Hills Road
Sixth Form College
Cambridge

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ROBOCON

2025: Dragon's Lair

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DRAGON'S LAIR

Long ago, in a square realm where dragons ruled the skies and herded cubic flocks of sheep, four mathematical dragons competed for dominance over sacred lands: Smaug, Tiamat, Balerion and Trevor. These dragons hid precious gems inside their territories, each holding unimaginable power: Smaug held rubies as red as dragon fire, Tiamat held jade as green as the lush forests, Balerion held diamonds as deep as the ocean, and Trevor held topazes as golden as the sun.

At the heart of each dragon's territory stood the Lair—ancient shrines that amplified the magical energy of the land. The dragons would place their most precious possessions here—enchanted sheep, whose wool shimmered with magic, and the powerful gems, all guarded with pride and strategy.

Every Easter, Rhaegal – the mischievous dragon overlord – casts a spell to scatter the gems and sheep (in a Gaussian distribution) throughout the island. Each dragon must embark on a treacherous journey to reclaim their possessions, while outsmarting their rivals.

Those who demonstrate creativity, resilience and ingenuity and succeed in retrieving the most sheep and their lost jewel will be rewarded by Rhaegal with trophies forged in dragon's fire.

Let the games begin and may the best dragon soar to victory!

CLARIFICATIONS

To ask any questions or for clarifications, please feel free to email Rhaegal the dragon at robotics@hrsfc.ac.uk. In all cases, the rules on the website are updated and reflect the most recent state of the game and supersede previous version including the hard copy. Should we feel any clarifications to the rules need to be made, they will be published to the website and we will inform all teams by email. The rules used during the competition will be the rules published on the official website: robocon.uk and these rules supersede printed copies and copies served by the RoboCon brain.

VERSION 1.0

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Table of Contents

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1. AWARDS

1.1. Main competition awards

Prizes are given to the teams that place highest at the end of the competition. These will be the teams in 1st, 2nd and 3rd place.

1.2. Gem-cutting precision

The prize that is given to the team that impresses the judges through either an ingenious technical or logical advancement.

1.3. Dragon's eye for detail

The prize that is given to the team with the most robot and team flair

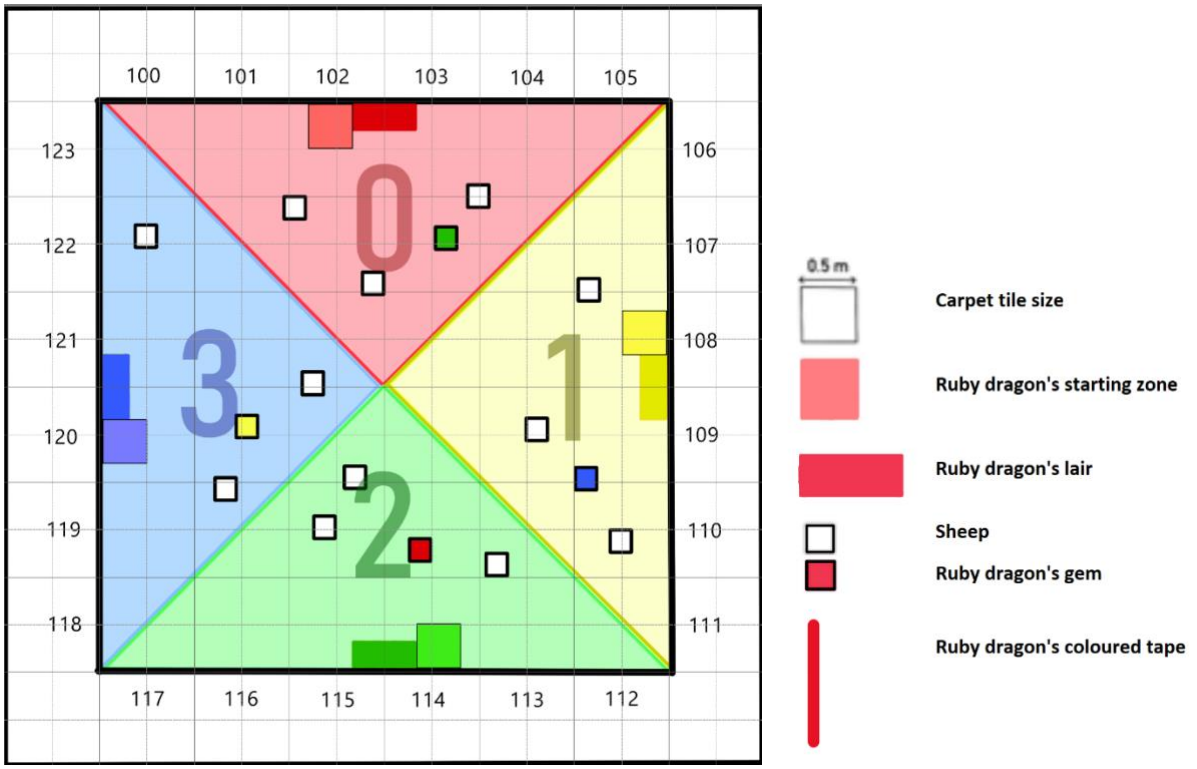
1.4. Fire-born resolve

The prize that is given to the team who demonstrate the most perseverance in the face of adversity

2. SPECIFICATION

2.1. ARENA DIAGRAM

Figure 1



Sheep locations for illustration only, the actual placement will be random within the territory

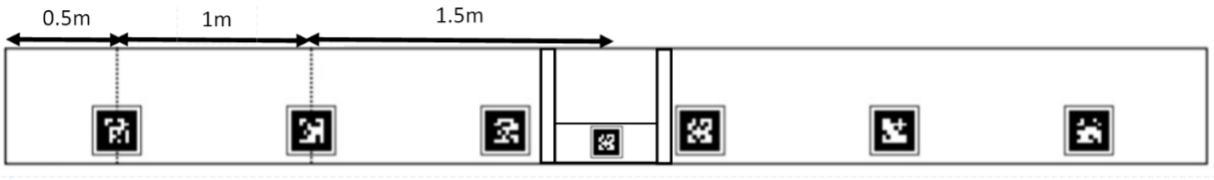


Figure 2

Front elevation view from the perspective of the robot in its starting position.

2.2. GAME FEATURES

2.2.1. Territory

2.2.2. The arena is divided into 4 territories.

2.2.3. Each territory corresponds to a dragon: Smaug (Red), Tiamat (Green), Balerion (Blue), Trevor (Topaz)

2.2.4. Each territory is a right angle isosceles triangle with base 6m ± 50mm and sides $\sqrt{(6^2/2)}$ ± 50mm.

2.2.5. Each territory is bordered by tape of the same colour as the territory (48mm wide) as specified in Figure 1.

2.2.6. The coloured tape is part of the corresponding territory.

2.2.7. Dragon's Lair

2.2.7.1. The lair is a raised shelf centred on the back wall of each territory.

2.2.7.2. The lair is considered part of the territory.

2.2.7.3. The lair has a length of 700mm ± 50mm and depth 300mm ± 50mm, with the long side against the arena wall.

2.2.7.4. The shelf is 150mm ± 10mm above the floor of the arena. See Figure 1 for more details.

2.2.7.5. The lair is approximately the same height as the Really Useful Box (the kit box) that we have given you.

2.2.7.6. The lair has walls on either side stretching up to the height of the arena and protrude exactly as much as the lair itself. See Figures 1 and 2

2.2.8. Sheep

2.2.8.1. At the start of the round each team starts with 3 sheep in their territory of the arena.

2.2.8.2. Sheep are roughly cubic boxes made of single-walled cardboard with side lengths 127mm ± 10 mm and are identified by AprilTag markers on each face. These are specified in Section 6. A sample sheep and sheep markers are provided in the kit.

2.2.8.3. A sheep is considered in a territory if its centroid is within the territory.

2.2.8.4. When a robot is in contact with sheep that is also in a lair, the sheep is only considered in the lair and not in possession of the robot for the purpose of scoring.

2.2.8.5. A sheep is considered touching the floor of the lair if at least 2 vertices of the sheep touch the top surface of the lair.

2.2.9. Gems

2.2.9.1. There are 4 gems of 4 different colours in the arena. These gems are ruby (red), jade (green), diamond (blue) and topaz (yellow). Gems have the same dimensions as the sheep.

2.2.9.2. There will be 1 gem in each territory of the arena. The colour of the gem will not be the same as the colour of the territory.

2.2.9.3. Your team's gem will be found in the opposite territory to yours.

2.2.9.4. A gem is considered touching the floor of the lair if at least 2 vertices of the gem are inside the lair.

2.2.9.5. Gems are roughly cubic boxes made of single-walled cardboard with side lengths 127mm ± 10 mm and are identified by AprilTag markers on each face. These are specified in Section 6. Gem markers are provided in the kit.

2.2.9.6. A gem is considered in a territory if its centroid is within the territory.

2.2.9.7. When a robot is in contact with gem that is also in a lair, the gem is only considered in the lair and not in possession of the robot for the purpose of scoring.

2.2.10. Arena

2.2.10.1. The floor of the arena is carpeted. A close pile industrial carpet will be used.

2.2.10.2. The arena will be surrounded by 0.5m tall walls. No competitors or audience members will be permitted beyond these walls into the arena during a round.

2.2.10.3. Each wall of the arena features 6 AprilTag markers. Their spacing and numerical value are as indicated in Figure 2.

2.2.10.4. The arena markers will be 50mm ± 10mm above the floor. This can be seen in Figure 2.

2.2.10.5. The arena contains 4 territories. The territories will be separated by coloured tape.

2.2.10.6. In each territory there is a lair in the middle of the wall. The lair is a 700mm ± 10mm long platform at the centre of the arena wall. The lair is raised by 150mm ± 10mm. (See 1.2).

2.2.10.7. There is an AprilTag marker centred at the front of each lair. This can be seen in Figure 2.

2.3. MARKERS

2.3.1. The arena and the sheep and the gems involved in the game are labelled using AprilTag markers. Each marker pattern encodes a number.

2.3.2. Each marker number is associated with a specific feature of the arena and has an associated size. An example AprilTag can be seen below.

2.3.3. The markers can be printed on a black and white printer, and their designs can be downloaded from the documentation section of the Hills Road RoboCon website https://www.robocon.uk/

2.3.4. All markers will be laminated with a matte finish.

2.3.5. The markers on the arena wall will be 200mm x 200mm in size. They will be 50mm off the floor.

2.3.6. The markers on the sheep and gems will be on cubes of size 127mm x 127mm x 127mm. An example cube with AprilTags will be included in your kit.

2.3.7. At the start of the game, each territory will contain 3 sheep and 1 gem, each with their own unique AprilTag code. The sheep and gems and their corresponding numbers are as follows:

Feature	April tag Number range (inclusive)			
Sheep	0 – 23			
Arena marker	100 -123 (refer to fig.2)			
Team	Smaug	Tiamat	Trevor	Balerion
Gem type	Ruby	Jade	Topaz	Diamond
Gem	24	26	28	30
Lair	50	51	52	53

3. REGULATIONS

3.1. The referee will be referred to as "Rhaegal" the Dragon.

3.2. Rhaegal has the final say in any circumstance.

3.3. No remote-controlled systems are permitted.

3.4. RoboCon is a non-contact competition and no robots should be engineered with harming other robots in mind. We don't want any further dragon fights.

3.5. Robots may not deliberately damage anything – including sheep or gems, the arena or other robots. At Rhaegal's discretion, teams who engage in collisions deliberately or do not take sufficient precautions to avoid collisions may be disqualified from rounds until the issue has been resolved. Rhaegal will decide whether or not this action was deliberate.

3.6. Robots may not deliberately leave debris in the arena.

3.7. Teams must not imitate any features of the arena in a way that could potentially confuse other teams' robots.

3.8. Hills Road RoboCon reserves the right to examine your robot software and hardware at any time, to verify that rules are being followed.

3.9. Assistance provided by Hills Road RoboCon is provided with no guarantees.

3.10. All kit deployed by Hills Road RoboCon remains the property of Hills Road RoboCon. The kit must be returned to Hills Road RoboCon at the end of the competition in acceptable condition.

3.11. Robots must pass an inspection by a Hills Road RoboCon Inspector before they are permitted in the arena.

3.12. At the beginning of each round, robots must fit into a cube with internal dimensions of 400mm x 400mm on each side. During the round, the robot may extend beyond this size.

3.13. For everyone's safety, the robot's power switch must always be red and easily accessible while the robot is active – including throughout the game.

3.14. The robot is to be started in the arena using a physical start button. You must position this where a team member can reach it from outside of the arena.

3.15. You may use custom hardware to enhance your robot's electronics, but all power must be drawn from the connectors on the BrainBox.

3.16. The BrainBox and battery must not be disassembled, altered or otherwise tampered with in any way.

3.17. All wires connected to the robot's ground (0V line) must be black. Black wires must not be used for anything else. It is strongly recommended that all wiring is neat and removable, as this will reduce the time required to debug problems, and teams may be asked to tidy their wiring before a member of Hills Road RoboCon will approach any issues with their robot.

3.18. All electronics should be securely fixed to the robot and should also be easily removable if required.

3.19. It must not be possible to injure oneself on the robot. This may be tested using a Frankfurter sausage to simulate a finger – anything that could cause harm, such as high-speed rotating parts, should be suitably shielded.

3.20. The lithium polymer battery provided in the kit must be shielded from mechanical and thermal harm. This includes ensuring that it is protected from harm in the case of accidental collision with another robot. Teams found to be in violation of this rule will have their batteries confiscated until they have demonstrably rectified the issue.

3.21. If teams wish to use batteries, chargers or cables other than the ones provided with the kit, they must seek approval from Hills Road RoboCon through **robotics@hrsfc.ac.uk** first.

3.22. Robots may not include additional radio transmitters or receivers to those in the BrainBox.

3.23. Attaching a GoPro or similar small video recorder to your robot to record a round is permitted, but it must be powered by its own internal batteries and cannot be

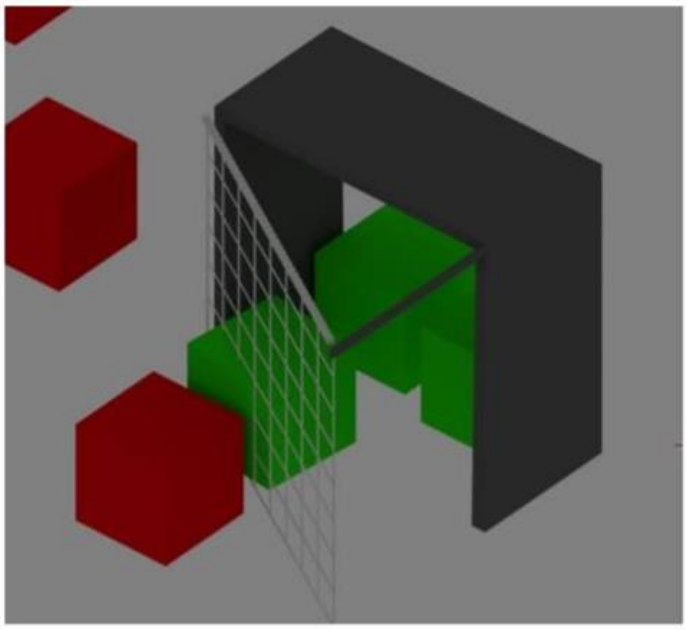
connected to any of the other electronics of the robot. It must fit within the internal dimensions defined in section 4.11.

3.24. A USB port must remain free and accessible for the use of Hills Road RoboCon during the competition. If you want to use a USB device such as an Arduino, you will need to provide your own USB hub.

4. POSSESSION RULES

4.1. The perimeter of the robot is defined by a virtual 'thread', wrapped around the furthest extremities of the robot, as shown in Figure 4.

4.2. Sheep or gems fully or partially inside the perimeter of the robot are considered to be possessed by that robot (coloured green in Figure4)



5. ROUNDS AND GAME POINTS

5.1. A round of Dragons lair is 180 seconds
5.2. There will be up to 4 robots in a round.
5.3. Scoring will begin 10 seconds after the end of the round.
5.4. There must be no team members in the arena during the minute before a round starts. Robots must be placed in the arena before this time.
5.5. Teams must not, under any circumstance, enter any body part or object into the arena during a round, except to press the start button on their robots at the beginning of that round.
5.6. Interfering with items or any robot during the round will result in the offending team's disqualification, and they may be asked to leave the arena.
5.7. Robots must not be programmed to interfere with other robots. Accidental contact between robots is expected – we reserve the right to review your code to ensure it complies with this rule.
5.8. A round may be terminated prematurely if all participating teams state that they are happy for the round to end, so that the round does not drag on.
5.9. At the end of a round, Rhaegal will total the score for each competing team.
5.10. Teams must not enter the arena or touch any robots or game items in the arena during this time in order to ensure fair scoring.
5.11. Any robot touched before Rhaegal 'releases' the arena may result in the offending team's league points for the round being forfeit.
5.12. Any items touched before it is released will result in the offending team scoring 0 league points for that round.
5.13. Scoring is judged according to the state of the arena at the end of the round.
5.14. Scoring is as follows:

Condition	Score
Robot leaves the start zone	+1
Each sheep or gem in your possession	+2
Possession of own gem	+5
Each sheep or another team's gem in your territory and not in any robot's possession	+3
Own gem in territory and not in any robot's possession	+7
Each sheep or another team's gem on the raised floor of own lair	+6
Own gem on the raised floor of own lair	+12

6. LEAGUE POINTS AND KNOCKOUT ROUNDS

The competition is split into a day of league rounds to create a seeding table which are used the next day in the knockout rounds.

The behaviour of scoring for these two types of rounds is described below.

6.1. LEAGUE ROUNDS

6.1.1. Only teams with robots present in the arena at the start of a given round can score points from that round.

6.1.2. League point scoring:

Score	**League points**
Highest score	8 league points
Second highest score	6 league point
Third highest score	4 league points
Fourth highest score	2 league points

6.1.3. In the case of a draw, in which two or more teams score the same, each of the teams will gain the average number of points of their places. For instance, if two teams score equally and are therefore in joint first place, they will both score the average of the first and second place scores, 7.

6.1.4. Teams whose robots were disqualified from a round will gain no league points for the round.

6.2. KNOCKOUT ROUNDS:

6.2.1. Once the league has been completed, a knockout competition will begin. The positions of the teams in the league will seed the positions of teams in the knockout rounds.

6.2.2. Each round in the knockout competition involves up to 4 teams. The teams that come 1st and 2nd in each knockout round will continue to the next round of the knockout.

6.2.3. In case of a tie in a knockout round, the team ranked highest in the league will go through.

6.2.4. If there is a tie in the final for first place, then a rematch may be played at the game makers discretion

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7. KIT RETURN

- Each team will be provided with a kit which contains a disclaimer form detailing your obligations with respect to assembly, use, and return of the kit which is lent to you for the duration of RoboCon 2025. Each team is issued with a kit with the following parts, which is to be returned at the end of the competition.
- Items to be returned:
  - Electronic Kit:
    - 1x BrainBox
    - 1x Power switch- latching (red switch, black connector)
    - 1x Start Button- momentary (Black switch, green connector)
    - 1x 6-pin GPIO connector
    - 1x 2-pin 12V Accessory connector
  - Batteries:
    - 1 x 3S (11.1V nominal) LiPo Battery
    - 1 x Turnigy E3 Compact 2S/3S Lipo Charger
    - 1 x “LiPo Safe” bag for storage and charging of batteries
  - Computer:
    - Linux laptop, paired with electronics for programming and Wi-Fi download
    - Power brick and lead
  - Other:
    - 1x 12L Really Useful Box
    - 1x Really Useful Box Lid
- Items to be returned if still in working order:
  - 1x Minibot chassis
  - 2x TT motors with connectors
  - 1x microservo 9g SG90
  - 1x Sheep markers
  - 1x Sheep
- If possible, the kit should be returned at the competition, but in no case later than 14 days after the competition. If you wish to keep the kit beyond that, this must be arranged by us prior to the competition date via an email to robotics@hrsfc.ac.uk .

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THANKS

We would like to thank Will Munns, Mr Smalley, Mr Massey and the sponsors listed below, without whom we would not have been able to run this competition.

The Technology Partnership

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CMR SURGICAL

“Robotics, cybernetics and artificial intelligence are some of the most rapidly changing fields of science and technology, with tremendous opportunities for future engineers. This generation of students are the ones who will write the next chapter in technology and this competition may be the starting point for their careers. Several Hills Road students who became interested in engineering and robotics through the Robotics group and entering competitions have gone on to degrees and careers in this exciting field,” says David Massey, Founder of Hills Road Robotics.