolution of 1920 x 1080 pixels, providing high-quality visual content.
FOV (Field of View)	A camera or other optical device can see the extent of the observable world at any given moment.
Game Arena	The designated competition area where robots perform tasks and challenges.
Machine Learning	A subset of artificial intelligence that provides systems the ability to automatically learn and improve from experience without being explicitly programmed, often used in pattern recognition and decision-making.

PictoBlox	The specified programming software used for programming the robots in the competition.
Quarky	The specified hardware/microcontroller used for building robots in the competition.
Robotics	The interdisciplinary field integrates mechanical engineering, electronics, computer science, and artificial intelligence to design, build, and operate robots.
Smart City	A city that uses digital technology to enhance performance and well-being and reduce costs and resource consumption across the city.
Sensors	Devices that detect and respond to inputs from the physical environment, such as light, heat, motion, or pressure.
Teleportation Strategy	A strategic move where the robot is instantly moved between predefined starting or reset points on the competition field.
Track	The specific category or type of competition within the overall robotics event (e.g., Track-2: Robo City Challenge).
Wired Connection	A physical connection using wires or cables to transfer data or power between devices.
Wireless Connection	A connection that allows data or power transfer between devices without the need for physical wires or cables.
Wind Turbine	A device that converts wind energy into electrical power.

Important: *Please note that minor updates to this competition's rules and guidelines may be made before/during the competition to ensure accuracy and fairness. Before the competition, you will receive your time slot and table number.*