Hills Road Sixth Form College

ROBOCON

2023

DO ANDROIDS DREAM OF ELECTRIC SHEEPDOGS?

RULEBOOK

**Hills Road
Sixth Form College**
Cambridge

DO ANDROIDS DREAM OF ELECTRIC SHEEPDOGS?

The year is 2085 and the humans are dead. The androids left behind seek purpose. Recreating human activities has now become the driving philosophical endeavour for the android race. The national sheepdog trials held annually in Cambridge have become a major focus for the newly formed android civilisation. Shepherdesses come together to compete against each other to demonstrate the best in artificial intelligence.
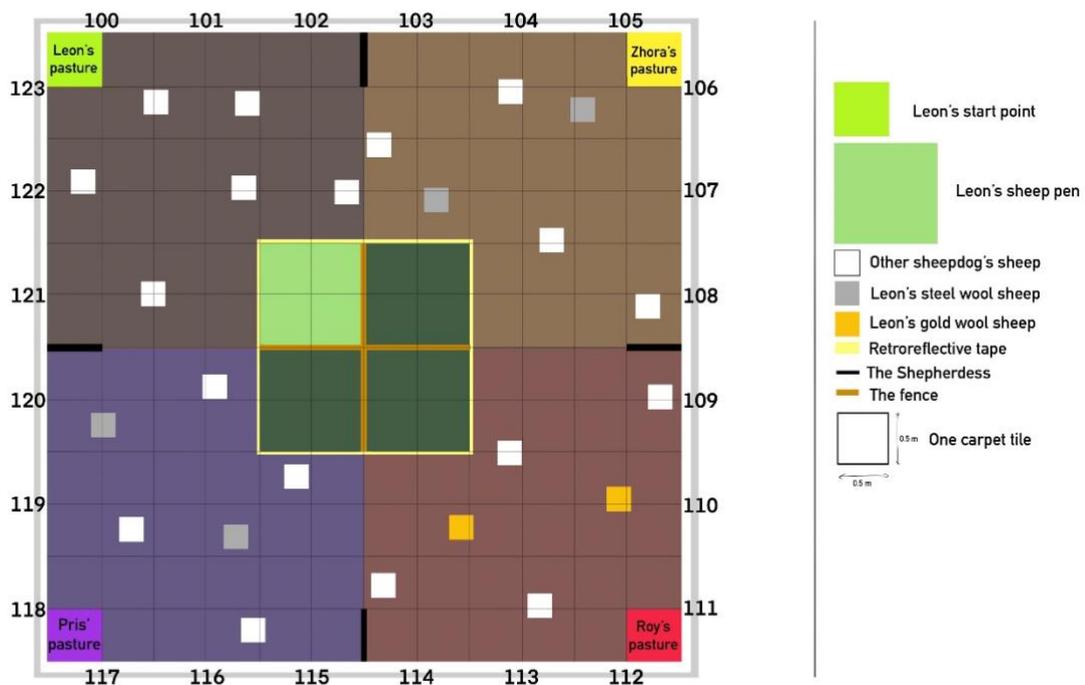
GAME RULES

FIGURE 1: THE ARENA

The sheepdog trials are presided over by the National AI guardian Alexa.

The competition will take place in the area defined in Figure 1. The aim of the game is to get as many points as possible by herding sheep.

The arena is divided into four pastures owned by Leon, Zhora, Pris, and Roy. In each zone there are a number of features defined in the following section.

1 GAME FEATURES

1.1.   Starting zone

1.1.1.   Before the start of a round, participating teams will be given time to set up their robot in the arena. During this time, teams must place their robot in the pasture that they are assigned such that it is entirely within its starting zone, with no parts overhanging its boundary.

1.2.   Pasture

1.2.1.   The pasture is defined as the quarter of the arena area your robot starts within.

1.2.2.   In the inner corner of each pasture there is a pen.

1.2.3.   Pens are defined in section 5.

1.2.4.   Sheep score more points if they are within the pen at the end of the game.

1.3.   Sheep

1.3.1.   24 sheep are grazing in the four pastures. Robots will be judged based on their ability to collect sheep, but some sheep are worth more than others.

1.3.2.   Sheep are made of side length 100mm cardboard boxes.

1.3.3.   Four of your "steel wool" sheep are grazing randomly and evenly in the two adjacent pastures to yours (two in each pasture).

1.3.4.   Two of your "golden fleece" sheep are grazing randomly in the opposite corner pasture to yours. As these sheep are further from your pen, collection is considered to be a more worthy task and rewarded with a greater number of points (see table 1).

1.3.5.   All other sheep are scored equally regardless of wool type.

1.3.6.   A sheep is considered in an area if its centroid is in said area.

1.4.   The Shepherdess

1.4.1.   Each sheepdog has a shepherdess, and every good sheepdog has to return to its Shepherdess after it has finished its task. The sheepdog gains additional points for retuning to the Shepherdess at the end of the round.

1.4.2.   The shepherdess stands at the border of the pasture.

1.4.3.   The sheepdog's shepherdess is positioned clockwise from the starting zone.

1.4.4.   The sheepdog is considered to be at the Shepherdess' side if any part of the robot is over the line of tape on the floor at the end of the round.

1.4.5.   The team may substitute the shepherdess avatar with one of their one design to compliment their team image or assist their robot to locate its end position. The shepherdess must not protrude more than 10 mm into the arena, and must not overlap the arena markers

2.   RULES OF THE ROUND

2.1.   A round lasts 180 seconds.

2.2.   There will be up to 4 robots in a round.

2.3.   Scoring will begin 10 seconds after the end of the round and will depend only on the final positions of items in the arena.

2.4.   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. Teams that do not get out of the arena in time may be forfeit from the round at the discretion of Alexa.

2.5.   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. Interfering with sheep or any robot during the round will result in the offending team's disqualification, and they may be asked to leave the arena.

2.6.   A round may be terminated prematurely if all participating teams state to Alexa that they are happy for the round to end.

2.7.   At the end of a round, Alexa will total the score for each competing team. Teams must not enter the arena or touch any robots or sheep in the arena during this time in order to ensure fair scoring. Any robot touched before Alexa 'releases' the arena may result in the offending team's league points for the round being forfeit. Any sheep touched before it is released will result in the offending team losing 3 game points.

2.8.   Game points are scored by sheep location as follows:

Condition	Score (per occurrence)
Your steel wool sheep is in your pasture	2
Your golden fleece sheep is in your pasture	4
Your steel wool sheep is in your pen	4
Your golden fleece sheep is in your pen	8
Other people's sheep in your pen	1
Your robot is next to your Shepherdess	2+ number of sheep in pen
Robot is actively herding	1
First movement	1

TABLE 1: THE POINTS SYSTEM

(SEE APENDIX FOR SHEEP HERDING)

3. LEAGUE POINTS AND KNOCKOUT ROUNDS

3.1.   The competition is split into a seeding league followed by knockout rounds.

3.2.   League rounds:

   3.2.1.   Only teams with robots present in the arena at the start of a given round can score league points from it.

   3.2.2.   The team with the most game points in a round will gain 8 league points.

   3.2.3.   The team with the second-most game points in a round gain 6 league points.

   3.2.4.   The team with the third-most game points in a round will gain 4 league points.

   3.2.5.   The team with the least game points in a round will gain 2 league points.

   3.2.6.   In the case of a draw, in which two or more teams score the same number of game points, 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, they will both score the average of the first and second place scores, 7.

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

3.3.   Knockout rounds:

   3.3.1.   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.

   3.3.2.   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.

   3.3.3.   In the event of a tie in a knockout round, the team that ranked highest in the league will go through.

   3.3.4.   If there is a tie in the final for first place, then a rematch may be played at Alexa's discretion.

4. REGULATIONS

4.1. Alexa's decision is final.

4.2. No remote-control systems may be used during the competition.

4.3. This is a non-contact sport, although accidental bumps and scrapes are inevitable.

4.4. Robots may not deliberately damage anything – including sheep, the arena and other robots. At Alexa'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.

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

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

4.7. Hills Road RoboCon reserves the right to examine your robot software and hardware at any time.

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

4.9. 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.

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

4.11. At the beginning of each round, robots must fit into a cube with internal dimensions of 400x400mm on each side. During the round, the robot may extend beyond this size.

4.12. For everyone's safety, the robot's power switch must be red and easily accessible at all times – including throughout the game.

4.13. 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.

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

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

4.16. The BrainBox's power cable includes a 20A fuse. Under no circumstances should this fuse fail. If it does, this indicates a highly dangerous fault in the BrainBox – DO NOT REPLACE THE FUSE. RETURN THE UNIT IMMEDIATELY FOR REPAIR.

4.17. 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.

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

4.19. It must not be possible to injure oneself on the robot. This will 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.

4.20. 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.

4.21. 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.

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

4.23. 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 3.10.

4.24. One USB port must remain free and accessible for the use of Hills Road RoboCon during the competition. USB extension cables and hubs may be used to move this to a more convenient location.

4.25. Robots must obey the Three Laws of Robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.
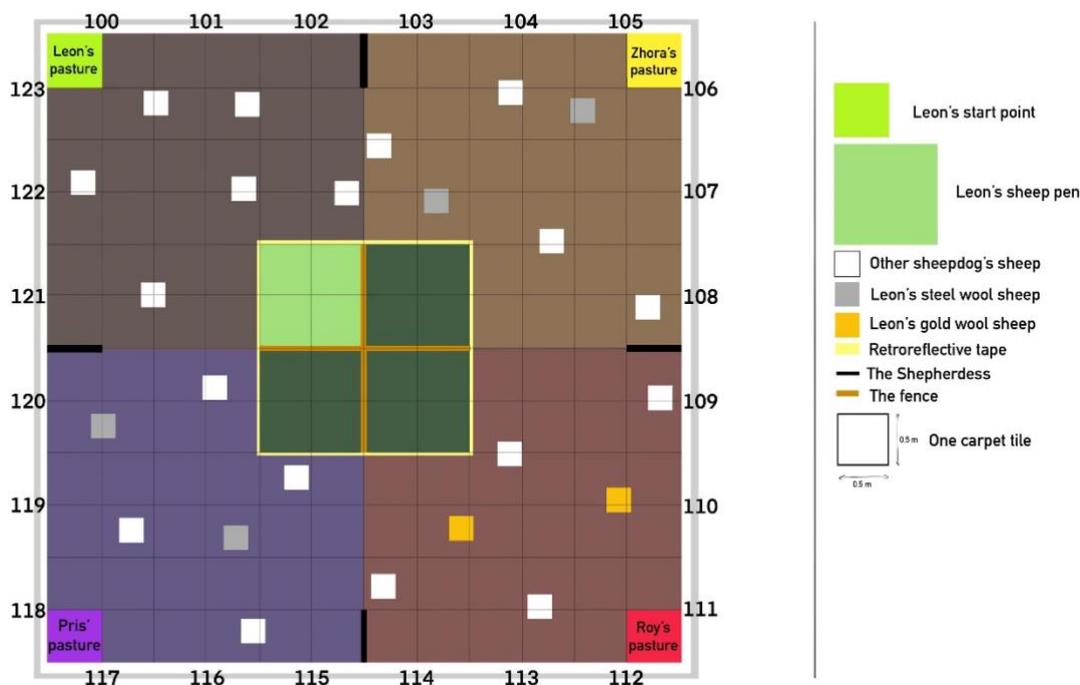
SPECIFICATIONS

5. THE ARENA

FIGURE 2: THE ARENA

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

5.2. 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.

5.3. The arena contains four pastures. These extend from the arena corners by 3m along the arena wall in each direction to form 3 x 3m squares.

5.4. In the outer corner of each pasture is a start zone, which extends from the arena corners by 0.5m along the arena wall in each direction to form a 0.5 x 0.5m square.

5.5. In the inner corner of each pasture, there is a 1 x 1m pen. The outer perimeter of all four pens together is marked using retroreflective tape. For scoring purposes, the tape is considered part of the pen.

5.6. Pens are separated from each other with a short wooden fence (approximately 10mm tall and 25mm wide).

5.7. Each wall of the arena features 6 AprilTag markers (see figure 3). Their spacing along the arena wall and their numerical values are as indicated in Figure 2.

FIGURE 3: THE ARENA WALL

5.8.   The bottom of the AprilTag markers will be 50mm from the floor.

5.9.   The pastures are numbered from 100, in the top left, and increase clockwise. (see figure 2).

6.   MARKERS

6.1.   The arena and the sheep involved in the game are labelled using AprilTag markers. Each marker pattern encodes a number. Each marker number is associated with a specific feature of the arena and has an associated size.

FIGURE 4: AN EXAMPLE APRILTAG MARKER

6.2.   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/markers.zip .

6.3.   At the start of the game, each pasture will contain six sheep, each with their own unique AprilTag code. The numbers associated with these sheep are as follows:

Pasture	Numbers	
	Steel wool sheep	Gold wool sheep
Leon's sheep	00-05	06-09
Zhora's sheep	10-15	16-19
Pris' sheep	20-25	26-29
Roy's sheep	30-35	36-39

TABLE 2: APRIL TAG NUMBERS

7. KIT RETURN

7.1. 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 2023. Each team is issued with a kit with the following parts, which is to be returned at the end of the competition.

7.2. Items to be returned:

- Electronic Kit:
    o 1x BrainBox
    o 1x Power switch- latching (red switch, black connector)
    o 1x Start Button- momentary (Black switch, green connector)
    o 1x 6-pin GPIO connector
    o 1x 2-pin 12V Accessory connector

- Batteries:
    o 2 x 3S (11.1V nominal) LiPo Battery
    o 1 x Turnigy E3 Compact 2S/3S
    o LiPo Charger
    o 1 x "LiPo Safe" bag for storage and charging of batteries

- Computer:
    o Windows operating system, paired with electronics for programming and Wi-Fi download
    o Power brick and lead

- Other:
    o 1x 12L Really Useful Box
    o 1x Really Useful Box Lid
    o 1x IR proximity sensor

7.3. Items to be returned if still in working order:

    o 1x Minibot chassis
    o 2x TT motors with connectors
    o 1x microservo 9g SG90
    o 4x sheep markers
    o 1x sheep
    o Retroreflective tape sample

7.4. 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 .

8. AWARDS

8.1. Main competition awards

    8.1.1.   Prizes will be awarded to the teams that are placed highest at the end of the competition. The teams in 1st, 2nd and 3rd place will receive awards.

8.2. Machine learning prize

    8.2.1.   This prize is given to the team that demonstrate that they have widen the field of possibilities through either an ingenious technical or logical development.

8.3. Jeb_ prize

    8.3.1.   This prize is given to the team with the most robot and team flair.

8.4. Never gonna give ewe up prize

    8.4.1.   This prize is given to the team who demonstrate perseverance in the face of adversity.

9. CLARIFICATION

9.1.   Requests for rule clarification may be sent to robotics@hrsfc.ac.uk . Requests received within one month of the competition are unlikely to be processed.

9.2.   In all cases the rues on the website are updated and reflect the most recent state of the game and supersede previous version including the hardcopy.

APENDIX

10. HERDING THE SHEEP

10.1. Sheep fully or partially inside the perimeter of the robot are considered to be controlled by that robot. The perimeter of the robot is defined by a virtual 'thread', wrapped around the furthest extremities of the robot, as shown in Figure 5.
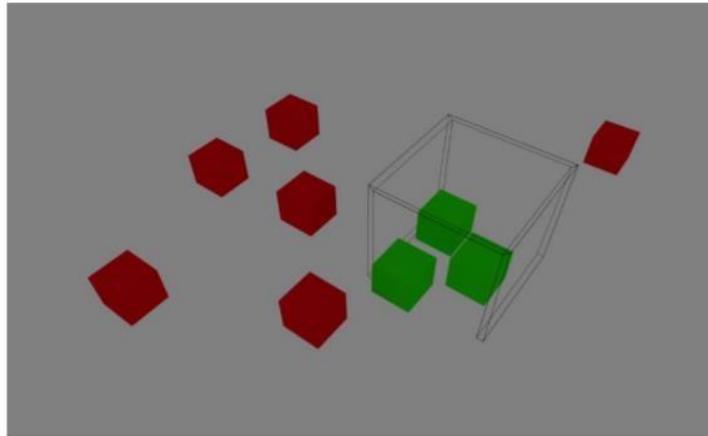

FIGURE 2: THE RED BLOCKS ARE UNDER NO ONE'S CONTROL. THE GREEN BLOCK ARE UNDER THE ROBOTS CONTROL

10.2. The virtual thread is wrapped around the furthest extremity of the robot and defines its perimeter. The sheep that is partially within the perimeter is considered to be being herded by the robot, as shown in Figure 6. The wire mesh in Figure 6 also exhibits how a robot's perimeter is defined when it is not of uniform dimensions.
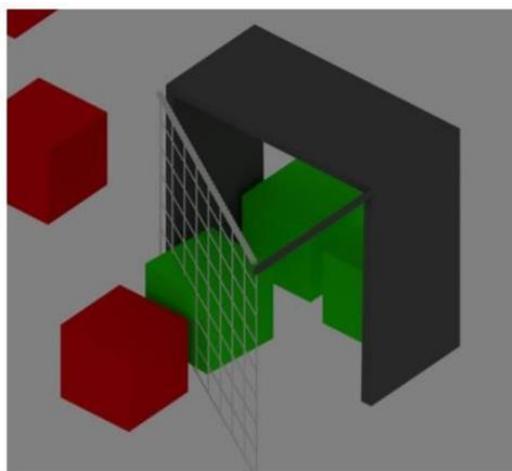

FIGURE 6: HOW A ROBOT'S PERIMETER IS DETERMINED

10.3. If a sheep is being herded by more than one robot, its game points will be counted based on its position in the arena alone.

Rev1

THANKS

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

"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.