RoboCupJunior Rescue Simulation Rules 2024

Official Resources

RoboCupJunior Official Website	RoboCupJunior Official Forum	RCJ Rescue Community Website
https://junior.robocup.org	https://junior.forum.robocup.org	https://rescue.rcj.cloud

The RoboCupJunior Rescue Simulation rules are developed and reviewed by the RoboCupJunior Rescue Committee. The simulation platform is developed and maintained by the Platform development team.

Corrections and clarifications to the rules may be posted on the forum before updating this rule file. It is the responsibility of the teams to review the forum to have a complete vision of these rules.

Before you read the rules

Please read through the RoboCupJunior General Rules before proceeding with these rules, as they are the premise for all rules. The English rules published by the RoboCupJunior Rescue Committee are the only official rules for RoboCupJunior Rescue Simulation 2024. In the translated versions, each regional committee can publish only reference information for non-English speakers to understand the rules better. It is the responsibility of the teams to read and understand the official rules.

The "robot" refers to "virtual robot" in these rules.

Scenario

Rescue teams can use robots to navigate complicated to dangerous or hard-to-access environments for search and rescue operations to minimize the risk to humans. In this challenge, the autonomous controller for a robot must be developed to search and identify **wall tokens** [1] in a simulated hazardous rescue scenario. The robot must navigate through challenging terrains without getting stuck, search for wall tokens and signal the wall tokens locations alongside the map of the maze environment to human search teams.
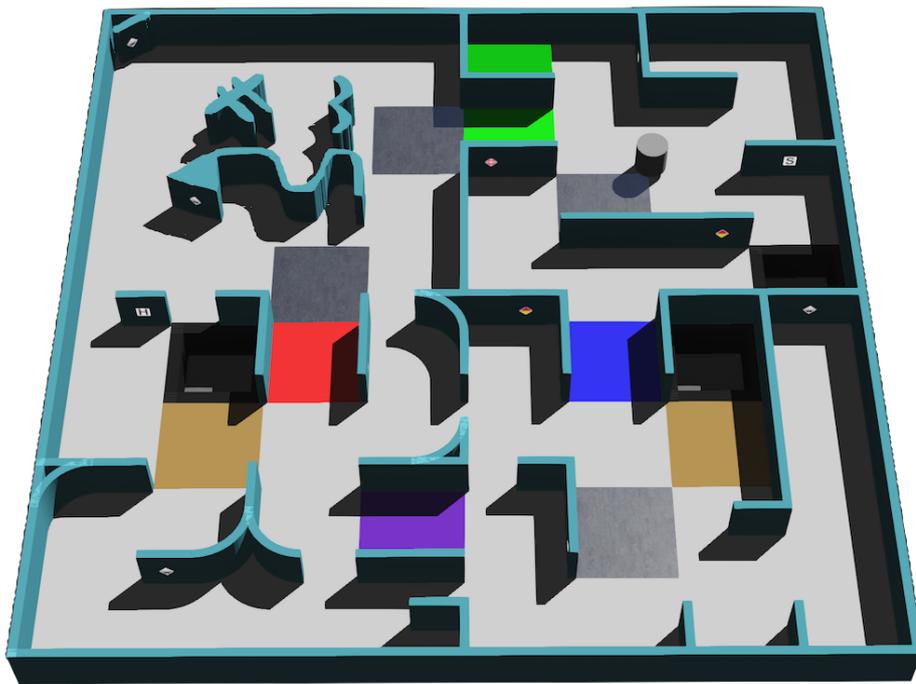
Summary

Since this simulates a rescue environment, the robot's goal should be to try its best to locate all wall tokens by navigating and mapping simultaneously, i.e., map out unknown **areas** [2]. There are four areas. Areas 1 to 3 consist of a tile-based system maze-like layout. Area 4 (optional area) is not tile-based, and teams are encouraged to explore interesting simultaneous localization and mapping algorithms.

If the robot is stuck anywhere in the field, it can be restarted at the last visited checkpoint. [3]

Changes from the RoboCupJunior Rescue Simulation Rules 2023

- Changed "victims" to "wall tokens"

- Changed "domains" to "areas"

- Deleted "Silver tiles in the field represent checkpoints, so the robot can save the position to a map (if it uses a map) in a non-volatile medium and restore it in case of a restart."

- Deleted "and their robots"

- Changed "Adults" to "Non-team members (mentors, teachers, parents and other family, chaperones or translators)"

- Added "Depending on the competition, games may be executed in one of the following ways or another way. The organizer will notify the teams in advance of how the games will be executed at the competition. It is the responsibility of the teams to be prepared to participate in the games in the manner notified."

- Added "Teams need to prepare proper documents to show how to run the program on the organizer's computer."

- Added "The game will be executed on a simulation environment prepared on a cloud environment. Teams will need to provide a Docker file or image that will run on the cloud environment according to the documentation provided."

- Changed "three" to "four"

- Changed "For areas 2 and 3, regions where the robot cannot physically traverse (i.e., openings that are half tile length) will not contain victims and hazmat signs. Such areas must be fully viewable from the opening." to "Regions where the robot cannot physically traverse, openings that are smaller than the robots width will not contain wall tokens."

- Changed "Every scoring element will be accessible by a path with a minimum width of 12 cm. Note that" to "For area 4"

- Added "Area 4: This area's layout is not based on a tile system, meaning walls and obstacles are not placed according to a grid system (i.e., arbitrarily)."

- Deleted "meaning the height of a robot's distance sensor will not affect a robot's performance."

- Deleted "Every scoring element will be accessible by a path with a minimum width of 12 cm. Note that"

- Changed "are intended to be of the width of the tile" to "must be at least the width of the robot itself"

- Changed "Walls may or may not lead to the starting tile consistently following the leftmost/rightmost wall. Walls that lead to the starting tile are called 'linear walls'. The walls that do NOT lead to the starting tile are called 'floating walls'" to "Tiles that lead to the starting tile consistently following the leftmost or rightmost wall are called 'linear tiles'. The tiles that do NOT lead to the starting tile consistently following the leftmost or rightmost wall are called 'floating tiles'. The concept of the quarter tile is not taken into account in this."

- Changed "wall" to "the tile"

- Deleted "All traversable paths measure a minimum of 12 cm in width."

- Deleted "Area 4 will not exceed one-quarter of the entire arena."

- Changed "connection tiles" to "passages"

- Changed "at the start of each game" to "throughout the field"

- Changed "red and green tile entrances" to "passages"

- Added "All these items will be placed in random locations in the field with the following restrictions."

- Changed "Affects the straight-drivability and speed of the robot." to "While the robot is on this tile, simulation time is consumed at 5 times the normal rate."

- Deleted "It must be at least 8cm away from every wall."

- Added "Obstacles affect the width of the pathway."

- Added "There are two kinds of wall tokens - letter victims and hazmat signs."

- Changed "Victims and hazmat signs are represented by a 2cm by 2cm image placed anywhere on walls (including curved surfaces)." to "Wall tokens are represented by a 2cm by 2cm image placed anywhere on walls (including curved surfaces). However, they are not placed in the passages connecting areas."

- Added "Letter"

- Changed "robot" to "robot's hardware"

- Added "letter"

- Added "at least 4 weeks"

- Added "and proper documents"

- Added "If the team agrees,"

- Changed "will" to "may"

- Added "All teams must submit a Poster file before the competition and bring a physical Poster to the competition venue. The Poster is a public document that will be shared with the community during the Poster Presentation session at the competiiton venue. A template for the Poster and rubrics are available on the https://junior.robocup.org/rcj-rescue-line/[RoboCupJunior Official website]."

- Added "The deadline for delivering the documents is scheduled for 3 weeks before the first day of the competition."

- Changed "Teams" to "If the team's robot or program violates the rules, the team"

- Changed "loading programs~" to "starting the game"

- Deleted "* When the beginning of a round is called, teams must submit their computer with the program to run saved on it. The organizers will announce the method to collect the computers."

- Deleted "* The organizers will decide the time limit of submitting the computer with the program to be run in each game."

- Added "The organizers will announce in advance how to participate in the games, which will vary depending on how the competition is conducted. It is the team's responsibility to check and follow the announcements."

- Added "Failure to comply with the announcements, whether intended or unintended, will result in points being deducted between 20% and 100% from that game's score. The percentage will be determined by the organizer based on fairness among the teams and throughout the competition. Teams will not be allowed to comment on this decision."

- Deleted "* When the beginning of a round is called, teams must submit their computer with the program to run saved on it. The organizers will announce the method to collect the computers."

- Deleted "* The organizers will decide the time limit of submitting the computer with the program to be run in each game."

- Changed "If the computer is not submitted by the time limit, the team is considered to have abandoned the game. The" to "If a team fails to play in that game for any reason,"

- Deleted "after the round's computer submission time expires"

- Added "for the first time just before games"

- Deleted "* Teams must submit the source code and any other required documents before a particular day set by the RoboCupJunior Rescue Committee. Organizers will share details through the Official RoboCupJunior Forum."

- Added "The next team in the game order must wait their turn near the game area. The referee will give the teams a maximum of 2 minutes to prepare to ready for starting the game."

- Deleted "* The next team in line should prepare the computer submitted at the beginning of the previous team's round to run the program as a client to the game server. The referees will give a maximum of 2 minutes."

- Deleted "on the game server"

- Changed "When ready, run the program and report to the referee. The team cannot touch a client's computer after this" to "The team cannot touch game-related equipment after the game starts"

- Changed "real time (not simulated time)" to "simulated time"

- Deleted "* Referees will start the game with the submitted code loaded on the simulation platform."

- Deleted "A button will allow the referee to execute a manual lack of progress."

- Added "However, depending on the game execution way, this may not apply."

- Changed "The Robot can be installed in any direction." to "The robot is re-placed by the simulation engine and its direction can not be specified by the team."

- Changed "victim identification (VI)" to "wall token identification (TI)"

- Changed "Victim" to "Wall token"

- Changed "tile on a linear wall (within a 6 cm radius from a victim - see 4.6.2 above) in Area 4 or adjacent to a linear wall(even diagonally), i.e., all wall tokens at the six tiles around a linear wall i.e., all wall tokens at the six tiles around a linear wall" to "linear tile"

- Added "Letter"

- Changed "On other walls (i.e., floating walls)" to "For wall tokens located on a floating tile in Area 1 to 3 and all wall tokens in Area 4"

- Added "Letter"

- Changed "Victim type identification (VT)" to "Wall token type identification (TT)"

- Added "Letter"

- Changed "Victim or hazmat sign misidentification (VMI). A misidentification will cause 5 points deduction. However, the total points will never go below zero points." to "Wall token misidentification (TMI). A misidentification will cause 5 points deduction. However, this deduction will not bring the total score below zero."

- Deleted "The robot identifies a victim as a hazmat sign or vice versa."

- Changed "VI, VT" to "TI, TT"

- Changed "connection tiles from 1 to 2 as '6', 2 to 3 as '7', 3 to 4 as '8' and 1 to 4 as '9'; victims as the corresponding victim" to "passages from 1 to 2 as 'b', 1 to 3 as 'y', 1 to 4 as 'g', 2 to 3 as 'p', 2 to 4 as 'o' and 3 to 4 as 'r'; wall tokens as the corresponding wall token"

- Changed "zeros" to "'*'"

- Added "Depending on the game execution way, this may not apply."

- Added "Competition"

- Changed ". There will be no hardware changes required compared to the main scoring runs." to "and robot."

- Added "The deadline for delivering the documents is scheduled for 3 weeks before the first day of the competition through an online form."

- Added "The current state and behaviour of the simulation environment during the competition will be considered to be the truth. This includes errors that could be labeled as bugs, or behaviour that deviates from the rules, as long as they are the same for all teams. If you notice any weird behaviour while testing before the competition, contact us through the https://junior.forum.robocup.org/c/robocupjunior-rescue[RoboCupJunior Forum]"

Contents

1. Code of Conduct

1.1. Spirit

1. It is expected that all participants (students and mentors alike) respect the aims and ideals of RoboCupJunior as set out in our mission statement.

2. The volunteers, referees, and officials will act within the event's spirit to ensure the competition is competitive, fair, and, most importantly, fun.

3. **It is not whether you win or lose but how much you learn that counts!**

1.2. Fair Play

1. Robots that cause deliberate or repeated damage to the field will be disqualified.

2. Humans that cause deliberate interference with the Rescue Simulation runs, including the simulation engine, server, or computers, will be disqualified.

3. It is expected that all teams aim to participate fairly.

1.3. Behavior

1. Each team is responsible for verifying the latest version of the rules on the RoboCupJunior Official website and additional clarifications/corrections on the official forum made by the RoboCupJunior Rescue Committee before the competition.

2. Participants should be mindful of other people [4] when moving around the tournament venue.

3. Participants are not allowed to enter setup areas of other leagues or teams unless explicitly invited to do so by team members.

4. Teams will be responsible for checking updated information (schedules, meetings, announcements, etc.) during the event. The RoboCupJunior Rescue Committee will provide updated information on notice boards in the venue, the local competition website, or the RoboCupJunior website if possible.

5. Participants and their companions who misbehave may be asked to leave the venue and risk being disqualified from the tournament.

6. Referees, officials, tournament organizers, and local law enforcement authorities will enforce these rules equally to all participants.

7. Teams are expected to be at the venue early on the setup day as important activities will occur. These activities include but are not limited to registration, participation raffle, interviews, captains, and mentor's meetings, among others.

1.4. Mentors

1. **Non-team members (mentors, teachers, parents and other family, chaperones or translators)** [5] are not allowed in the student work area.

2. Mentors are not permitted to be directly involved in the programming before and during the competition.

3. In the first instance, mentor interference with robots or referee decisions will result in a warning. If this behavior recurs, the team could face a possible elimination from the tournament.

4. Robots have to be the work of the students. Any robot that appears identical to another robot may be prompted for re-inspection.

1.5. Ethics and Integrity

1. Fraud and misconduct are not condoned. Fraudulent acts may include the following:

   a. Mentors working on the software or hardware of student's robot(s) during the competition.

   b. More experienced/advanced groups of students may provide advice but should not do the work for other groups. Otherwise, the team risks being disqualified.

2. RoboCupJunior reserves the right to revoke an award if fraudulent behavior is proven after the award ceremony occurs.

3. Suppose it is evident that a mentor intentionally violates the code of conduct and modifies and works on the student's robot(s) during the competition. In that case, the mentor will be banned from future participation in RoboCupJunior competitions.

4. Teams that violate the code of conduct can be disqualified from the tournament. Disqualifying a single team member from further participation in the tournament is also possible.

5. Referees, officials, tournament organizers, and local law enforcement authorities will give a team a warning in less severe cases of violations of the code of conduct. A team can be disqualified immediately without warning for severe or repeated violations of the code of conduct.

1.6. Sharing

1. The spirit of world RoboCup competitions is that teams should share technological and curricular developments with other participants after the tournament. Sharing furthers the mission of RoboCupJunior as an educational initiative.

2. The RoboCupJunior Rescue Committee may publish developments on the RoboCupJunior website after the event.

3. Participants are strongly encouraged to ask questions to their fellow competitors to foster a culture of curiosity and exploration in the fields of science and technology.

4. The RoboCupJunior Forum should be used for general queries and discussions. In contrast, the platform-specific Discord server should be used for technical questions regarding the platform.

2. Field

2.1. Simulation platforms

1. We will be running games on a platform called Webots. For the setup guide: Platform wiki page.

2. Teams are required to create programs to solve maze tasks.

3. **Depending on the competition, games may be executed in one of the following ways or another way. The organizer will notify the teams in advance of how the games will be executed at the competition. It is the responsibility of the teams to be prepared to participate in the games in the manner notified.**

   a. The organizers will run the games on a server-client model and prepare one RJ-45 socket for teams to connect to the game server. **Teams must prepare a computer and an ethernet cable to run the prepared programs.**

   b. The organizers will run and record the games on the computer which the organizer prepared. They will collect all the teams' simulation software before the competition is recorded. The recordings will be used as competition runs and showcased during the competition. **Teams need to prepare proper documents to show how to run the program on the organizer's computer.**

   c. **The game will be executed on a simulation environment prepared on a cloud environment. Teams will need to provide a Docker file or image that will run on the cloud environment according to the documentation provided.**

4. Teams are encouraged to develop their worlds and upload these to the forum to enable sharing.

2.2. Description

1. The field may be divided into **four** [6] distinct areas with different types of walls for the robot to navigate around.

2. All areas are connected by a passage of one standard tile in width. A color will mark the floor of this passage.

3. The field layout will consist of a collection of tiles with a horizontal floor, a perimeter wall, and walls within the field.

4. **Regions where the robot cannot physically traverse, openings that are smaller than the robots width will not contain wall tokens.** [7]

5. **For area 4** [8] the course may require diagonal movement. The robot's action is not aligned to cardinalities (north, east, south, or west directions).

2.3. Tiles, Areas, and Walls

1. The field is divided into tiles of 12cm by 12cm in dimension. The tiles are not physical structures but rather a concept of how the field is generated. For areas 2 and 3, quarter-tiles are considered, where each tile is subdivided into four 6cm by 6cm squares.

2. The walls will have a thickness of 1cm and a height of 6cm.

   - Area 1: Walls are placed on the edges of each tile.

   - Area 2: Walls can be placed on the edges of each quarter tile.

   - Area 3: Walls can be placed on the edges of each quarter tile. Organizers can round a 90-degree corner into a quarter circle.

   - **Area 4: This area's layout is not based on a tile system, meaning walls and obstacles are not placed according to a grid system (i.e., arbitrarily).**

     - There will be various objects, e.g., boxes, inside this area. Note that these objects will not vary by height (within the context of the robot). [9] In the end, since walls can take any shape, there is no real distinction between objects and walls.

     - [10]
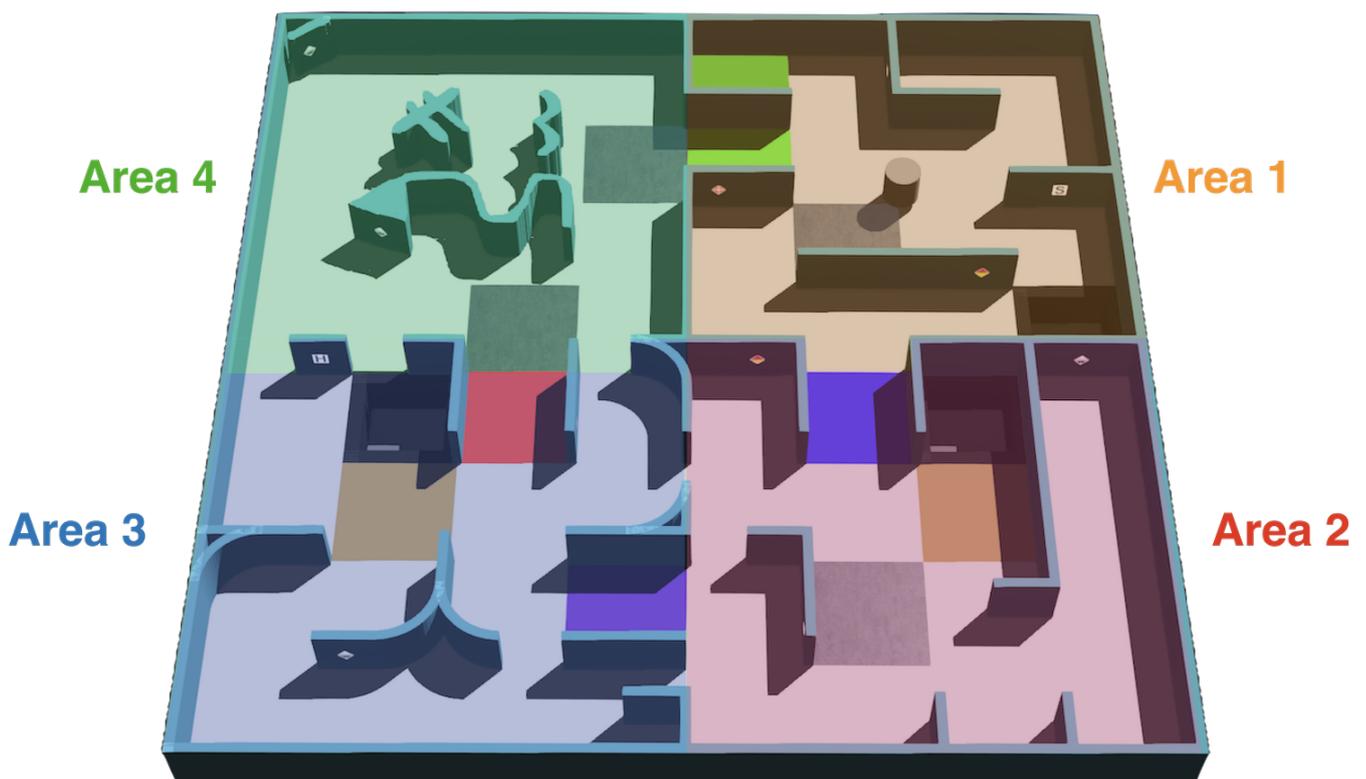
3. Pathways for the robot **must be at least the width of the robot itself** [11] and may open into foyers more expansive than the pathways.

4. Passages connecting areas (e.g. 1 → 2, 3 → 4) will be distinctively color-coded. Each passage consists of a single tile with standard tile width and must have two sides surrounded by a wall such that the tile has an unambiguous entrance and exit.

5. One of the outermost tiles in Area 1 is the starting tile, where a robot should start the run.

6. **Tiles that lead to the starting tile consistently following the leftmost or rightmost wall are called 'linear tiles'. The tiles that do NOT lead to the starting tile consistently following the leftmost or rightmost wall are called 'floating tiles'. The concept of the quarter tile is not taken into account in this.** [12]

7. Black holes will affect the determination of **the tile** [13] type (linear or floating) since they can be considered virtual walls.
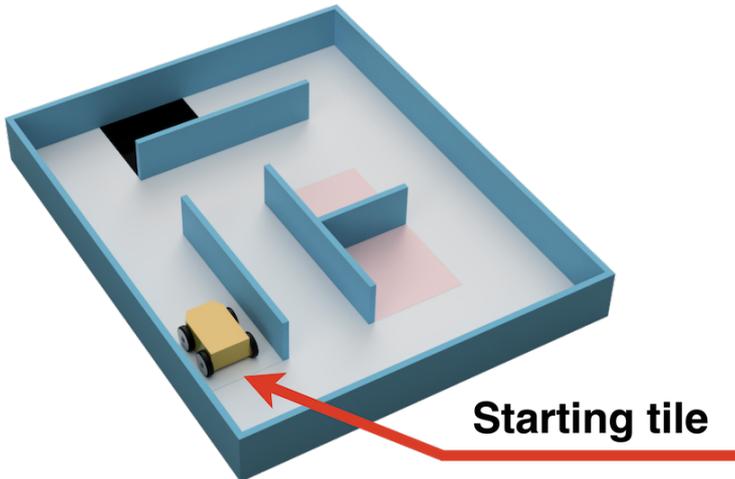
Starting tile

Linear tile

Floating tile

※The color and wall configurations are for illustration only.

8. [14]

9. [15]

2.4. Division of Areas

The colors of the **passages** [16] are as such:

	Area 1	Area 2	Area 3	Area 4
Area 1		Blue	Yellow	Green
Area 2	Blue		Purple	Orange
Area 3	Yellow	Purple		Red
Area 4	Green	Orange	Red	

※The actual color tones will follow the platform implementation.

2.5. Checkpoints

1. Silver tiles in the field represent checkpoints.

2. Silver tiles will be placed randomly **throughout the field** [17].

3. Area 4 will contain checkpoints immediately after the **passages** [18] to the room.

2.6. Swamps, Obstacles, and Holes

1. **All these items will be placed in random locations in the field with the following restrictions.**

2. Swamps:

    a. The color is brown.

    b. **While the robot is on this tile, simulation time is consumed at 5 times the normal rate.** [19]

3. Obstacles:

    a. May be fixed to the floor.

    b. May be any shape, including rectangular, pyramidal, spherical or cylindrical.

    c. The color of the obstacle is not specified.

    d. [20]

    e. **Obstacles affect the width of the pathway.**

4. Holes:

    a. The edge of the holes is colored black and will be 1.5cm from neighboring tiles.

    b. The robot has to avoid the hole.

Swamp   Hole   Obstacle
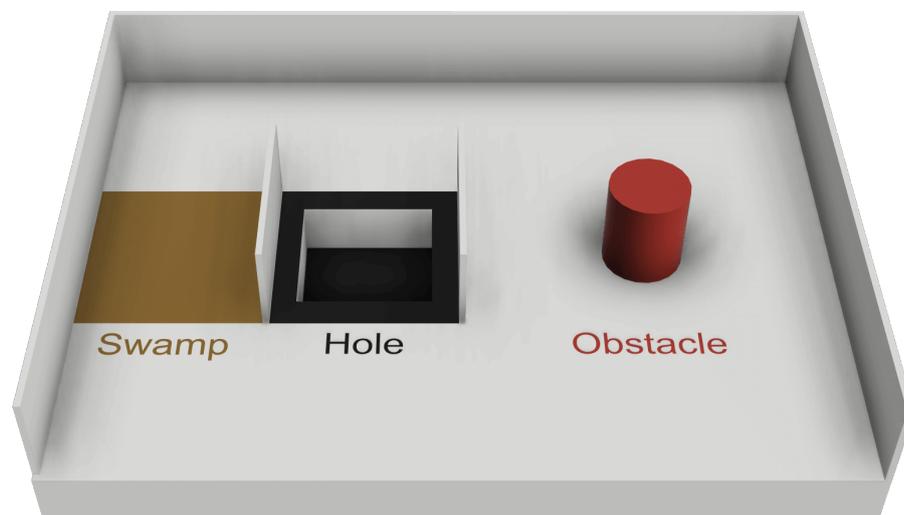
2.7. Wall Tokens

1. **There are two kinds of wall tokens - letter victims and hazmat signs.**

2. **Wall tokens are represented by a 2cm by 2cm image placed anywhere on walls (including curved surfaces). However, they are not placed in the passages connecting areas.** [21]

3. **Letter** victims are uppercase letters printed on or attached to the wall. They are printed in black,

using a sans serif typeface such as "Arial". The letters represent the health status of the victim.

   a. Harmed victim: H

   b. Stable victim: S

   c. Unharmed victim: U

4. Hazmat signs are taken from the RoboCup Rescue League Website, out of which four will be used:

- Flammable Gas [F]
- Poison [P]
- Corrosive [C]
- Organic Peroxide [O]

3. Robots

3.1. Construction

1. The organizers provide the robot model used on each platform.

2. Using the robot customizer tool, teams can customize their **robot's hardware** [22](sensor locations, sensor types, wheel location, etc.).

3. An upper bound to the budget is introduced. Each sensor and wheel costs a certain amount which teams can view in the Robot Customiser Tool. This upper bound is 3000. The number of sensors is also limited, which can be viewed using the same tool.

3.2. Sensors

1. The robot has the following sensors.

   a. Location sensor to detect where the robot is in the field.

b. Color sensor to detect floor color.

c. Distance sensors to measure distance to surrounding walls.

d. RGB camera to search **letter** victims and hazmat signs.

e. LiDAR to measure the distance to surrounding walls.

f. Inertial measurement unit (IMU) sensors: gyroscopic and accelerometers.

2. The RoboCupJunior Rescue Committee will have created the simulation world and robot with noise that is similar to real-world noise levels. Teams should ensure their programs are robust to this noise. Organizers will not change the noise levels within the simulation for the competition.

3.3. Control

1. Robots must be controlled autonomously.

2. The referee will start robots.

3. Robots may utilize various maze navigation algorithms. Any pre-mapped type of dead reckoning (movements predefined based on known locations or placement of features in the field) is prohibited.

3.4. Team

1. Each team must have between 2 and 4 members.

2. A student can be registered on only one team across all RoboCupJunior leagues/sub-leagues.

3. A team can only participate in one league/sub-league across all RoboCupJunior leagues/sub-leagues.

4. Each team member must explain their work and have a specific technical role.

5. All team members must be of the correct age, as stated on the RoboCupJunior General Rules.

6. Mentors/parents cannot work with or help the students during the competition. The students will have to self-govern themselves (without a mentor's supervision or assistance) during the long stretch of hours at the competition.

3.5. Inspection

1. Students will be asked to explain the operation of their programs to verify that all are their works.

2. Students will be asked about their preparation efforts. The RoboCupJunior Rescue Committee may request them to answer surveys and participate in videotaped interviews for research purposes.

3. All teams must complete a web form before the competition to allow referees to prepare better for the interviews. The RoboCupJunior Rescue Committee will provide instructions on submitting the form to the teams **at least 4 weeks** before the competition.

4. All teams must submit their Technical Description Paper (TDP) before the competition. The TDP is a public document that will be shared with the community. A template for the TDP and rubrics are available on the RoboCupJunior Official website.

5. All teams have to submit their source code **and proper documents** before the competition. **If the team agrees,** the organizers **may** [23] share them online after the competition such that other teams can draw inspiration and learn from them.

6. All teams must submit their Engineering Journal before the competition. The organizers will not share the journals with other teams without the team's permission. The organizers will request permission at the registration. A guide for the Engineering Journal format and rubrics are available on the RoboCupJunior Official website.

> **ℹ** However, it is highly recommended that teams publicly share their Engineering Journal. The RoboCupJunior Rescue Committee will share the team's journals alongside their poster presentation and TDP through the RoboCupJunior Forum of the teams that provided their consent. The aim is that other teams could learn from them.

7. **All teams must submit a Poster file before the competition and bring a physical Poster to the competition venue. The Poster is a public document that will be shared with the community during the Poster Presentation session at the competiiton venue. A template for the Poster and rubrics are available on the RoboCupJunior Official website.**

8. **The deadline for delivering the documents is scheduled for 3 weeks before the first day of the competition.**

3.6. Violations

1. **If the team's robot or program violates the rules, the team** [24] must make modifications within the schedule of the tournament, and teams cannot delay tournament play while making modifications.

2. No mentor assistance is allowed during the competition. (See Section 1, "Code of Conduct")

3. Any software specifically designed to complete any single primary task of RoboCupJunior Rescue, e.g., any letter recognition libraries such as Tesseract or EasyOCR, etc., will be prohibited.

4. Any rule violations may be penalized by disqualification from the tournament or the game or result in a loss of points at the discretion of the referees, officials, or RoboCupJunior Rescue Committee.

4. Play

4.1. Pre-round Practice

1. When possible, teams will have access to practice simulation environments for calibration and testing throughout the competition.

2. Whenever there are dedicated independent simulation environments for competition and practice, it is at the organizers' discretion if testing is allowed in the competition environments.

4.2. Humans

1. Teams should designate one of their members as "captain" and another as "co-captain." Only these two team members will be allowed access to the competition areas where the simulation environments are located unless otherwise directed by a referee.

2. The referee performs all operations of the simulation environment in-game, such as **starting the game** [25] and operating LoP.

3. No one is allowed to touch the simulation environments intentionally during a game.

4.3. Before the game

1. [26]

2. [27]

3. **The organizers will announce in advance how to participate in the games, which will vary depending on how the competition is conducted. It is the team's responsibility to check and follow the announcements.**

4. **Failure to comply with the announcements, whether intended or unintended, will result in points being deducted between 20% and 100% from that game's score. The percentage will be determined by the organizer based on fairness among the teams and throughout the competition. Teams will not be allowed to comment on this decision.**

5. [28]

6. [29]

7. **If a team fails to play in that game for any reason,** [30] score of the game will be -50 points.

8. Organizers will only reveal Competition World for each round [31]**for the first time just before games**.

9. No program changes or updates after each round's deadline is allowed.

10. A game begins at the scheduled starting time, whether or not the team is present or ready. Start times will be posted around the venue.

11. Pre-mapping the field or wall token's location is prohibited. Pre-mapping activities will result in immediate robot disqualification for the round.

12. [32]

4.4. Start the game

1. **The next team in the game order must wait their turn near the game area. The referee will give the teams a maximum of 2 minutes to prepare to ready for starting the game.**

2. [33]

3. The game will start with a referee's operation [34].

4. **The team cannot touch game-related equipment after the game starts** [35] for any reason.

5. The game time allowed is 8 minutes in **simulated time** [36]. Since this is a simulation, an additional one-minute real-time will be allowed. Thus, referees will terminate the controller when 9 minutes of real-time expire.

6. A "visited tile" means that the center of the Robot is inside. The game management system makes this judgment.

7. [37]

4.5. Lack of progress

1. A Lack of Progress (LoP) occurs when:

   a. The robot has fallen into a hole.

   b. The robot being in a fixed location for 20 seconds or more (automatically called).

   c. The referee determines the Robot is not entirely static but stuck in a motion sequence. [38]

   d. The robot can call the LoP autonomously.

   e. In any other cases, calling for LOP rests on the team captain, but the referee must make the final decision. **However, depending on the game execution way, this may not apply.**

2. If there is a lack of progress, the Robot must return to the last visited checkpoint (or the start tile if it never reached a checkpoint). **The robot is re-placed by the simulation engine and its direction can not be specified by the team.** [39] For the definition of the visited tile (see 4.4.5).

3. When a LOP is triggered, the engine will send a letter "L" to the robot.

4.6. Scoring

1. To identify a wall token, the robot must stop at each one for 1 second. After 1 second, it must send a command to the game manager with the type of the wall token in a platform-specific format.

2. For successful **wall token identification (TI)** [40], the center of the robot must be equal to or less than half a tile distance from the location of the wall token when the robot indicates a wall token has been identified.
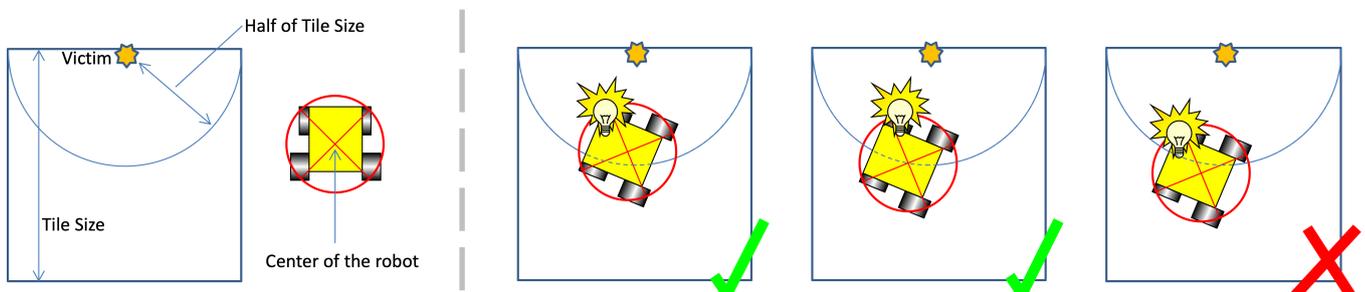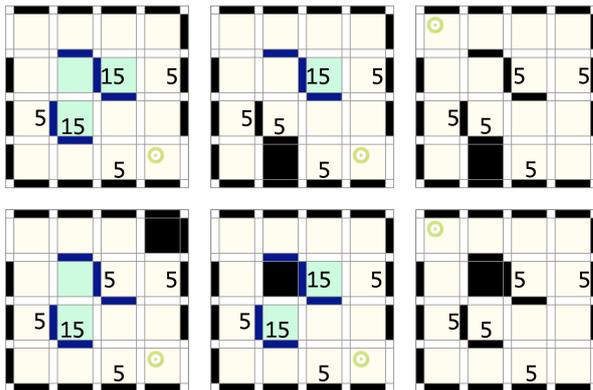

3. **Wall token** [41] identification (TI). Points are rewarded for each successful identification of a wall token on the field.

   a. For wall tokens located on a **linear tile** [42] in Area 1 to 3

      i. **Letter** victims: 5 points
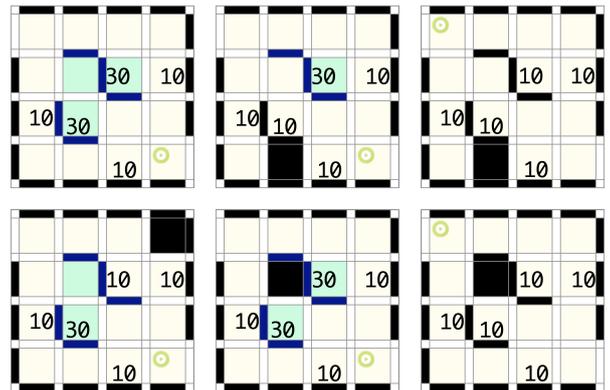
ii. Hazmat signs: 10 points

b. **For wall tokens located on a floating tile in Area 1 to 3 and all wall tokens in Area 4** [43]

i. **Letter** victims: 15 points

ii. Hazmat signs: 30 points

| | Floating tile | | Linear tile | ■ Black hole | ▶ Starting tile | 5_{15} Letter victims | 10_{30} Hazmat signs |

Letter victims   ## Hazmat signs

4. **Wall token type identification (TT)** [44]. Additional points are rewarded if the victim's reported type or hazmat sign are correct.

a. **Letter** victims: 10 points

b. Hazmat sign: 20 points

5. **Wall token misidentification (TMI). A misidentification will cause 5 points deduction. However, this deduction will not bring the total score below zero.** [45]
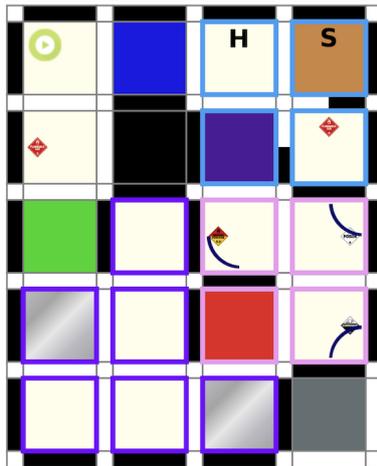
The following is considered a misidentification:

a. The robot identifies the location of the wall token as greater than half the tile size away from the true position.

b. [46]

c. The robot identifies a wall token where is none.

6. Successful checkpoint negotiation (CN). A robot is awarded 10 points for each visited checkpoint. Refer to 4.4.5 for definition of visited tile.

7. Lack of progress (LoP). Each LoP will cause 5 points deduction. However, the total points will never go below zero points.

8. Area multipliers (AM).

a. The scores for **TI, TT** [47], and CN obtained in each of the four areas will be multiplied by a unique multiplier. The multipliers are 1, 1.25, 1.5, and 2 for areas 1, 2, 3, and 4, respectively.

9. Successful exit bonus (EB). A robot will be awarded additional 10% of the total score as an exit bonus if: it can identify at least one wall token and return to the starting tile while sending an 'exit' command to the game manager to finish the game.

10. Mapping bonus (MB).

    a. The robot may submit a matrix with the maze map at any time. The maze map should be encoded in the following prescribed format. The map aims to encode the environment's geometry, key elements such as holes, and victim locations. The mapping bonus is a multiplier between 1 and 2.

    b. For Area 1, 2 and 3:

       i. Each quarter tile and its surrounding edges and vertices will be represented by a cell (value).

       ii. Walls are marked by '1'; holes as '2'; swamps as '3'; checkpoints as '4'; starting tile as '5'; **passages from 1 to 2 as 'b', 1 to 3 as 'y', 1 to 4 as 'g', 2 to 3 as 'p', 2 to 4 as 'o' and 3 to 4 as 'r'; wall tokens as the corresponding wall token** [48] code (H,S,U,F,P,C,O) and any other tiles/edges/vertices should be '0'.

       iii. For curved walls in area 3, the vertex should be represented by a '0'

       iv. The presence of a wall token should be marked on the cell expressing the corresponding wall. Organizers should concatenate the entry if more than one wall token is on a wall.

       v. Organizers can store maps in any rotation as long as it is a multiple of 90°

       vi. Organizers will check the correctness of a submitted map matrix against the matrix representing the real map (real map matrix).

          A. Organizers will use the starting tile to align the two maps' matrices. The two values are compared for every non-zero entry on both the real and submitted map matrices.

          B. If the two values match, the correct count is incremented. Otherwise, the incorrect count is incremented.

          C. The correctness is given by the ratio of the correct count over the sum of the correct count and incorrect count.

          D. Organizers will calculate the correctness for each possible orientation of the submitted map matrix aligned to the real map matrix. The maximum value will be used.

       vii. The mapping bonus multiplier will be the correctness + 1

       viii. Ambiguous edge cases will be noted in the official documentation. For new edge cases that are not defined, please contact the International RoboCupJunior Rescue Committee or the platform development team.

       ix. The method of submitting a map matrix is described in the documentation and example codes located in the platform releases.

    c. For Area 4

       i. Simply fill area 4 elements with '*' [49]. This includes the border of area 4.

    d. Example
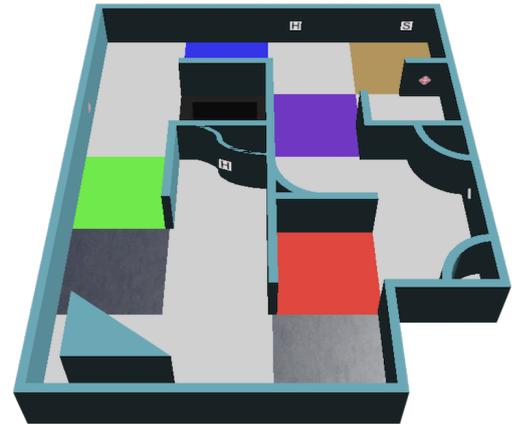
Setup from world editor   **Matrix for mapping bonus**   **World image (.wbt)**

11. There are no duplicate rewards. For example, if a robot visits a checkpoint multiple times, only one successful checkpoint negotiation will be rewarded. The same result applies to all other scoring rules.

12. Scoring will be automated through the platform scoring engine.

$$\text{Field Score} = \left(\sum_{i=1}^{4} (\text{TI}_i + \text{TT}_i + \text{CN}_i) \cdot \text{AM}_i - \text{TMI}_i - \text{LOP}_i \right) \cdot \text{EB} \cdot \text{MB}$$

Example:

TI	Wall Token Identification
TT	Wall Token Type Identification
CN	Checkpoint Negotiation
VMI	Wall Token MisIdentification
LOP	Lack Of Progress
EB	Exit Bonus
MB	Map Bonus

The multipliers are 1, 1.25, 1.5 and 2 for areas 1, 2, 3 and 4 respectively

	AM	TI				TT		CN	Sum-VI, TT, CN	TMI	LOP	Sum-TMI & LOP
score ea.		5	10	15	30	10	20	10		-5	-5	
Area 1	1	2	4	0	0	2	3	1	140	1	2	-15
Area 2	1.25	1	1	3	2	4	3	1	287.5	0	1	-5
Area 3	1.5	2	2	4	3	6	3	1	465	2	1	-15
Area 4	2	1	1	1	1	2	2	1	260	0	2	-10
									1152.5			**-45**

Sub-total for TI, TT, CN		1152.50
Sub-total TMI & LOP		-45.00
		1107.50
With 10% EB	1107.5 x 1.1	1218.25
With MB (assuming all correct)	1218.25 x 2	**2436.5**

4.7. End of Play

1. A team may elect to stop the game early at any time. In this case, the team captain must indicate the team's desire to terminate the game to the referee. The team will be awarded all points earned up to the call at the end of the game.

2. The game ends when:

    a. The time expires.

    b. The Robot sends an 'exit' command to the game manager.

    c. The team captain calls the end of the game. **Depending on the game execution way, this may**

5. Competition

This chapter outlines the structure of an international RoboCupJunior Rescue competition. The competition format and the inclusion of elements like rubrics based scoring, Technical Challenges and the SuperTeam Challenge may vary in local, regional and super-regional competitions. Please refer to the respective organiser for details.

5.1. Rounds & Scoring

1. The competition will consist of multiple rounds of which the worst one or more will be omitted from the final score. The worst round is defined by the lowest normalized field score of the team.

2. The field score for every round will be normalized with the score of the best team of that round:

   ```
   (NORMALIZED FIELD SCORE) = (FIELD SCORE) / (BEST FIELD SCORE)
   ```

3. The normalized field scores will be used to calculate the mean. The worst round(s) will not be considered here:

   ```
   (MEAN OF NORMALIZED FIELD SCORES) = (SUM OF NORMALIZED FIELD SCORES EXCLUDING OMITTED
   ROUNDS) / (NUMBER OF ROUNDS - NUMBER OF OMITTED ROUNDS)
   ```

4. The normalized rubrics score is made up of a sum of normalized scores for the individual rubrics as follows:

   ```
   (NORMALIZED RUBRICS SCORE) =
       0.4 x (TDP SCORE) / (BEST TDP SCORE)
     + 0.4 x (ENGINEERING JOURNAL SCORE) / (BEST ENGINEERING JOURNAL SCORE)
     + 0.2 x (POSTER SCORE) / (BEST POSTER SCORE)
   ```

5. The Rubrics for TDP, Engineering Journal, and Poster will be available on the RoboCupJunior website and the RCJ Rescue Community website.

6. The score from the Technical Challenge will be normalized with the score of the best team:

   ```
   (NORMALIZED TECHNICAL CHALLENGE SCORE) = (TECHNICAL CHALLENGE SCORE) / (BEST TECHNICAL
   CHALLENGE SCORE)
   ```

7. The final score is made up of a weighted sum of normalized scores from the field score, the rubrics and the Technical Challenge as such:

```
(TOTAL SCORE) =
    0.7 x (MEAN OF NORMALIZED FIELD SCORES)
  + 0.2 x (NORMALIZED RUBRICS SCORE)
  + 0.1 x (NORMALIZED TECHNICAL CHALLENGE SCORE)
```

8. Ties in scoring will be resolved based on the mean of normalized field scores.

5.2. Technical Challenge

The Technical Challenge is an additional part of the competition where the teams' ability to quickly modify the bahaviour of their robot will be tested. It consists of one or more mini-tasks with only a limited timespan to solve.

1. The Technical Challenge will take place after the scoring runs have ended.

2. The rules of the individual parts of the Technical Challenge will not be announced before the competition. The teams will only have limited time to prepare for the Challenge.

3. The timeframe for the completion of these tasks will be announced alongside the rules and scoring at a team meeting after the scoring runs.

4. The rules will require the teams to reprogram their robot to change its behaviour **and robot.** [50]

5. The time given will correspond to the difficulty level of the tasks.

5.3. SuperTeam Challenge

The SuperTeam Challenge takes place independantly of the main competition and won't influence the team's individual score. It has its own award and is focussed on the cooperation between the teams.

1. Each SuperTeam will consist of at least two teams. Teams coming from regions that share a native language will not be part of the same SuperTeam.

2. The rules of the SuperTeam Challenge will be announced at the competition and require the teams of each SuperTeam to work together.

3. The SuperTeam Challenge will require substantial software changes and may require minor hardware adjustments.

6. Open Technical Evaluation

6.1. Description

1. The organizers will evaluate your technical innovation during a dedicated time frame. All teams need to prepare for an open display during this time frame.

2. Referees will circulate and interact with the teams. The Open Technical Evaluation is intended to be a casual conversation with a question-and-answer atmosphere.

3. The Open Technical Evaluation's main objective is to emphasize the innovation's ingenuity. Innovative may mean technical advances compared to existing knowledge or an out-of-the-ordinary, simple but clever solution to existing tasks.

6.2. Evaluation Aspects

1. A standardized rubric system will be used, focusing on:
   - creativity
   - cleverness
   - simplicity
   - functionality

2. Your 'work' can include (but is not limited to) one of the following aspects:
   - creation of a new software algorithm for a solution

3. Teams must provide documents that explain their work. Each invention must be supported by concise but clear documentation. The documents must show precise steps towards the creation of the invention.

4. **The deadline for delivering the documents is scheduled for 3 weeks before the first day of the competition through an online form.**

5. Documents must include one Technical Description Paper (TDP), one poster and one Engineering Journal. Teams should be prepared to explain their work.

6. TDP should describe your team's project planning, robot's configuration and design choices, your software architecture and solutions and, the applied process on performance evaluation. A template for the TDP and rubrics are available on the RoboCupJunior Official website.

7. Engineering Journals should demonstrate your best practices in the development process. A guide for the Engineering Journal format and rubrics are available on the RoboCupJunior Official website.

8. The poster should include but is not limited to: the name of the team, country, league, programming language/libraries used, detailed description of the algorithm you developed, time used for development, and awards won by the team in its country, etc. A guide for the poster format and rubrics are available RoboCupJunior Official website.

6.3. Sharing

1. Teams are encouraged to review others' posters, TDPs and presentations.

2. Teams awarded certificates must post their documents and presentation online when the RoboCupJunior Rescue Committee asks.

7. Conflict Resolution

7.1. Referee and Referee Assistant

1. During gameplay, the decisions made by the referee or the referee assistant are final.

2. After gameplay, the referee will ask the captain to sign the score sheet. Captains will be given a maximum of 1 minute to review the score sheet and sign it. By signing the score sheet, the captain accepts the final score on behalf of the entire team. In case of further clarification, the team captain should write their comments on the score sheet and sign it.

7.2. Rule Clarification

1. If any rule clarification is needed, please contact the International RoboCupJunior Rescue Committee through the RoboCupJunior Forum.

2. If necessary, even during a tournament, a rule clarification may be made by members of the International RoboCupJunior Rescue Committee.

7.3. Special Circumstances

1. If particular circumstances, such as unforeseen problems or capabilities of a robot occurs, rules may be modified by the RoboCupJunior Rescue Committee Chair in conjunction with available committee members, even during a tournament.

2. Suppose team captains/mentors do not attend the team meetings to discuss problems, and the resulting rule modifications described at 7.3.1. In that case, the organizers will understand that they agreed and were aware of the changes.

3. **The current state and behaviour of the simulation environment during the competition will be considered to be the truth. This includes errors that could be labeled as bugs, or behaviour that deviates from the rules, as long as they are the same for all teams. If you notice any weird behaviour while testing before the competition, contact us through the RoboCupJunior Forum**

4. In the event of unexpected issues, the Organizers will do their utmost to avoid any disadvantage to the team.

[1] In previous version this said "victims"

[2] In previous version this said "domains"

[3] In previous version this said "Silver tiles in the field represent checkpoints, so the robot can save the position to a map (if it uses a map) in a non-volatile medium and restore it in case of a restart."

[4] In previous version this said "and their robots"

[5] In previous version this said "Adults"

[6] In previous version this said "three"

[7] In previous version this said "For areas 2 and 3, regions where the robot cannot physically traverse (i.e., openings that are half tile length) will not contain victims and hazmat signs. Such areas must be fully viewable from the opening."

[8] In previous version this said "Every scoring element will be accessible by a path with a minimum width of 12 cm. Note that"

[9] In previous version this said "meaning the height of a robot's distance sensor will not affect a robot's performance."

[10] In previous version this said "Every scoring element will be accessible by a path with a minimum width of 12 cm. Note that"

[11] In previous version this said "are intended to be of the width of the tile"

[12] In previous version this said "Walls may or may not lead to the starting tile consistently following the leftmost/rightmost wall. Walls that lead to the starting tile are called 'linear walls'. The walls that do NOT lead to the starting tile are called 'floating walls'"

[13] In previous version this said "wall"

[14] In previous version this said "All traversable paths measure a minimum of 12 cm in width."

[15] In previous version this said "Area 4 will not exceed one-quarter of the entire arena."

[16] In previous version this said "connection tiles"

[17] In previous version this said "at the start of each game"

[18] In previous version this said "red and green tile entrances"

[19] In previous version this said "Affects the straight-drivability and speed of the robot."

[20] In previous version this said "It must be at least 8cm away from every wall."

[21] In previous version this said "Victims and hazmat signs are represented by a 2cm by 2cm image placed anywhere on walls (including curved surfaces)."

[22] In previous version this said "robot"

[23] In previous version this said "will"

[24] In previous version this said "Teams"

[25] In previous version this said "loading programs~"

[26] In previous version this said "* When the beginning of a round is called, teams must submit their computer with the program to run saved on it. The organizers will announce the method to collect the computers."

[27] In previous version this said "* The organizers will decide the time limit of submitting the computer with the program to be run in each game."

[28] In previous version this said "* When the beginning of a round is called, teams must submit their computer with the program to run saved on it. The organizers will announce the method to collect the computers."

[29] In previous version this said "* The organizers will decide the time limit of submitting the computer with the program to be run in each game."

[30] In previous version this said "If the computer is not submitted by the time limit, the team is considered to have abandoned the game. The"

[31] In previous version this said "after the round's computer submission time expires"

[32] In previous version this said "* Teams must submit the source code and any other required documents before a particular day set by the RoboCupJunior Rescue Committee. Organizers will share details through the Official RoboCupJunior Forum."

[33] In previous version this said "* The next team in line should prepare the computer submitted at the beginning of the previous team's round to run the program as a client to the game server. The referees will give a maximum of 2 minutes."

[34] In previous version this said "on the game server"

[35] In previous version this said "When ready, run the program and report to the referee. The team cannot touch a client's computer after this"

[36] In previous version this said "real time (not simulated time)"

[37] In previous version this said "* Referees will start the game with the submitted code loaded on the simulation platform."

[38] In previous version this said "A button will allow the referee to execute a manual lack of progress."

[39] In previous version this said "The Robot can be installed in any direction."

[40] In previous version this said "victim identification (VI)"

[41] In previous version this said "Victim"

[42] In previous version this said "tile on a linear wall (within a 6 cm radius from a victim - see 4.6.2 above) in Area 4 or adjacent to a linear wall(even diagonally), i.e., all wall tokens at the six tiles around a linear wall i.e., all wall tokens at the six tiles around a linear wall"

[43] In previous version this said "On other walls (i.e., floating walls)"

[44] In previous version this said "Victim type identification (VT)"

[45] In previous version this said "Victim or hazmat sign misidentification (VMI). A misidentification will cause 5 points deduction. However, the total points will never go below zero points."

[46] In previous version this said "The robot identifies a victim as a hazmat sign or vice versa."

[47] In previous version this said "VI, VT"

[48] In previous version this said "connection tiles from 1 to 2 as '6', 2 to 3 as '7', 3 to 4 as '8' and 1 to 4 as '9'; victims as the corresponding victim"

[49] In previous version this said "zeros"

[50] In previous version this said ". There will be no hardware changes required compared to the main scoring runs."