NRC 2023 AI Maker Series

Secondary

GAME RULES

Version: 22 June 2023

Organiser: Sponsored by:

Supported by:

NRC 2023 AI Maker Series - Primary
CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	26 May 2023	Official Challenge Booklet release
1.1	22 June 2023	- 2.1 Teams Definition - 8 Game Objects, Positioning, Randomisation

Contents

GAME DESCRIPTION

1. General Information

1.1. National Robotics Competition (NRC) 2023

<u>National Robotics Competition (NRC)</u> has been an ongoing competition organised annually by Science Centre Singapore for the past 24 years with support from the Ministry of Education, various partners and sponsors. This competition has attracted more than 62,500 participants and 250,000 supporters to date.

NRC spurs students' interest and innovation in Science, Technology, Engineering and Mathematics (STEM). Students will be able to put their knowledge to practice and engage in hands-on STEM learning. With NRC as a stage for students to develop kinaesthetic learning and collaboration, it encourages students to develop problem solving skills, entrepreneurial skills, creative thinking skills and team spirit among the participants.

This year, NRC marks its 25th Anniversary and it promises to be filled with exciting challenges that will ensure a fun and meaningful learning experience for the participants. NRC is also an excellent opportunity for students to interact with their peers, teachers and judges from the various industries during the course of the competition.

NRC 2023 tournaments comprise:

- NRC Regular Category
- NRC Open Category
- **NRC AI Maker Series**
- NRC Preschool
  - Kubo Challenge
  - ARTec Challenge
- NRC CoderZ Coding Challenge
- NRC RoboCup Singapore CoSpace Coding Challenges *NEW*
  - Autonomous Driving Category
  - Rescue Category

Registration for these category challenges will be via https://www.gevme.com/NRC2023. Competition registration opens from **24 February to 1 July 2023.**

Note: Registration will be on a first come, first serve basis. If the category is full, your registration will be rejected and refunded.

1.2. Theme for NRC 2023

Every year, NRC revolves around a specific theme and this year, the theme for NRC is "**Sustainable Solutions**". Climate change is a global challenge, and Singapore is taking firm actions to do our part to build a sustainable future. This year, the challenges will revolve around Singapore's national agenda on sustainable development.

2. Teams and Rules Hierarchy

2.1. Team Definition

Each team will have a minimum of 2 members and up to 3 members.

This category is open to the following age groups:

- Secondary Students 12 - 17 years old (in season 2023: born years 2016-2011)

Students need not be from the same school. However, all the members of a team must be in the same category age group to qualify.

2.2. Expectations on Teams

Teams should behave fairly and be respectful towards other teams, coaches, judges and competition organizers. Teams are to adhere to the competition rules to ensure fair competition.

The construction and coding of the robot may be done only by the team. The task of the coach is to accompany them, help them with organizational and logistical matters and support the team in the case of questions or problems. The coach cannot be involved in the construction and programming of the robot.

On the competition day, during mission runs, coaches/mentors are not allowed to communicate with their teams.

If any of the rules mentioned in this document are broken or violated, the judges or chief referees can decide on one or more of the following consequences. Before a decision is reached, a team or individual team members may be interviewed to find out more about the possible violation of the rules. The interview can include questions about the robot or the program.

- A team may not qualify for the next round of the tournament. (e.g. finals)
- A team may not qualify for the national/international finals.
- A team may be disqualified completely from the competition immediately.

2.3 Rules Hierarchy

On the competition day, the following rule hierarchy applies:

- The Game Rules document of the age group will clarify the missions on the field and may add special game definitions.
- The Chief Referees have the final say in any decision.

During a season, NRC may publish additional Question & Answers (Q&As) that can clarify, extend, or re-define rules in game and general rule documents. Teams should read these Q&As before the competition.

2.4. Competition Format and Procedure

<u>Competition Format</u>

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┌──────────┐  ┌──────────┐  ┌──────────┐  ┌──────────┐
│ Technical │─▶│Calibrations│─▶│Presentation│─▶│ Robot Run │
│  Report   │  │          │  │          │  │          │
└──────────┘  └──────────┘  └──────────┘  └──────────┘
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<u>Important Dates</u>

|	Dates & Time	Remarks
Technical Report	18 August, 23 59	Online submission deadline for technical report
Calibrations	8 September 2023	1 hour of calibrations will be given to teams to test out the playfield
Presentations		Informal presentation will be done on the actual day for teams to present their technical report
Robot Run		Two rounds of 2-minute robot run will be given for each team

3. Introduction to AI Maker Series

The use of autonomous vehicles in agriculture and transportation have been increasing in the recent years. Many of the operations that vehicles must perform are based on sensor information and Artificial Intelligence (AI) algorithms. Vehicles need to collect data, plan their trajectory and execute the trajectory. These tasks, especially the last two require non-traditional programming approaches and rely on machine learning techniques, which are part of AI.

AI has the potential to change and improve many aspects of our lives in the future. AI can perform tasks such as Natural Language Processing, where it is able to understand regular human speech and text. AI can also perform Image Recognition, which is the ability to identify an object or feature in an image or video.

Autonomous vehicles can safely navigate on roads. It can help transport people and goods in the most efficient route. In this category, teams are to design and build a robot that demonstrates the abilities of an autonomous vehicle.

4. Game Field

e.g
Inside
square

e.g
Outside
square

Starting
Line

Direction of travel
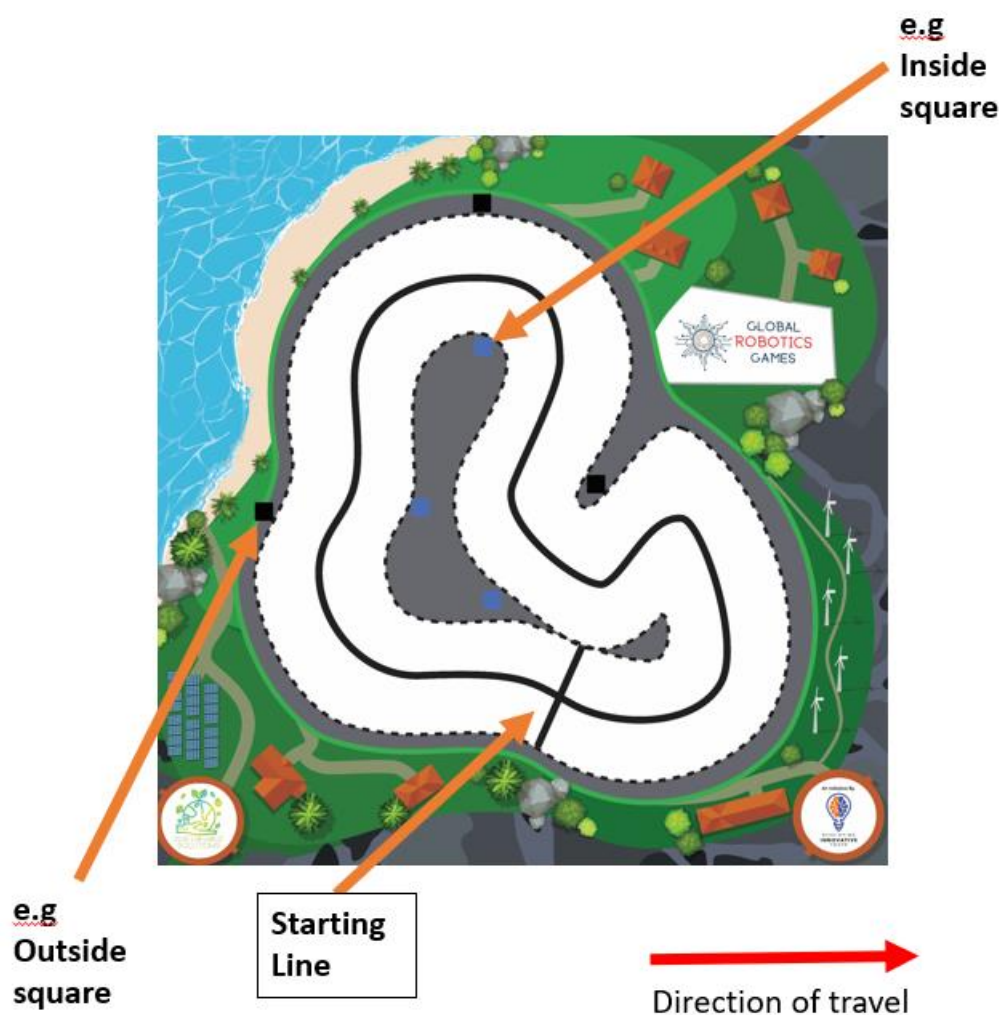
5. Game Objectives

To design and build a robot that can travel on the playfield's Road using only Artificial Intelligence (AI) or Machine Learning (ML) models. Additionally, the robot should be able to correctly identify a Solar-Panel Card or a Cone Card placed along the Road.

6. Game Missions

For a better understanding, the missions will be explained in multiple sections.

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Scoring for each mission will be:

As the game is going on, referee will call out the scores

6.1 Completing a round.

Autonomous Vehicles are needed to create an efficient and effective transportation system in any city.

The team should program their robot to complete as many rounds of the Road as possible. A round is considered complete if the robot starts of the Left of the Starting Line and successfully navigates itself around the Road such that it completely crosses the Starting Line again. The robot must travel only in an anti-clockwise direction on the playfield. The entire robot must cross the Starting Line from left to right to complete a round.

If the robot completely leaves the Road at any time, the Referee will signal the team to restart the round. The team can then pick up the robot and place it on the left of the Starting Line.

Teams will score 10 points for completing each round using AI or ML.

6.2 Detecting a Card

Visual recognition is a growing field of AI with many applications. It can help in reducing menial observation tasks performed by humans. It can also assist in safety procedures for vehicles.

Teams must program the robot to be able to detect either a Solar-Panel card or Cone card as the robot is travelling on the Road. The Solar-Panel Card or Cone Card will be placed either in the Inside Squares (marked in blue) or the Outside Squares (marked in black)

The robot must give off a signal whenever a card is correctly identified. The signal will be verbally acknowledged by the Referee.

Teams will be given 3 points for successfully detecting a card using AI or ML. In each round, teams will only score a maximum of 12 points. 3 pts for detecting each card successfully. Teams will not score more points even if it detects the card multiple times during each round.

Refer to Section 11 for more information.

Type of card detected	Signal to give
Solar Panel Card	Robot flashes a green light for 1 sec
Cone card	Robot flashes a red light for 1 sec.

7. Game Rules

If there is any uncertainty during the robot attempt, the judge will make the final decision.
The judge will decide in favour of the team if no clear decision is possible.

7.1 Pre-Run

- Referees will measure the width and length of the robot.
- Robot must be within 250 mm x 250 mm in size only. Robot may be of any height.
- Teams will place their robot completely on the left side of the Starting Line.
- Teams must ensure that direction of travel must be anti-clockwise only.
- For each game-run, referees will choose to place the Cards on either the Inside Squares (blue colour) or the Outside Squares (black colour).
  a. 2 X Solar-Panel cards and 2 X Cone cards will be randomly placed on the four squares.
  b. E.g Referee chooses Inside Squares. The placement of cards may be as such:

Solar Panel Cards

Cone Cards

7.2 Start of Robot Run

- Time begins when the referee gives the signal to start.
- Students may start their programs and let the robot run.
- Each game-run is 2 minutes (120 seconds).

7.3 During Robot Run

The robot must be able to travel down the Road and detect the Solar-Panel and Cone cards with the assistance of an Artificial Intelligence model created by the team. The robot is not allowed to use the direct input from sensors, to navigate its way around the Road.

- Any team suspected of using any other means, except for an AI and ML model, may be stopped and asked to show their robot's codes, systems and AI or ML model to the Referees.
- Failing to prove that an AI or ML model is the only system used in helping to steer the robot, may result in disqualification.

Teams are allowed:

- To interrupt their robot, pick up their robot and place it on the left of the Starting Line if the robot has completely left the Road.
    a. Only after Referees can give the signal to the team to pick up their robots.
    b. That attempt to complete a round will be considered incomplete.
- To stop their robot at any time.
    a. Teams have to inform the Referee when choosing to stop their robot.
    b. The Run will be considered finished and time will be recorded as 120 seconds. The team can then proceed to remove their robot from the field.

Teams are not allowed:

- To touch their robot without the Referee's signal.
- To touch any Solar-Panel cards or Cone cards during the match.

If the robot knocks the Solar Panel Cards or the Cone Cards out of position:

- Referees will wait for the robot to drive past the position of the Card. Then Referees will reset the card in the blue or black squares.

7.4 Ending of Robot Run

A robot run will end if…

- The 2 minutes mark is up (120 seconds).
- The robot has completely left the game table.
- The robot or team has violated the rules or regulations.
- A team member shouts "STOP", and the robot does not move anymore. If the robot is still moving, the robot attempt will only end once the robot stops by itself or is stopped by the team or judge.

After the game-run, referees will score the attempt. Teams are required to sign off the scores noted on the scoring sheet (on paper or digital). Once the score is signed off no further changes are possible.

If a team does not want to sign off after a certain period of time, the judge can decide to disqualify the team for this game-run. It is not allowed for a team coach to join the discussion with judges on the scoring of the game-run. Video or photo proofs will not be accepted.

If a team finishes an attempt without having solved a task that yields positive points, the time of that run will be set at 120 seconds.

The ranking of teams depends on the overall tournament format. For example, the best attempts out of two game-runs could be used and if competing teams have the same points, the ranking is decided by the record of time.

8. Game Objects, Positioning, Randomisation

Solar-Panel card	

Cone card	

Image Card Dimension: 74mm by 105mm

Image Download

8.1 Technical Report

While creating the robot and AI or ML models, we must also be mindful of documenting our work. A good engineer is one who is meticulous in his report and can communicate his/her work efficiently.

All teams will have to submit a digital copy of their Technical Report by 18th Aug '23, 23 59. Here are the details of what should be included.

8.1.1 Robot Design:

Each team is required to submit 1 picture of each side of their robot. Namely:

- Picture of the top of the robot;
- Picture of the bottom top of the robot;
- Picture of the left top of the robot;
- Picture of the right top of the robot;
- Picture of the front top of the robot;
- Picture of the back top of the robot.

8.1.2 List of Sensors and Cameras:

Teams should clearly identify and list all the sensors and cameras used in the robot. Students should also remark on how the sensors/cameras were used and show samples of codes to explain how the input from these sensors/cameras are used.

8.1.3 Artificial Intelligence model

Teams should explain the AI or ML model created that allows the robot to follow the Road and to detect the Solar-Panel card or Cone card.

Teams should describe the following:

- The process used in training the AI model to achieve these missions.
- The software employed to create the AI model.
- The programming language used in creating the AI model.
- How was the robot programmed to react to the AI model?

An online drive/folder will be shared with each team to allow them to share their Technical Report.

9. Robot Materials and Regulations

- Every team builds one robot to solve the challenges on the field. The maximum robot dimensions before the robots start a run are 250 mm x 250 mm. Cables must be included in these dimensions.
- The robot may be built with any building materials. E.g LEGO bricks, pre-cut plastic car bodies, robots fitted with cameras.
- The robot may be fitted with any controller system. E.g Arduino boards, Raspberry Pi, Quarky, LEGO Education SPIKE Prime hub.
- More than one controller may be used.
- The robot must be powered by a battery system carried by the robot. The robot must be self-powered.
- The number of motors to be used is not restricted.
- The number of Cameras to be used is not restricted.
- A team should place the controller in the robot in a way that makes it easy to check the program and stop the robot by a Referee.
- A team is not allowed to perform any actions or movements to interfere or assist the robot after the robot has started with the game-run, except with the Referees signal.
- Any software to code the robot is allowed and teams can prepare the code before the competition day. If a team uses a software that requires an online connection (e.g. a browser-based tool), the team should check if there is an offline version for the competition day. The competition organizer is not responsible for providing an online infrastructure (e.g. WiFi for everyone).
- Bluetooth, Wi-Fi or any remote connection must be switched off during check time and game-runs. Teams can only use remote connections if there is no other way to transfer the code from a device (e.g. a tablet) to the controller. However, it is strongly recommended to transfer code via cable to avoid problems (e.g. multiple devices with the same name) on the competition day. Of course, it is not allowed to interfere or obstruct any other team or robot with the remote connections a team uses.

- A team should prepare and bring all the equipment, enough spare parts, software and portable computers it needs during the tournament. Teams are not allowed to share a laptop and / or the program for a robot on the competition day. The competition organizer is not responsible for the maintenance or replacement of any material, not even in case of any accidents or malfunctions.
- The robot can be marked (label, ribbons, etc.) to prevent participants from losing it or confusing it with the robots of the other teams, as long as this does not change its performance or give clues about the assembly process.
- Teams can bring the robots assembled to the competition. They do not need to rebuild the robots on the competition day

10. Scoring

Definitions for the scoring

"Completely" means that the robot and all of its parts are past the area/line of consideration. No projection of the robot falls in the area/line of consideration.

Tasks	Each	Total
1. Completing a round		
Robot started on the left of the Starting Line, it has successfully travelled on the Road only and completely passed the Starting Line.	**10**	
2. Detecting a card		
Robot has detected a Solar-Panel card and successfully shown green light for 1 second or beeped once.	**3**	
Robot has detected a Cone card and successfully shown a red light for 1 second or beeped twice.	**3**	
3. Technical Report		
3.1 Robot Design: 6 pictures of each side of robot are submitted		**20**
3.2 List of Sensors and Cameras is submitted		**20**
3.3 AI or ML model description is submitted		**20**

11. Scoring Interpretation

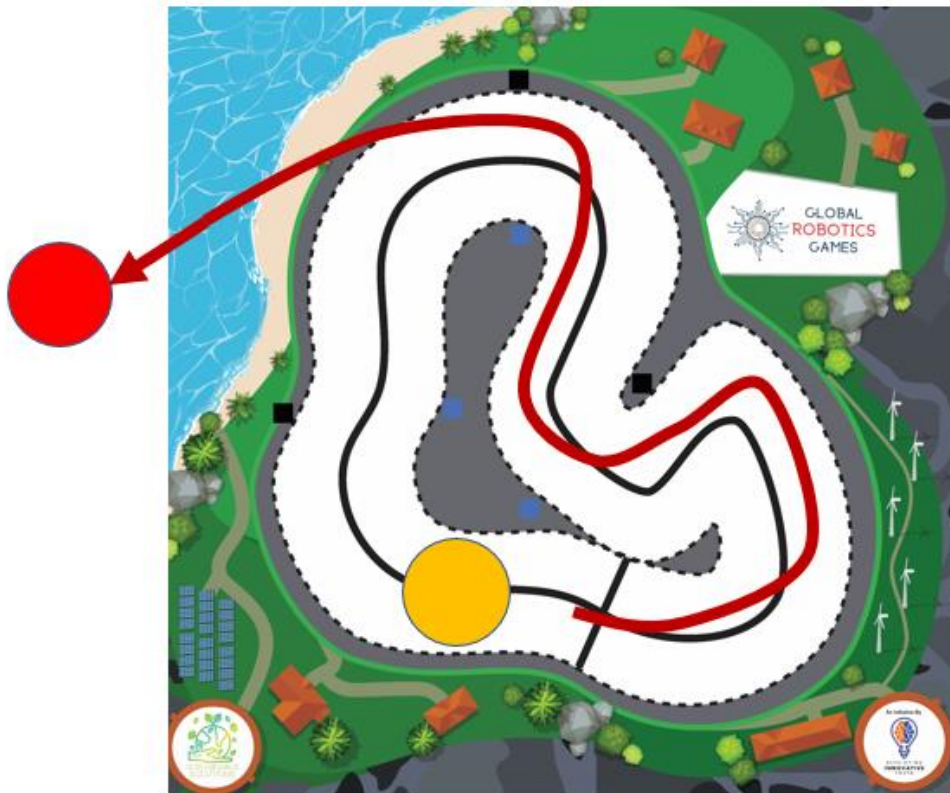**Scenarios of a complete/incomplete round**

Scenario 1: this is considered a complete round:
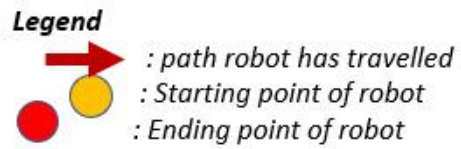
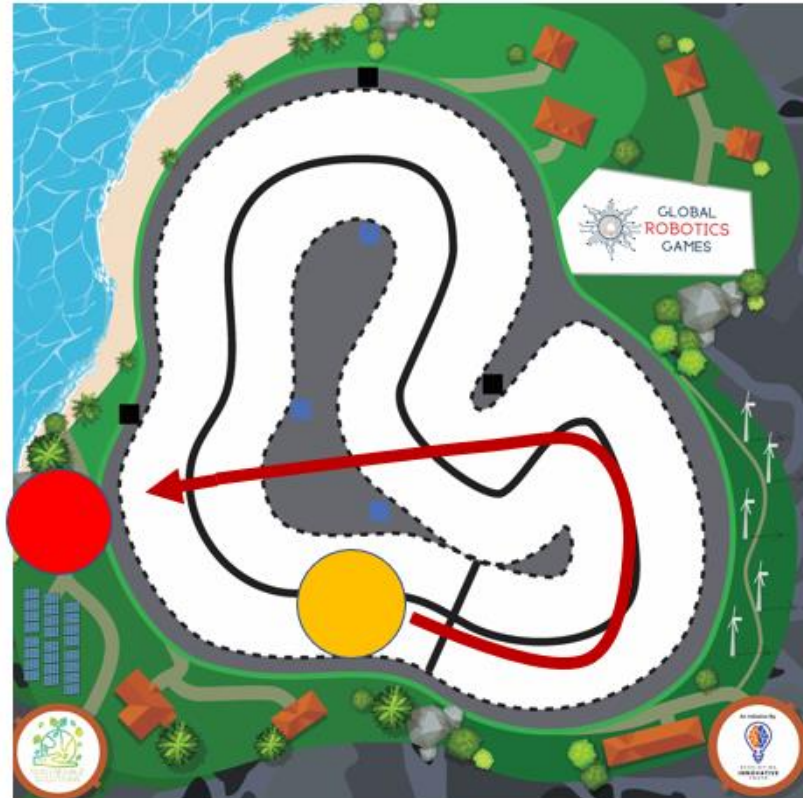**Scenario 2: This is considered an incomplete round:**

Scenario 3: This is an incomplete round:

END