



RoboCup@Home

Rules & Regulations

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Chapter 1

Introduction

1.1. RoboCup

ROBOCUP is an international joint project to promote AI, robotics, and related fields. It is an attempt to foster AI and intelligent-robotics research by providing standard problems where a wide range of technologies can be integrated and examined. More information can be found at <http://www.robocup.org/>.

1.2. RoboCup@Home

The ROBOCUP@HOME league aims to develop service and assistive robot technology with high relevance for future personal domestic applications. It is the largest international annual competition for autonomous service robots and is part of the RoboCup initiative. A set of benchmark tests is used to evaluate the abilities and performance of different robots in a realistic, non-standardized home environment setting. The focus is on, but is not limited to, the following domains: human-robot interaction and cooperation, navigation and mapping in dynamic environments, computer vision and object recognition under natural light conditions, object manipulation, adaptive behaviors, behavior integration, ambient intelligence, standardization and system integration. The competition is co-located with the RoboCup symposium.

1.3. Organization

@HOME is organized into three subcommittees. The current members of the committees are listed at <https://athome.robocup.org/committees/>.

1.3.1. Executive Committee — rc-home-ec@lists.robocup.org

The *executive committee* (EC) consists of members of the board of trustees, and representatives of each activity area, and supervises both the TC and OC. The committee is responsible for the long-term planning of the league and cast the final vote in all decisions within the competition, including those pertaining to any of the committees and any other affair that requires a qualified vote. Additionally, the EC must act when any of the committees fail, as it responds to the Trustee board and directs the league accordingly.

1.3.2. Technical Committee — rc-home-tc@lists.robocup.org

The *technical committee* (TC) is responsible for the rules of the league; its main focus is writing the rulebook and refereeing. The members of the *executive committee* (EC) are also members of the *technical committee* (TC).

1.3.3. Organizing Committee — rc-home-oc@lists.robocup.org

The *organizing committee* (OC) is responsible for the organization of the competition, namely it creates the schedule and provides information about the scenarios. The *Local Organizing Committee* (LOC), on the other hand, is responsible for the setup and organization of the competition venue.

1.4. Infrastructure

RoboCup@Home Mailing List The official @HOME mailing list can be found at robocup-athome@lists.robocup.org. You can subscribe to the mailing list at: <https://lists.robocup.org/mm/lists/robocup-athome.lists.robocup.org/>

RoboCup@Home Web Page The official @HOME website that also hosts this rulebook can be found at <https://athome.robocup.org/>

RoboCup@Home Rulebook Repository The official @HOME *Rulebook Repository* is where rules are publicly discussed before applying changes. The entire @HOME community is welcome and encouraged to actively participate in creating and discussing the rules. The *Rulebook Repository* is hosted at <https://github.com/RoboCupAtHome/RuleBook/>

RoboCup@Home Telegram Group The official @HOME *Telegram Group* is a communication channel for the @HOME community where rules are discussed, announcements are made, and questions are answered. Beyond supporting the technical aspects of the competition, the group is a meeting point to stay in contact with the community, foster knowledge exchange, and strengthen relationships. The *Telegram Group* can be reached at <https://t.me/RoboCupAtHome>

RoboCup@Home Wiki The official @HOME *Wiki* is meant to be a central place to collect information on all topics related to the @HOME league. The wiki was set up to simplify and unify the exchange of relevant information; this includes, but is not limited to, hardware, software, media, data, and more. The *Wiki* can be reached at <https://github.com/RoboCupAtHome/AtHomeCommunityWiki/wiki>

1.5. Leagues

@HOME consists of a single league, meaning teams have complete freedom in selecting their robot platform. The official league and its name is:

- *Open Platform League* (OPL)

1.5.1. Open Platform League (OPL)

The *Open Platform League* (OPL) has followed the same core philosophy since the foundation of @HOME. Its main goal is to develop and test robots that can assist humans in domestic environments. With no hardware constraints, the OPL offers teams full freedom to design and configure their own robots. This openness allows for a wide range of approaches, making the league accessible to both new and experienced teams. In this league, robots are pushed to their performance limits without being restricted by predefined design requirements.

1.6. Competition

The competition consists of a series of *Tests* held in a daily life environment, followed by the *Final*. Teams compete in the tests to evaluate their robot capabilities, and the highest-ranked teams advance to the *Final*. The *Final* features a single integrated task where the top teams compete to determine the winner.

1.7. Awards

The @HOME league features the *awards* described below. Note that all awards need to be approved by the *RoboCup Federation* (RCF); based on a decision by the RCF, some of them may not be awarded.

1.7.1. Winner of the Competition

For each league, there will be 1st, 2nd, and 3rd place award trophies (or only 1st and 2nd place trophies if the number of teams in a league is eight or fewer).

1.7.2. Best Human-Robot Interface Award

To honor outstanding human-robot interfaces developed for interacting with robots in @HOME, a special *Best Human-Robot Interface Award* may be awarded to one of the participating teams. Special attention is given to interfaces that are open and available to the @HOME community.

The @HOME *executive committee* (EC) members nominate a set of candidates for the award and the TC elects the winner. A TC member whose team is among the nominees is not allowed to vote. No *Best Human-Robot Interface Award* is given if the EC decides there is no outstanding interface and thus no nominees.

1.7.3. Best Poster Award

To promote scientific knowledge exchange and reward teams for their efforts in presenting research contributions, all scientific posters are evaluated for the *Best OPL Poster Award*.

Candidate posters must present innovative and state-of-the-art research in a field directly applicable to @HOME, with clear and easy-to-understand results. In addition to being attractive and well-rated in the *Poster Session* (see Section 4.3), the research must also have a measurable impact on the team's performance during the competition.

The @HOME *executive committee* (EC) members nominate a set of candidates for the award and the TC elects the winner. A *technical committee* (TC) member whose team is among the nominees is not allowed to vote.

1.7.4. Open Challenge Award

To encourage teams to showcase their research to other teams during the competition off-hours, @HOME grants the *Best Open Challenge Award* to the team that presents the best open demonstration during the competition. This award is given only if a team demonstrates innovative research relevant to the global objectives of @HOME.

The @HOME TC members, with a recommendation from the team leaders, nominate a set of candidates for the award. The EC decides whether the award should be granted and then elects the winner. A *technical committee* (TC) member is not allowed to nominate their own team without a recommendation from the team leaders.

1.7.5. Skill Certificates

The @HOME league features certificates for best demonstrated skills in *Navigation*, *Manipulation*, *Person Recognition*, and *Natural Language Processing*. A team receives the certificate if it scores at least 75% of the attainable points for that skill across all tests and challenges. For example, if a robot scores manipulation points during the *Help-me-Carry* test to open the door, that will count for the *Manipulation* certificate. Note that the certificate will only be awarded if the team is *not* the overall winner of the competition.

1.7.6. Open-source software award

Since Nagoya 2017, RoboCup@Home awards the best contribution to the community by means of an open-source software solution. To be eligible for the award, the software must be easy to read, well-documented, follow standard design patterns, actively maintained, and meet the IEEE software engineering metrics of scalability, portability, maintainability, fault tolerance, and robustness. Additionally, the open-source software must be available as a framework-independent standalone library to ensure it can be reused with any software architecture.

Candidates must submit their application to the *technical committee* (TC) at least one month before the competition via a short paper (maximum 4 pages), in the same format as the *Team Description Paper* (TDP) (see Section 3.1.2), including a brief explanation of the approach, comparison with state-of-the-art techniques, statement of the used metrics and software design patterns, and the name of the teams and other collaborators using the software.

The @HOME *executive committee* (EC) members nominate a set of candidates for the award and the *technical committee* (TC) elects the winner. A *technical committee* (TC) member whose team is among the nominees is not allowed to vote.

Chapter 2

Concepts Behind the Competition

A set of conceptual key criteria forms the foundation of the @HOME competition. These criteria represent a shared understanding of the general concept of the competition. The specific rules are detailed in the @HOME Rules & Regulations.

2.1. Lean Set of Rules

To enable diverse, general, and transmissible approaches in the @HOME competition, the rule set should be as concise as possible. However, it must also be specific enough to eliminate ambiguity and prevent disagreements during the competition. If discrepancies or multiple interpretations arise, decisions will be made by the *technical committee* (TC) and on-site referees.

Note: Once the test scoresheet is signed the *technical committee* (TC)'s decision is final and cannot be reversed.

2.2. Autonomy & Mobility

The aim of @HOME is to foster mobile autonomous service robotics and natural human-robot interaction. Thus, all robots participating in the RoboCup@Home competition must be *mobile* and *autonomous*, meaning that humans are not allowed to directly (remotely) control the robot, including through verbal commands.

2.3. Aiming for Applications

To drive technological advancement and maintain the competition's interest, the scenario and the tests will steadily increase in complexity. While fundamental abilities are tested, the focus will shift toward real-world applications with higher levels of complexity and uncertainty. In @HOME, solutions that are practical, reliable, general, cost-effective, and applicable are highly valued.

2.4. Social Relevance

The competition and its tests should produce outcomes that are socially relevant, as the goal is to demonstrate the value of autonomous robotic applications to the public. This should be achieved by showing applications where robots directly help or assist humans in everyday

situations. Examples include a personal robot assistant, a guide robot for the blind, or robot care for the elderly.

2.5. Scientific Value

@HOME should not only highlight current practical applications, but also encourage the presentation of innovative approaches, even if they are not yet fully applicable or require special configurations. Therefore, approaches with high scientific value are rewarded.

2.6. Time Constraints

To accommodate many teams and tests, as well as to promote simplicity in setup procedures, the setup time and test duration are very limited.

2.7. No Standardized Scenario

The competition scenario should be simple, effective, available worldwide, and low-cost. As uncertainty is a key part of the competition, no standardized scenario will be provided. Instead, the scenario is expected to reflect typical environments of the country where the competition is held.

It could be a domestic setting like a living room or kitchen, or an office, supermarket, or restaurant. The scenario may change annually to ensure the tests remain relevant and engaging. Additionally, tests may occur in previously unknown environments, such as nearby public spaces.

2.8. Attractiveness

The competition should be appealing to both the audience and the public. Thus, approaches that are highly attractive and original are rewarded.

2.9. Community

While teams compete against each other during the competition, members of the @HOME league are expected to collaborate and share knowledge to advance robotic technology collectively.

The *RoboCup@Home mailing list* and the *Rulebook Repository* can be used to communicate with other teams and discuss league-specific issues such as rule changes or proposals for new tests. Additionally, every team is expected to share technical, scientific, and team-related information in a Team Description Paper and on their team website.

Finally, all teams are invited to submit papers on related research to the ROBOCUP SYMPOSIUM, which accompanies the annual RoboCup World Championship.

2.10. Desired Abilities

The following are the key technical abilities that the tests in @HOME aim to evaluate

- Navigation in dynamic environments
- Fast and easy calibration and setup (the ultimate goal is to have a robot up and running out of the box)
- Object recognition
- Object manipulation
- Detection and recognition of humans
- Natural human-robot interaction
- Speech recognition
- Gesture recognition
- Robot applications (@HOME is aiming for applications of robots in daily life)
- Ambient intelligence, such as communicating with surrounding devices, retrieving information from the internet, etc.

Chapter 3

General Rules and Regulations

These are the general rules and regulations for the competition in the ROBOCUP@HOME league. Each rule in this section implicitly includes the phrase “*unless stated otherwise*”. This means that any additional or contrary rules, particularly those related to test specifications, take precedence over the rules stated in this section.

3.1. Team Registration and Qualification

3.1.1. Registration and Qualification Process

Each year, there are three phases in the process towards participation in @HOME:

1. *Preregistration*
2. *Qualification* announcement
3. *Final Registration* for qualified teams

The *Preregistration* process is initiated by a call for participation sent to the *RoboCup@Home mailing list*. Preregistration requires a *Team Description Paper*, a *Qualification Video*, and a *Team Website*. The expected contents of these are described below.

3.1.2. Team Description Paper

The *Team Description Paper* (TDP) is an 8-pages scientific paper that must include a description of your main research, including the scientific contribution, goals, scope, and results. The *Team Description Paper* (TDP) has to be written in English and formatted using the template of the RoboCup International Symposium without any alterations. The paper should contain the following items:

- The focus of research and the contributions in the respective fields
- Innovative technology (if any)
- Re-usability of the system for other research groups
- Applicability of the robot in real-world scenarios
- Photo(s) of the robot(s) used

As an appendix on the 9th page (after the references), please include:

- Team name
- Contact information
- Website URL

- Names of the team members
- Photo(s) of the robot(s), unless included before
- Description of the hardware used
- A brief, compact list of *external devices* (see Section 3.4), if any
- A brief, compact list of any used 3rd party software packages (e.g. ROS' `object_recognition` should be listed, but OpenCV doesn't have to be because it is a rather standard library)
- **[Open Platform League only]** A brief description of the hardware used by the robot(s)

During the qualification process, the *Team Description Paper* (TDP) will be scored according to its scientific value, novelty, and contributions.

3.1.3. Qualification Video

As a proof of running hardware, each team has to provide a *Qualification Video* that demonstrates at least two of the following minimum requirements:

- Human-robot interaction
- Safe navigation (indoors, with obstacle avoidance)
- Object detection and manipulation
- People detection
- Speech recognition
- Speech synthesis (clear and loud)

It is also recommended that the video include some of the following abilities:

- Activity recognition
- Complex speech recognition
- Complex action planning
- Gesture recognition
- Failure recovery

The video should not exceed 10 min, be self-explanatory and be designed for a general audience. It must show the robot solving complex tasks relevant to @HOME. In particular, to qualify for the competition, the video must demonstrate that the robot is able to successfully solve at least one test from the current or previous year's rule book. For robots moving slowly, we recommend speeding up the video, but please indicate the speed factor being used when doing so (e.g. 2x). The same rule applies for slow motion scenes.

3.1.4. Team Website

The *Team Website* should be designed for a broader audience and include scientific material (scientific papers, datasets, and documented open source code). The requirements for the website are as follows:

1. **Language:** The *Team Website* must be in English. Other languages may be available, but English must be default language.
2. **Team:** A comprehensive list of all team members, including brief profiles.

3. **RoboCup:** Link to the league website and previous participations of the team at ROBOCUP (not necessarily only @HOME).
4. **Scientific approach:** Include a research statement, a description of the used approach, and information on scientific achievements.
5. **Publications:** Relevant *publications* from at least the last five years should be included. Downloadable publications are scored higher during the qualification process.
6. **Open source material:** Blueprints, datasets, repositories, or any other contributions to the league are highly valued during the qualification process.
7. **Multimedia:** Photos and videos of the robot(s) used should be included and easily accessible.

3.1.5. Qualification

During the *Qualification Process*, a selection will be made by the *organizing committee* (OC). The following factors are evaluated in the decision process:

- The scientific value, novelty, and contributions of the *Team Description Paper* (TDP)
- The number of abilities and the complexity of the tasks shown in the *Qualification Video*
- The contents of the *Team Website*, where relevant publications and open source resources are highly valued

In addition, the following evaluation criteria are considered:

- The performance in previous competitions
- Relevant scientific contributions and publications
- Any additional contributions to the @HOME league

Important note for the Standard Platform Leagues: Only unmodified robots may compete in Standard Platform Leagues. Any *unauthorized* modification made to the robot that are found in the qualification material will automatically disqualify the team in the qualification process.

3.1.6. Participation Confirmation

In order to have as many participating teams as possible, qualified teams *must* contact the *organizing committee* (OC) to confirm (or cancel) the participation several months in advance. Confirming attendance implies that the team has sufficient resources to register for the competition and commits to attend the event. Qualified teams that do not confirm their participation may be disqualified.

3.2. Scenario

Most competition tests take place in the ROBOCUP@HOMEArena, but some tests may take place outside, in a previously unknown public place. In this section, the *Arena* and its contents are described, including the furnishing and other information common to all tests and leagues.

3.2.1. RoboCup@Home Arena

The ROBOCUP@HOME*Arena* is a realistic home setting (an apartment) composed of interconnected rooms. The minimal configuration consists of:

- a bedroom,
- a dining room,
- a living room, and
- a kitchen

There is typically one *Arena* per league. Depending on the local organization, there may be multiple *Arenas* that differ, and a robot must be prepared to perform any task in any *Arena*.

The arena is designed to resemble a typical apartment in the hosting country, including all necessities and decorations found in a *normal* home. Note that what is considered *normal* may vary by culture and location. Decorations can include, but are not limited to, plants, mirrors, paintings, posters, plates, picture frames, wall clocks, candles with holders, and books.

3.2.2. Walls, Doors, and Floor

The indoor home setting will be surrounded by high and low *walls*, which are built up using standard fair construction material.

1. **Walls:** Walls are fixed and cannot be modified during the competition. The minimum wall height is 60 cm; a maximum height is not specified, but must allow the audience to view the competition.
2. **Doors:** Rooms are connected by doors (at least one). All doors have handles, not knobs, and can be closed at any time. It is expected that robots can open these doors or find alternative paths around them. Doors must meet minimum accessibility requirements, with a recommended width of 915 mm.
3. **Floor:** The floor and doorways are even, so there are no major steps or stairs. Minor variations, such as carpets, floor transitions, and small gaps (especially at doorways), can be expected.
4. **Appearance:** The floor and walls are mostly monochromatic, but may have textures like carpets or posters on walls.

3.2.3. Furniture

The *Arena* is furnished with typical objects common to the host country. The minimal configuration consists of:

- a bed,
- a couch,
- a small table,
- a small dinner table with two chairs,
- two trash bins,
- an open cupboard or a small table with a television and remote control,
- a chest of drawers,
- a high cabinet with doors



Figure 3.1.: An example of a ROBOCUP@HOME scenario

- a bookcase, and
- a coat rack

The kitchen in the *Arena* includes:

- a dishwasher,
- a microwave,
- a sink, and
- a refrigerator (with some cans and plastic bottles inside)

A typical *Arena* setup is shown in Figure 3.1a.

Chest of drawers

The chest of drawers has at least two drawers located between 90 cm and 120 cm from the floor. These drawers require U-shaped handles for easy access.

High Cabinet

A high cabinet is any shelf-like furniture where objects can be placed. The minimum distance between shelves is 30 cm. The Cabinet must have two side-by-side doors blocking the access to at least the lower three shelves. These doors require U-shaped handles for easy access.

Fridge

At least one functional fridge is required in the *Arena* and must be at least 120 cm in size.

3.2.4. Changes to the Arena

Since robots should be able to function in the real world, the *Arena* is not fixed and might change without notice.

1. **Major changes:** Furniture that is not fully static in everyday environments may be moved slightly between tests. In particular, furniture will not change rooms or move drastically within a room, but a couch or table may be slightly rotated or moved. Fixed locations for such furniture items should not be assumed. Walls will stay in place and rooms will retain their function. Passages might be blocked.
2. **Minor Changes:** Slightly moved chairs, slightly closed doors, or similar adjustments may occur at any time, even during a test.

3.2.5. Objects

Some tests in the RoboCup@Home league involve recognizing and manipulating objects (see Figure Figure 3.1b). The *technical committee* (TC) will compile a list of at least 30 objects for this purpose. Each object will have a picture, an official name, and an *Object Category* (e.g., an *Apple* is in the *Fruits* category). Most objects are lightweight and easy to grasp with one hand. Every *Object Category* has an assigned *Predefined Location*, where objects of that category are usually found during tests (for example, an *Fruits* can be found on the *Kitchen Table*). These locations are announced during the *Setup Days* (see Section 4).

Objects are provided at the competition for training. Teams may keep at most five training objects at a time and for up to one hour. Modifying the objects is not allowed.

Two types of objects are used in the tasks:

1. **Known Objects:** Objects previously known to the robot, divided into:
 - 1.1. **Consistent Objects:** Objects whose image appears in the list of objects.
 - 1.2. **Similar Objects:** Objects not in the list but similar enough to one of the listed objects that a person would consider them the same kind (e.g., an apple with a different color or a cloth with a different pattern).
 - 1.3. **Standard Objects:** Objects chosen from the *YCB Dataset*.¹ These are published six months in advance on the ROBOCUP@HOME website², for teams to acquire and train on beforehand.
2. **Unknown Objects:** Any other object not in the object list but can be grasped or handled (e.g., *Arena* decorations).

The minimal configuration of *Known Objects* consists of:

- **Tableware:** Dish, bowl, cup (or mug), and napkin (see Figure 3.2a).
- **Cutlery:** Fork, knife, and spoon.
- **Trash Bags:** Large plastic trash bags, preferably with a handle.
- **Bags:** Lightweight and with stiff, vertical handles (see Figure 3.2b).
- **Dry Food Container:** Dry food containers (see Figure 3.2d).
- **Disks or books:** A set of discs (LP, CD, DVD, or BluRay) or books.
- **Coat rack:** A rack or pole to hang coats and other clothes.
- **Trays:** A transport objects like trays or baskets, intended for bimanual manipulation (see Figure 3.2c).
- **Pourable:** An object whose content can be poured (such as a cereal box).

¹<http://www.ycbbenchmarks.com/object-set/>

²<https://athome.robocup.org/standard-objects>

- **Heavy object:** Weighing between 1.0 kg and 1.5 kg.
- **Tiny object:** A lightweight object not larger than 5 cm (such as paper, a teabag, or a pen).
- **Fragile object:** An object that is easy to break (such as a chocolate egg).
- **Deformable object:** A flexible object that may change shapes (such as cloth).
- **Garbage bag:** A garbage bag that can be tied.

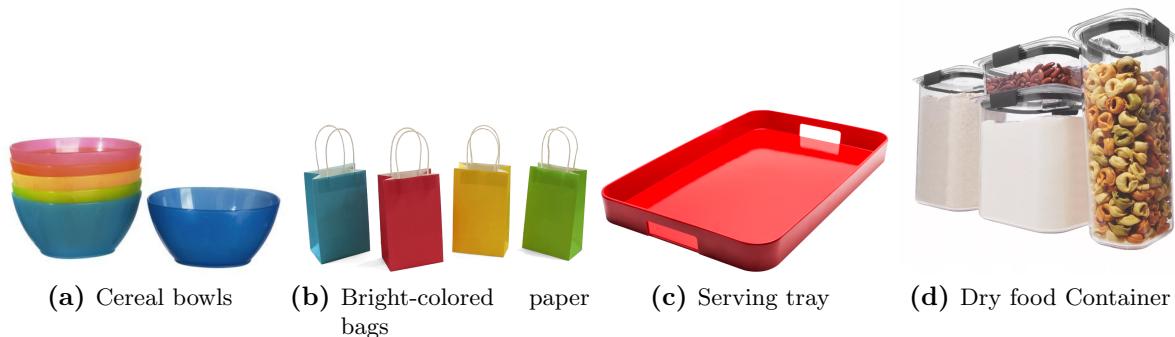


Figure 3.2.: Example of object containers

During the competition, objects can be requested based on their *Object Category*, physical attributes, or a combination of both. Relevant attributes to be used are:

- Color (such as red, blue, black with white dots, etc.).
- Relative estimated size (smallest, largest, big one, etc.).
- Relative estimated weight (lightest, heaviest).
- Relative position to other objects (left of, rightmost, etc.).
- Description (is fragile, is a container, can be poured, requires two hands, etc.).

Remark: Measurements are estimations and based on common sense. It is acceptable for robots to consider similar objects to be about the same size or weight.

3.2.6. Predefined Rooms and Locations

Some tests require robots to interact with *Predefined Location* where people or objects may be found. The *Arena* includes at least two *doors*, named *Entrance* and *Exit*, which connect to and from the *Arena*.

Room names, predefined locations, and location classes are announced during the *Setup Days* (see Section 4).

3.2.7. Predefined Person Names

Some tests involve memorizing a person's name. Each person in the *Arena* is assigned a *Predefined Name* by the *technical committee* (TC). The list of names contains 25 % male, 25 % female, and 50 % gender-neutral names taken from the list of most commonly used names in the United States. Predefined names are announced during the *Setup Days* (see Section 4).

3.2.8. Wireless network

For wireless communication, an *Arena Network* is provided. The actual infrastructure depends on the local organization. Reliability and performance of the network are not guaranteed, so robots are expected to be able to function without it.

The following rules apply:

- Only the *Arena Network* can be used during tests.
- Only the active team in a task is allowed to use the *Arena Network*.
- The *Arena Network* provides one Virtual Local Area Network (VLAN) per team.
- Each VLAN has its own SSID and password.
- VLAN traffic is isolated from other teams.
- Each VLAN is also connected to the Internet.

Teams broadcasting unauthorized wireless networks will be disqualified. This includes networks with concealed SSIDs. It is recommended to check all devices for any unauthorized wireless network activity.

3.3. Robots

3.3.1. Number of Robots

1. **Registration:** The maximum *number of robots* per team is *two*.
2. **Regular Tests:** Only one robot is allowed per test. Different robots can be used for different test runs.

3.3.2. Appearance and Safety

Robots must have a product-like appearance and be safe to operate. The following rules apply to all robots:

1. **Cover:** Internal hardware (electronics and cables) must be fully covered to ensure safety. The use of visible duct tape is strictly prohibited.
2. **Loose cables:** No loose cables should hang out of the robot.
3. **Safety:** The robot must not have sharp edges or protruding parts that could harm people.
4. **Annoyance:** The robot must not emit continuous loud noises or use blinding lights.
5. **Marks:** The robot must not display any artificial marks or patterns.
6. **Driving:** Obstacle avoidance is mandatory to ensure safe movement.

The compliance with these rules will be verified during *Robot Inspection* (see [4.4](#)).

3.3.3. Robot Specifications for the Open Platform League

Robots competing in the RoboCup@Home Open Platform League must comply with security specifications to ensure they do not pose any risk to people or property while operating.

Size and Weight

1. **Dimensions:** The robot must fit within the dimensions of an average door, which are typically 200 cm by 70 cm in most countries. The *technical committee* (TC) may allow the qualification and registration of larger robots, but they cannot guarantee that these robots can actually enter the *Arena* due to local restrictions. If in doubt, please contact the *Local Organizing Committee* (LOC).
2. **Weight:** While there are no specific weight restrictions, the robot's total weight and the pressure it exerts on the floor must not exceed local regulations for the construction of offices and/or buildings in the country where the competition is held.
3. **Transportation:** Team members are responsible for quickly removing the robot from the *Arena*. The robot must be transportable by the team members in a way that is both quick and easy.

Appearance

Open Platform League (OPL) robots should appear as safe, finished products rather than early-stage prototypes. This includes ensuring that all internal hardware (electronics and cables) is completely covered for safety. While covering the robot's internal components with a t-shirt is not prohibited, it is not recommended.

Emergency Stop Button

1. **Accessibility and visibility:** Each robot must have an easily accessible and visible *Emergency Stop* button.
2. **Color:** The *Emergency Stop* button must be colored red and must be the only red button on the robot. The *technical committee* (TC) may ask the team to tape over or remove any other red buttons present on the robot.
3. **Robot behavior:** When the *Emergency Stop* button is pressed, the robot and all its parts must stop moving immediately.

Start Button

1. **Requirements:** As explained in Section 3.6.8, teams that cannot perform the default start signal (opening the door) must provide a *Start Button* that can be used to start tests. Teams must inform the TC in advance of any test that involves a start signal, including the *Robot Inspection*.
2. **Definition:** The *Start Button* can be any “one-button procedure” that is easy for a referee to execute, such as releasing the *Emergency Stop*, pressing a green button, or using a software button in a graphical user interface.

Note: All robot requirements will be tested during the *Robot Inspection* (see 4.4).

3.4. External devices

Everything that a team uses during a test and is not part of the robot is considered an *External Device*. All *External Devices* must be authorized by the *technical committee* (TC) during the

Robot Inspection test (see Section 4.4). The TC specifies whether an *External Device* can be used freely or under referee supervision, and determines its impact on scoring.

Note: The use of wireless devices, such as hand microphones and headsets, is not allowed, with the exception of *External Computing* as specified below. The competition organizers do not guarantee or take any responsibility for the availability or reliability of the network or the internet connection in the *Arena*. Teams can thus use *External Computing* resources at their own risk.

3.4.1. On-site External Computing

Computing resources that are not physically attached to the robot are considered *External Computing* resources. The use of up to five *External Computing* resources is allowed, but only in the *Arena Network* (see Section 3.2.8) and with a prior approval of the *technical committee* (TC).

Teams must inform the *technical committee* (TC) about the use of any *External Computing* at least one month before the competition. **Note:** Robots must be able to operate safely even if *External Computing* is unavailable.

External Computing devices must be placed in the *External Computing Resource Area* (ECRA), which is announced by the *technical committee* (TC) during the *Setup Days*. A switch connected to the *Arena* wireless network will be available to teams in the *External Computing Resource Area* (ECRA). During a *Test Block*, at most two laptops and two people from different teams are allowed in the *External Computing Resource Area* (ECRA) simultaneously, one member each of the teams up next. No peripherals, such as screens, mice, keyboards, and so forth, are allowed to be used.

During a *Test Slot*, everyone must stay at least 1m away from the *External Computing Resource Area* (ECRA). Interacting with anything in the *External Computing Resource Area* (ECRA) after the referee has given the start signal for a test will result in the test being stopped with a score of zero.

If a laptop is used as *External Computing*, a team can only place it in the *External Computing Resource Area* (ECRA) if their *Test Slot* is up next and must remove the device immediately after the test.

3.4.2. On-line external computing

Teams are allowed to use *External Computing* through the internet connection of the *Arena Network*; this includes cloud services or online APIs.

3.5. Organization of the Competition

3.5.1. Competition Structure

The competition consists of a series of tasks, repeated on each competition day, designed to test specific robot capabilities, followed by a *Final* as the final evaluation of the teams' overall performance.

1. **Robot Inspection:** All teams must pass a *Robot Inspection* during the *Setup Days* to be eligible for competition (see Section 4.4).

2. **Tasks:** Teams compete in a set of tasks that evaluate different robot abilities. Each task is repeated on multiple competition days, giving teams more than one opportunity to attempt it. For ranking purposes, the *best score* obtained in each task is considered.
3. **Final:** The top *three teams*, namely the ones with the highest overall score, advance to the *Final*. The final round features a single integrated task that tests all abilities evaluated throughout the competition.

In cases where there is no significant score difference between teams, the *technical committee* (TC) may decide to include additional teams in the *Final*.

3.5.2. Schedule

1. **Daily Task Runs:** Each competition day features the same set of four tasks. Two tasks are executed in parallel in different arenas. Once a team completes its run in one arena, it proceeds to the other arena according to the schedule.
2. **Team Groups:** Teams are assigned to fixed groups (e.g. A, B, C, D). Each block has predetermined start times for the arenas and tasks. This ensures an even distribution of teams across arenas and reduced waiting time.
3. **Test Slots:** Within each arena, teams are allocated a specific Test Slot that defines the maximum time available to complete the task. Teams must be ready at their assigned block start time.
4. **Participation is default:** Teams must inform the *organizing committee* (OC) in advance if they are skipping a Test Block. If they do not provide such notification, they may be penalized for not attending (see Section 3.8.1).

| | Day 1 | Day 2 | Day 3 | Day 4 |
|--------------------------|---------|--------|--------|------------|
| Block 1 (9:00–11:00) | Task 1 | Task 2 | Task 2 | Restaurant |
| | —Break— | | | |
| Block 2 (13:00–15:00) | Task 3 | Task 4 | Task 4 | Task 2 |
| | —Break— | | | |
| Block 3 (17:00–19:00) | | | Task 4 | Task 3 |

Table 3.1.: Example schedule. Each team has two Test Slots assigned in every Test Block.

Note that the actual allocation of blocks will be announced by the *organizing committee* (OC) during the *Setup Days* (see Table 3.1).

3.5.3. Scoring System

The scoring system for the competition is designed to evaluate robot performance based on task completion. Each task has a primary objective and a set of bonus scores. Teams must complete parts of the main objective to receive any points. Bonuses are not awarded otherwise.

| | Arena 1 | Arena 2 |
|-------|---------|---------|
| 12:00 | Group A | Group C |
| 12:30 | Group B | Group D |
| 13:00 | Group C | Group A |
| 13:30 | Group D | Group B |

Table 3.2.: Example schedule for one block showing timeslots and group rotation between arenas.

The scoring system has the following constraints:

1. **Final:** The final score is normalized.
2. **Minimum score:** The minimum total score per test is *0 points*. While teams generally cannot receive negative points, penalties can result in a total score below zero. Specifically, teams may receive penalties for not attending (see Section 3.8.1) and for extraordinary violations (see Section 3.8.2).

3.6. Procedure during Tests

3.6.1. Safety First!

1. **Emergency Stop:** At any time, if a robot exhibits dangerous behavior towards people or objects, the owners must immediately stop it.
2. **Stopping on request:** If a referee, member of the Technical or Organizational committee, an Executive or Trustee of the federation stops the robot (by pressing the emergency button) there will be no discussion. Similarly, if they tell the team to stop the robot, the robot must be stopped *immediately*.
3. **Penalties:** Failure to comply results in immediate disqualification from the ongoing competition by the @HOME *technical committee* (TC). Additionally, the team and its members may be banned from future competitions for at least one year by the RoboCup Federation Trustee Board.

3.6.2. Maximum number of team members

1. **Regular Tests:** During regular tests, only one team member is allowed inside the *Arena*. Exceptions are tests that explicitly require volunteer assistance.
2. **Setup:** During the setup, the number of team members inside the *Arena* is not limited.

3.6.3. Fair play

Fair Play and cooperative behavior are expected from all teams throughout the competition, especially:

- while evaluating other teams,
- while refereeing, and
- when interacting with other teams' robots.

This includes the following:

- not attempting to cheat (e.g., pretending autonomous behavior where there is none),
- not exploiting the rules (e.g., not attempting to solve the task but trying to score), and
- not intentionally causing other robots to fail.
- not modifying robots in standard platforms.

Violating this rule may result in penalties such as negative scores, disqualification for a test, or even the entire competition.

3.6.4. Expected Robot's Behavior

Unless stated otherwise, it is expected that the robot behaves and reacts as a polite and friendly human would. This applies to both how the robot performs tasks and how it interacts with humans. As rule of thumb, one may ask any non-scientist how they would solve the task.

Please note that average users may not be familiar with the specific procedures for operating a robot. Therefore, interactions should be as natural as those with a human.

3.6.5. Robot Autonomy and Remote Control

1. **No touching:** During a test, the participants are not allowed to physically touch the robot(s) unless it is a “natural” way required by the task.
2. **Natural interaction:** The only allowed means to interact with the robot(s) are gestures and speech.
3. **Natural commands:** Anything that resembles direct control is forbidden.
4. **Remote Control:** Remotely controlling the robot(s) is strictly prohibited. This includes pressing buttons, or intentionally influencing sensors.
5. **Penalties:** Disregard of these rules will lead to disqualification for a test or for the entire competition.

3.6.6. Collisions

1. **Touching:** Gentle *touching* of objects is acceptable but not advised. Robots must not crash into anything. The “safety first” rule (Section 3.6.1) takes precedence over any other rule.
2. **Major collisions:** If a robot crushes into something during a test, it is immediately stopped. Additional penalties may apply.
3. **Functional touching:** Robots are allowed to apply pressure on objects, push furniture and, and interact with the environment using structural parts other than their manipulators. This is known as *functional touching*. However, the robot must clearly announce the interaction and kindly request not being stopped.

Remark: Referees may immediately stop a robot if there is suspicion of *dangerous* behavior.

3.6.7. Removal of robots

Robots that do not comply with the rules are stopped and removed from the *Arena*.

1. It is the decision of the referees and the *technical committee* (TC) member monitoring the test if and when to remove a robot.
2. When told to do so by the referees or the *technical committee* (TC) member, the team must immediately stop the robot, and remove it from the *Arena* without disturbing the ongoing test.
3. More than one team member is allowed to enter the *Arena* after the robot has been stopped to quickly remove it.

3.6.8. Start Signal

The default *start signal* (unless stated otherwise) is *door opening*. Other start signals are allowed but must be authorized by the *technical committee* (TC) during the Robot Inspection (see Section 4.4).

1. **Door opening:** The robot starts outside the *Arena* and is accompanied by a team member. The test begins when a referee (not a team member) opens the door.
2. **Start button:** If the robot cannot start automatically after the door is open, the team may use a start button to initiate the test.
 - 2.1. It must be a physical button on the robot (e.g., a dedicated one or releasing the eStop).
 - 2.2. It is allowed to use the robot's contact/pressure sensors (e.g., pushing the head or an arm joint).
 - 2.3. The use of the start button must be announced to the referees before the test starts.
 - 2.4. There may be penalties for using a start button in some tests.
3. **Ad-hoc start signal:** Other start signals are allowed but must be approved by the *technical committee* (TC) during the Robot Inspection (see Section 4.4).

These include:

- Verbal instructions
- Custom HRI interfaces (touchscreen, apps, software, etc.)

Remark: There may be penalties for using Ad-hoc start signals in some tests. The use of mouses, keyboards, and devices connected to *External Computing Resource Area* (ECRA) computers is strictly forbidden.

4. **No penalties for physical constraints (HSR only):** In cases where a physical issue (e.g., a door bump) prevents the league from ensuring a standard start signal with full safety for the HSR robot, no penalties will be applied. The following guidelines apply:

- The team must document the physical issue and notify the committee prior to the Robot Inspection.
- The issue must be reviewed and approved by the league's rules committee.
- An alternative start method will be determined on-site in consultation with the committee.

This rule ensures fairness and flexibility while addressing unavoidable physical challenges during league operations.

3.6.9. Restart Rule

During any test, teams are allowed to perform a single restart per attempt under the following conditions:

- A restart may only be requested until the robot scores 40 points.
- The test time continues to run during the restart.
- The team moves the robot back to the starting location.
- The team has a maximum of 60 s to restart the robot.
- Only one restart is permitted per test attempt.
- Only points scored after a restart are counted; points scored before the restart are not considered.

3.6.10. Entering and leaving the *Arena*

1. **Start position:** Unless stated otherwise, the robot starts outside of the *Arena*.
2. **Entering:** The robot must autonomously enter the *Arena*.

3.6.11. Gestures

Hand gestures may be used to control the robot in the following way:

1. **Definition:** The teams define the hand gestures by themselves.
2. **Approval:** Gestures need to be approved by the referees and *technical committee* (TC) member monitoring the test. Gestures should not involve more than the movement of both arms. This includes, for example, expressions of sign language or pointing gestures.
3. **Instructing operators:** It is the responsibility of the team to instruct operators.
 - 3.1. The team may only instruct the operator when told to do so by a referee.
 - 3.2. The team may only instruct the operator in the presence of a referee.
 - 3.3. The team may only instruct the robot for as long as allowed by the referee.
 - 3.4. When the robot has to instruct the operator, it is the robot that instructs the operator and *not* the team. The team is not allowed to guide the operator further, such as telling them to come closer or repeat a command.
 - 3.5. The robot is allowed to instruct the operator at any time.
4. **Receiving gestures:** Unless stated otherwise, it is not allowed to use a speech command to set the robot into a special mode for receiving gestures.

3.6.12. Referees

All tests are monitored by a referee, who is a member of the *technical committee* (TC). The referee may appoint an assistant to help with timekeeping and score sheets.

The following rules apply:

1. **Selection:** Referees are chosen by *executive committee* (EC), *technical committee* (TC), *organizing committee* (OC).
2. **Referee instructions:** Right before each test, the referee selects one or more assistants to aid during the test. The assistants will be instructed by the referee.

3.6.13. Operators

Unless stated otherwise, robots are operated by the referee or by a person selected by the referee. If the robot fails to understand the default operator, the team may request the use of a custom operator. A penalty may apply when using a custom operator.

3.6.14. Time limits

1. Unless stated otherwise, the time limit for each test is *5 minutes*.
2. **Inactivity:** Robots must not stand still or get stuck in endless loops. If a robot is not progressing in the task (and is clearly not attempting to do so), it is considered inactive. The robot must be removed from the *Arena* after 30 seconds of inactivity.
3. **Requesting time:** A robot (not the team) can request the referees to extend the inactivity time limit for a time-consuming process (e.g., 60 seconds). This time cannot exceed 3 minutes and can only be used once per test.
4. **Setup time:** Unless stated otherwise, there is no setup time. Robots need to be ready to enter the *Arena* no later than one minute after the door has been closed to the previous team.
5. **Time-up:** When the time is up, the team must immediately remove their robot(s) from the *Arena*. No more additional score will be given.
6. **Show must go on:** In special cases, the referee may allow the robot to continue the test for demonstration purposes, but no additional points will be scored.

3.7. Deus Ex Machina: Bypassing Features With Human Help

Because the Show Must Go On

Robots can't score unless they accomplish the main goal of a task. However, in many real-life situations, a minor malfunction may prevent the robot from accomplishing a task. To prevent this situation, while fostering awareness and human-robot interaction, robots are allowed to request human assistance during a test.

3.7.1. Procedure

The procedure to request human assistance while solving a task is as follows:

1. **Request help:** The robot must indicate loud and clear that it requires human assistance. It must be clearly stated:
 - The nature of the assistance
 - The particular goal or desired result
 - How the action must be carried out (when necessary)
 - Details about how to interact with the robot (when necessary)
 - Detailed information to identify objects for picking and placing (e.g. object name, color or location). The provided information needs to show that objects were perceived by the robot.

2. **Supervise:** The robot must be aware of the human's actions, being able to tell when the requested action has been completed, as well as guiding the human assistant (if necessary) during the process.
3. **Acknowledge:** The robot must politely thank the human for the assistance provided.

Example

In the following example, a robot has to clean the table but is unable to grasp the spoon.

R: I am sorry, but the spoon is too small for me to take.
Could you please help me with it?
Please say "robot yes" or "robot no" to confirm.
H: Robot, yes!
R: Thank you! Please follow my instructions.
Please take the purple spoon from the table. It is on my left.
(The robot also shows the result of the perception, e.g. by pointing at the spoon or showing a picture with a bounding box on the screen)
H: (Referee takes purple spoon)
R: I saw you took the spoon.
Would you be so kind as to follow me to the kitchen?
Please keep the spoon visible in front of you so I can track you. Thank you!
R: You can stop following me now.
As you can see, the dishwasher is already open.
Please place the spoon in the gray basket on the lower tray.
R: Lovely! Thanks for your help.
I'll let you know if I need further assistance.

3.7.2. Scoring

There is no limit in the amount of times a robot can request human assistance, but score reduction applies every time it is requested.

1. **Partial execution:** A reduction of 10% of the maximum attainable score is applied when the robot request a partial solution (e.g. pointing to the person the robot is looking for or placing an object within grasping distance). The referee decides whether the requested action is simple enough to corresponds to a partial execution or not.
2. **Full awareness:** A reduction of 20% of the maximum attainable score is applied when the robot is able to track and supervise activity, detecting possible, and when the requested action has been completed.
3. **No awareness:** A reduction of 30% of the maximum attainable score is applied when the robot has to be told when the requested action has been completed.
4. **Bonuses:** No bonus points can be scored when the robot requests help to solve part of a task that normally would grant a bonus.
5. **Score reduction overlap:** The score reduction for multiple requests of the same kind do not stack, but overlap. The total reduction applied corresponds to the worst execution (highest reduction of all similar help requests). This means, a robot won't be reduced again for requesting help to transport a second object, but a second reduction will apply when the robot asks for a door to be opened.

6. **Allowed types of assistance:** The types of assistance allowed in a given task are specified in the respective task description. It should be noted that only the assistance types explicitly mentioned in a task description are actually allowed in a task; other types of assistance are not allowed and will nullify the obtained points for the part of the task in which they are applied. For instance, if a task focused on manipulation does not explicitly mention a Deus Ex Machina penalty for instructing a person to perform a manipulation activity, it should not be assumed that this is a loophole that can be exploited.

3.7.3. Bypassing Automatic Speech Recognition

Giving commands to the robot is essential in many tests. When the robot is not able to receive spoken commands, teams are allowed to provide means to bypass ASR via an Alternative method for HRI (see Section 3.7.3). Nonetheless, Automatic Speech Recognition is preferred.

The following rules apply in addition to the ones specified in section Section 3.7.2

1. **ASR with Default Operator:** No score reduction. The command is given by the human operator who must speak (not shout) loud and clear. The *default operator* may repeat the command up to three times.
2. **ASR with Custom Operator:** A reduction of 10% of the maximum attainable score is applied when a *custom operator* is requested. The Team Leader chooses a person who gives the command *exactly as instructed by the referee*.
3. **Gestures:** A reduction of 20% of the maximum attainable score is applied when a gesture (or set of gestures) is used to instruct the robot.
4. **Alternative Natural Input Method:** A reduction of up to 20% of the maximum attainable score is applied when a *alternative HRI interface*, is used to instruct the robot. Natural alternative HRI interfaces (see Section 3.7.3) must be previously approved by the TC during the Robot Inspection (see Section 4.4).

Alternative interfaces for HRI

Alternative methods and interfaces for HRI offer a way for a robot to start or complete a task. Any reasonable method may be used, with the following criteria:

- **Intuitive to use and self-explanatory:** a manual should not be needed. Teams are not allowed to explain how to interface with the robot.
- **Effortless use:** Must be as easy to use as uttering a command.
- **Is smart and preemptive:** The interface adapts to the user input, displaying only the options that make sense or that the robot can actually perform.
- Exploits the best of the device being used (eg. touch screen, display area, speakers, etc.)

Preferably, the alternative HRI must be also adapted to the user. Consider localization (with English as the default), but also potential users of service robots at their home. For example: elderly people and people with physical disabilities.

3.8. Special penalties and bonuses

3.8.1. Penalty for not attending

1. **Automatic schedule:** All teams are automatically scheduled for all tests.
2. **Announcement:** If a team cannot participate in a test (for any reason), the team leader has to announce this to the *organizing committee* (OC) at least *60 minutes* before the test slot begins.
3. **Penalties:** A team that is not present at the start position when their scheduled test begins is not allowed to participate in the test. If the team has not announced its absence, it receives a penalty of *250 points*.

3.8.2. Extraordinary penalties

1. **Penalty for cheating:** If a team member is found cheating or breaking Fair Play, the team will be automatically disqualified from the running test, and receives a penalty of *500 points*. The *technical committee* (TC) may also disqualify the team for the entire competition.
2. **Penalty for faking robots:** If a team starts a test, but it does not solve any of the partial tasks (and is obviously not trying to do so), a penalty of *250 points* is imposed. The decision is made by the referees and the monitoring *technical committee* (TC) member.
3. **Extra penalty for collision:** In case of major, grossly negligent collisions the *technical committee* (TC) may disqualify the team for a test (the team receives *0 points*), or for the entire competition.
4. **Not showing up as referee or jury member:** If a team does not provide a referee or jury member who is present at the Arena on time, the team receives a penalty of *250 points*. Jury members missing a performance to evaluate are excluded from the jury, and the team is disqualified from the test (receives *0 points*). This will be remembered for qualification decisions in future competitions.
5. **Modifying or altering standard platform robots:** If any unauthorized modification is found on a Standard Platform League robot, the responsible team will be immediately disqualified for the entire competition. This will be remembered for qualification decisions in future competitions.

3.8.3. Bonus for outstanding performance

1. For every regular test, the @Home *technical committee* (TC) can decide to give an extra bonus for *outstanding performance* of up to 10% of the maximum test score.
2. This is to reward teams that do more than what is needed to solely score points in a test but show innovative and general approaches to enhance the scope of @Home.
3. If a team believes it deserves this bonus, it should inform the *technical committee* (TC) in advance and provide a brief explanation.
4. The decision to grant the bonus and its extent is solely at the discretion of the *technical committee* (TC).

3.9. Open Challenge

On the first two competition days after the end of the regular test blocks, teams will have an opportunity to present an *Open Challenge* in which they demonstrate their novel research and approaches.

3.9.1. Procedure

1. **Participation:** Teams have to announce whether they want to perform an *Open Challenge* to the OC during the *Setup Days*.
2. **Time:** Each team gets a 10 minute time slot for the *Open Challenge*; of these, 8 minutes are for presenting and 2 minutes are for questions by the audience.
3. **Arena Changes:** The team can rearrange the arena when their time slot starts, but all changes need to be reverted as soon as their time slot ends.
4. **Focus:** While the demonstrations are intended to share research insights, we still want to see robots performing; in particular, the *Open Challenge* should not be turned into a pure academic lecture.
5. **Leagues:** Ideally, the open challenges of all @HOME leagues will be scheduled consecutively to allow all participants to view all demonstrations. However, if more than 12 teams across the leagues register for the *Open Challenge*, each league will hold its *Open Challenge* concurrently to accommodate the increased number of participants.
6. **Award:** The *Open Challenge* does not contribute any points towards the official competition score, but participating teams are eligible to receive the *Best Open Challenge Award* (see 1.7.4).

Chapter 4

Setup and Preparation

Prior to the RoboCup@Home competition, all arriving teams will have an opportunity to set up their robots and prepare for the competition in a *Setup & Preparation* phase. This phase is scheduled to start on the first day of the competition, namely when the venue opens and the teams arrive. During the *Setup Days*, teams can assemble and test their robots. On the last setup day, a *Welcome Reception* will be held. To foster the knowledge exchange between teams, a conference-like *Poster Session* takes place during the reception. Additionally, all teams have to get their robots inspected by members of the *technical committee* (TC) to be allowed to participate in the competition.

Table 4.1.: General Schedule (distribution of tests over days may vary)

| Setup & Preparation | Tasks | Finals |
|--|--|--------|
| $\xrightarrow{\text{advance}}$ All teams that passed Inspection | $\xrightarrow{\text{advance}}$ Best 3 teams | |

Regular tests are not conducted during the setup & preparation phase.

4.1. General Setup

Depending on the schedule, the *Setup & Preparation* phase lasts for one or two days.

- 1. Start:** The *Setup & Preparation* starts when the venue opens for the first time.
- 2. Intention:** During the *Setup & Preparation*, teams arrive, bring or receive their robots, and assemble and test them.
- 3. Tables:** The local organization will set up and randomly assign team tables.
- 4. Groups:** Depending on the number of teams, the *organizing committee* (OC) may form multiple groups of teams (usually four). The *organizing committee* (OC) will assign teams to groups and announce the assignment to the teams.
- 5. Arena:** The *Arena* is available to all teams during the *Setup & Preparation*. The *organizing committee* (OC) may schedule special test or mapping slots in which *Arena* access is limited to one or more teams exclusively (all teams get slots). Note, however, that the *Arena* may not yet be complete and that the last work is conducted in the *Arena* during the *Setup Days*.

6. **Objects:** The delegation of EC, TC, OC and local organizers will buy the objects (see Section 3.2.5). Note, however, that the objects may not be available at all times and not from the beginning of the *Setup & Preparation*.

4.2. Welcome Reception

Since Eindhoven 2013, RoboCup@Home holds an own *Welcome Reception* in addition to the official opening ceremony. During the *Welcome Reception*, a *Poster Session* is held in which teams present their research focus and latest results (see Section 4.3).

1. **Time:** The *Welcome Reception* is held in the evening of the last setup day.
2. **Place:** The *Welcome Reception* takes place in the @Home Arena and/or in the @HOME team area.
3. **Snacks & drinks:** During the *Welcome Reception*, snacks and beverages (beers, sodas, etc.) are served.
4. **Organization:** It is the responsibility of the OC and the local organizers to organize the *Welcome Reception* and *Poster Session*, including:
 - 4.1. organizing poster stands (one per team) or alternatives for presenting the posters,
 - 4.2. organizing snacks and drinks, and
 - 4.3. inviting officials, sponsors, the local organization, and the trustees of the RoboCup Federation to the event.
5. **Poster presentation:** During the *Welcome Reception*, the teams give a poster presentation on their research focus, recent results, and their scientific contribution. Both the poster and the teaser talk are evaluated by a jury (see Section 4.3).

4.3. Poster Teaser Session

Before the *Welcome Reception* and *Poster Session*, a *Poster Teaser Session* is held. In this teaser session, each team can give a short presentation of their research and the poster being presented at the poster session.

4.3.1. Poster teaser session

1. **Presentation:** Each team has a maximum of three minutes to give a short presentation of their poster.
2. **Time:** The *Poster Teaser Session* is to be held before the *Welcome Reception* and *Poster Session* (see Section 4.2).
3. **Place:** The *Poster Session* may be held in or around the *Arena*, but should not interfere with the *Robot Inspection* (see Section 4.4).
4. **Evaluation:** The teaser and poster presentations are evaluated by a jury consisting of members of the other teams. Each team has to provide one person (preferably the team-leader) to follow and evaluate the entire *Poster Teaser Session* and the *Poster Session*.
5. **Criteria:** For each of the following evaluation criteria, a maximum of 10 points is given per jury member:

- 5.1. Novelty and scientific contribution
- 5.2. Relevance for RoboCup@Home
- 5.3. Presentation (quality of poster, teaser talk, and discussion during the *Poster Session*)
6. **Score:** The points given by each jury member are scaled to obtain a maximum of 50 points. The total score for each team is the mean of the jury member scores. To neglect outliers, the N best and worst scores are left out:

$$score = \frac{\sum \text{team-leader-score}}{\text{number-of-teams} - (2N + 1)}, N = \begin{cases} 1, & \text{number-of-teams} \geq 10 \\ 2, & \text{number-of-teams} < 10 \end{cases}$$

7. **Sheet collection:** The evaluation sheets are collected by the *organizing committee* (OC) at a later time (announced beforehand by the *organizing committee* (OC)), allowing teams to continue knowledge exchange during the first days of the competition.
8. **OC Instructions:**

- Prepare and distribute evaluation sheets before the *Poster Teaser Session*.
- Collect the evaluation sheets.
- Organize and manage the poster teaser presentations and the *Poster Session*.

4.4. Robot Inspection

Safety is the most important issue when interacting with humans and operating in the same physical workspace. Because of this, all participating robots are inspected before participating in RoboCup@Home. Every team needs to get their robot(s) inspected and approved so that they can participate in the competition.

1. **Procedure:** The *Robot Inspection* is conducted like a regular test, namely it starts with opening of the arena door (see Section 3.6.8). One team after another (and one robot after another) has to enter the *Arena* through a designated entrance door, move to the *Inspection Point*, and leave the arena through the designated exit door. In between entering and leaving, the robot is inspected by the *technical committee* (TC).
2. **Checked aspects:** During the *Robot Inspection*, each robot is checked for compliance with the competition rules (see Section 3.3), in particular:

- emergency button(s)
- collision avoidance (a TC member steps in front of the robot)
- voice of the robot (it must be loud and clear)
- custom containers (bowl, tray, etc.)
- external devices (including wireless network), if any
- Alternative human-robot interfaces (see Section 3.7.3).
- ***Standard Platform robots***
 - no modifications have been made
 - specification of the *Official Standard Laptop* (OSL) (if required)
- ***Open Platform robots***
 - robot speed and dimension
 - start button (if the team requires it)

- robot speaker system (plug for RF transmission)
 - other safety issues (duct tape, hanging cables, sharp edges etc.)
3. **Re-inspection:** If the robot is not approved in the inspection, it is the responsibility of the team to get the approval at a later point. Robots are not allowed to participate in any test before passing the *Robot Inspection*.
 4. **Time limit:** The robot inspection is interrupted after three minutes (per robot). When told so by the TC — in case of time interrupt or failure — the team has to move the robot out of the *Arena* through the designated exit door.
 5. **Appearance Evaluation:** In addition to the inspection, the TC evaluates the appearance of the robots. Robots are expected to look nice (no duct tape, no cables hanging loose etc.). In case of objection, the TC may penalize the team with a penalty of maximum 50 points.
 6. **Accompanying team member:** Each robot is accompanied by only one team member (the team leader is advised).
 7. **OC instructions (at least two hours before the *Robot Inspection*):**
 - Announce the entry and exit doors.
 - Announce the location of the *Inspection Point* in the *Arena*.
 - Specify and announce where and when the poster teaser and the poster presentation session take place.

Chapter 5

Tests

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5.1. Human Robot Interaction Challenge

Description

The robot is working as a receptionist at a party. The robot has to take two new guests to the living room, offer a free place to sit and introduce them to each other. The second guest brings a bag for the robot to carry.

Main goal: The robot welcomes and assists two newcomers at a party and offering them a seat, and maintaining appropriate gaze direction during conversation (at person speaking, direction of navigation). The second guest brings a bag to be placed somewhere in the house.

Optional goals:

1. Detect doorbell sound as a signal that a guest has arrived.
2. Open the entrance door for each arriving guest.
3. Visually describe the first guest to the second guest before reaching the living room.
4. Understand each guest's name and favorite drink without asking any confirmation or correction questions (non-essential questions).

Focus

System Integration, Human-Robot Interaction, Person Detection, Person Recognition

Setup

• Location:

- The test takes place in the living room.
- The robot starts inside the *Arena* at a predefined location near where guests are sitting.
- **Entrance:** The entrance door is open by default. The team leader can request it to be closed to allow the robot to earn additional points by opening it for the guests.

• People:

- **Arriving Guests:** Both guests have a name and a favorite drink. An arriving guest will wait by the door, and the robot has to move to meet guests by the door. A guest will not move inside the house until the robot has initiated conversation. It is not allowed to instruct guests to move in front of the robot to recognize the guest and start the conversation. The robot is the one that must approach the guest. Guests have to be guided to the living room where the robot will offer a free place to sit and introduce the guests to each other. Each guest will arrive separately.
- **Passive Guests:** A few individuals, including possibly spectators, can be anywhere in the arena — sitting or standing in relevant places, e.g., on the couch, near the seats, or in the area with the drinks.

Procedure

Both guests arrive separately. A doorbell will ring to signal the guest has arrived. The doorbell will only ring if the robot is waiting for a new guest at the starting position. The robot either

opens the door for the guest or meets them at the door. It greets the guest and asks for their name and favorite drink. The robot escorts the guests to the living room and offers a free seat. Once both guests are seated, the robot introduces them to each other. To introduce the two guests, the robot must (for both guests) look at a guest and state the other arriving guest name and favorite drink. The second guest will bring a bag for the host. The robot should ask for the bag to be handed over and move to the host. The host is already waiting and instructs the robot to follow him/her. The host will move to a random place in the house and inform the robot it can drop the bag there.

- **Doorbell:** A doorbell sound will be played when a guest is by the door ready to be met. The doorbell sound will not be provided beforehand and may be any traditional doorbell sound. As an alternative, if no doorbell sound is available, the guest can knock on the door. Waiting for the doorbell is optional, robots can bypass it and directly meet the guest at the door. In order for the doorbell sound to be considered detected, the robot must be waiting at the starting position and react instantly to the sound.
- **Greeting guests:** The names of the guests can be any popular english names. The favorite drinks of the guests can be any english named popular drink (it may not be in the list of objects provided). The guest paces slightly to the left and right during the conversation with the robot. Other people might appear in the background.
- **Looking at person:** The robot must look at the person it is talking to. Guests will move slightly to confirm the robot dynamically follows them with its gaze. Points for gaze tracking are awarded only if the robot continuously tracks the moving person.
- **Looking at direction of navigation:** The robot must look in the direction it is navigating. Persistently looking in an unrelated direction or at unrelated people during navigation results in a score deduction.
- **Seating People:** The robot must clearly indicate or point to a location or seat for each guest.
- **Switching Places:** After being seated, guests may switch seats.
- **Introductions:** When introducing guests, the robot must clearly identify the person being introduced and state their name and favorite drink. The robot must be looking at a guest and state the other arriving guest name and favorite drink. The robot must do this for both guests. Introducing two people means to introduce them to each other.
- **Non-Essential Questions:** If the robot does not ask any non-essential questions to help understand, confirm, or correct information, bonus points are awarded. Questions such as "Did you say your name is James?" or "Is your favorite drink milk?" are considered non-essential questions. However, asking a guest to repeat an answer because the robot could not hear is not considered a non-essential question.
- **Bag handover:** The robot must grab the bag from the second guest hand. If this is not possible, the robot can instruct the guest to place the bag somewhere in its structure
- **Follow the host:** The host will be sitting down in the living room, the robot must inform the host it has a bag and ask for the host to provide guidance. The robot should inform the operator when it is ready to follow the host. The operator walks naturally towards the designated bag drop location. When at the correct location, the robot will inform the robot it must place the bag on the floor.

Additional rules and remarks

1. **Opening Door Timing:** The Time of the test only starts after the first person enters the arena or 1 minute after start signal.
2. **Misunderstanding:** Not understanding the guests and asking them again is fine. Continuing with a wrong name or favorite drink causes a score reduction.
3. **Partial Scoring:** The main task allows partial scoring per guest.
4. **Additional Seating:** Referees may add chairs to the living room area.
5. **Deus ex Machina:** Score reduction applies per guest as follows:
 - **Custom Operator:** Since the main focus of the test is HRI, no custom operator can be chosen.
 - **Alternative HRI:** Using an alternative HRI to understand a guest causes a score reduction per information (name or favorite drink).
 - **Recognizing People:** If the robot has to ask for help to identify people, the score is reduced.
 - **Bag handover:** If the robot has to ask the guest for help during handover, the score is reduced. If the robot tells the guest to place the bag somewhere on its structure, no points are awarded for the handover.
 - **Follow the host:** Penalties apply if the robot loses the operator and needs help recovering. The following forms of assistance are penalized:
 - 5.1. Natural interaction (e.g., waving and calling)
 - 5.2. Unnatural interaction (e.g., raising both hands and jumping)
 - 5.3. Returning in front of the robot to resume following.
 - 5.4. Physical contact (e.g., pulling the robot's hand)

Instructions

To Referee

The referees need to:

- Assign name and favorite drink to two volunteers.
- Arrange and rearrange people in the living room.
- Open the entrance door upon request from the robot.

To OC

During setup day:

- Announce the bag that will be used for handover.

At least two hours before test:

- Announce the starting position.
- Recruit four volunteers: two as arriving guests and two as passive guests.

Score sheet

The maximum time for this test is **6:00** minutes.

| Action | Score |
|--|-----------------|
| Main Goal | |
| Offer a free seat to the new guest | 2×100 |
| Look in the direction of navigation or at the navigation goal | 2×15 |
| Look at the person talking, when receiving a guest | 2×50 |
| Introduce both guests to each other: correctly say name and favorite drink of each guest | 4×30 |
| While introducing guests, look to the correct guest while talking about the other guest | 2×50 |
| Grab the bag via handover from the guest | 50 |
| Following the host to the bag drop area | 200 |
| Drop the bag on the correct area | 50 |
| Bonus Rewards | |
| Detect the doorbell sound as a signal that a guest has arrived | 2×30 |
| Open the entrance door for a guest | 2×200 |
| Describe the first guest to the second guest (per correct visual attribute) | 4×20 |
| Not asking non essential questions to confirm or correct information | 4×15 |
| Penalties | |
| Wrong guest information was memorized (continue with wrong name, drink or interest) | 4×-40 |
| Describe the first guest to the second guest (per incorrect visual attribute) | 4×-20 |
| Ask the guest to place the bag somewhere on the robot | -50 |
| Drop the bag while following the host | -50 |
| Ask the host to place the bag on the bag drop location | -50 |
| Deus Ex Machina | |
| Alternative HRI | 6×-20 |
| Not recognizing people | 2×-200 |
| Rediscovering the operator by natural interaction | -50 |
| Asking operator to wait | -50 |
| Guiding the robot with physical contact (take by the hand) | -150 |
| Special Penalties & Bonuses | |
| Not attending (see sec. 3.8.1) | -500 |
| Outstanding performance (see sec. 3.8.3) | 145 |
| Total Score (excluding special penalties & standard bonuses) | 1450 |

5.2. Storing Groceries

The robot stores groceries into a cabinet with shelves. Objects are sorted on the shelves based on similarity, for instance an apple is stored next to other fruits.

Main goal: Move objects from a table to the cabinet, grouping them by category or similarity.
Refilling the cereal container.

Optional goals:

1. Opening the cabinet doors
2. Moving a *tiny* object
3. Moving a *heavy* object
4. Picking Objects from the shopping bag

Focus

Object detection and recognition, object feature recognition, object manipulation.

Setup

- **Locations:**

- **Start location:** Before the test, the robot waits outside the *Arena* and navigates to the testing area when the door is open.
- **Test location:** The testing area has a cabinet and a table nearby.

- **People:**

- No people are involved in the test, unless the robot requires human assistance.

- **Furniture:**

- **Table:** The table has 5–10 objects placed on it and the robot can choose which ones to grasp and in what order. On smaller tables, new objects will be added as the robot frees up space.
- **Shopping Bag:** A shopping bag with 5–10 additional items is placed on the ground next to the table.
- **Cabinet:** The cabinet contains objects arranged in groups — either by category or similarity — on different shelves.
- **Cabinet door:** The cabinet is initially closed. If the robot cannot open the door, it must clearly request assistance from the referee.

- **Objects:**

- **Table objects:** The objects on the table are arranged arbitrarily.
- **Cabinet objects:** The objects are placed behind the cabinet doors and cannot be accessed unless the doors are open.
- **Containers:** The container for the cornflakes is placed on the table.

Procedure

1. **Table location:** At least two hours before the test, the referees announce which table and cabinet that will be used in the test, along with the approximate table location.
2. **Test start:** The robot enters the testing area once the arena door is opened.
3. **Storing groceries:** After identifying the table, the robot moves the objects from the table to the cabinet.
4. **Pouring cereal:** The robot pours cereal into the designated open container.

Additional rules and remarks

1. **Table:** The approximate location of the table will be announced in advance, and it will be positioned near the cabinet.
2. **Incorrect categorization:** The score is reduced if an object is stored on the cabinet, but not on a shelf with similar objects; this reduction is applied per incorrectly stored object.
3. **New category:** Objects that do not semantically belong to any of the categories represented on the shelves should be grouped together on a new shelf.
4. **Deus Ex Machina:** The scores are reduced if human assistance is received, in particular for:
 - telling or pointing out to the robot where to place an object
 - moving an object instead of the robot
 - opening the cabinet doors
5. **Communicating Perception:** The robot must clearly communicate its perception to the referee. Pointing at the object or attempting to pick it up is sufficient. If using visualization, the robot must indicate where the referee should look and ensure the display is clearly accessible. If the team wants to utilize bounding boxes make sure **only** one object with a bounding box is shown at a time, so the referee is easily able to check and verify. The surrounding scene must also be visible, cropped views alone are insufficient.

OC Instructions

At least two hours before the test:

- Announce which table and cabinet will be used.
- Announce a rough location for the table.
- Select which bags will be used.
- Select which container will be used.

Referee Instructions

The referee needs to:

- Place 5–10 objects on the table.
- Place container and cornflakes on the table.
- Place 5–10 objects in a bag near the table.
- Place objects in the cabinet, grouping them by category or likeliness.
- Close the door of the cabinet.

Score sheet

The maximum time for this test is **7:00** minutes.

| Action | Score |
|---|--------|
| Main Goal | |
| Navigating to the table | 15 |
| Perceiving object and categorizing it correctly | 5×15 |
| Picking up an object for transportation to the cabinet | 5×50 |
| Perceiving objects in shelf and saying on which layer the currently handled object should be placed | 5×15 |
| Placing an object in the cabinet | 5×15 |
| Placing an object next to similar objects on the cabinet | 5×50 |
| Opening the first cabinet door | 200 |
| Opening the second cabinet door | 100 |
| Pouring cereal into the container | 300 |
| Bonus Rewards | |
| Picking up an object from the shopping bag | 5×50 |
| Picking up a tiny object | 70 |
| Placing a tiny object | 30 |
| Picking up a heavy object | 70 |
| Placing a heavy object | 30 |
| Autonomously Picking any Object | 50 |
| Autonomously Placing any Object | 50 |
| Deus Ex Machina Penalties | |
| Perceiving object and categorizing it wrongly | 10×-15 |
| A human handing an object over to the robot | 5×-50 |
| A human placing an object in the cabinet | 5×-15 |
| A human placing an object in the cabinet next to similar objects | 5×-50 |
| A human pointing at a target location | 5×-25 |
| A human opening the first cabinet door | -200 |
| A human opening the second cabinet door | -100 |
| Spilling cereal while pouring | -100 |
| Leaving cereal in the box | -100 |
| A human pouring cereal in the bowl | -300 |
| Special Penalties & Bonuses | |
| Not attending (see sec. 3.8.1) | -500 |
| Using alternative start signal (see sec. 3.6.8) | -100 |
| Outstanding performance (see sec. 3.8.3) | 189 |
| Total Score (excluding special penalties & standard bonuses) | 1890 |

5.3. General Purpose Service Robot

The robot is asked to understand and execute commands requiring a wide range of different abilities.

Main Goal: Execute three commands issued by the operator.

Optional Goals:

1. Understand a command given by a non-expert operator.

Focus

Task planning, object/people detection and recognition, object feature recognition, object manipulation

Setup

- **Locations:**

- **Task location:** The task takes place inside the *Arena*. Commands may require the robot to leave the room. The *Arena* is in its nominal configuration for this task.
- **Start location:** The robot starts outside the *Arena*. When the door opens, it must navigate towards the *Instruction Point*.
- **Instruction point:** The robot returns to this point after completing each command to receive the next one.

- **People:**

- **Professional Operator:** Typically the referee, issues standard commands to the robot.
- **Non-Expert Operator (optional):** A person without robotics expertise (e.g., from the audience). The referee provides the intended command goal to this operator, who then issues the instruction using their own wording.

For example, the generated command might be "*Bring me a coke from the kitchen.*" then the non-expert operator will be told "*The robot should bring you a coke, which is found in the kitchen.*", who then tells the robot *I want a coke. Go to the kitchen and get me one.*"

If the robot consistently fails to understand the non-expert operator (e.g. after two retries), teams can default to a custom operator.

Procedure

1. **Instruction point:** At least two hours before the test, the referees announce the location of the *Instruction Point*.
2. **Test start:** The robot moves to the *Instruction Point* when the arena door is open.
3. **Command execution:** The operator instructs the robot to execute a command and the robot performs the task.
4. **Back to the instruction point:** The robot goes back to the *Instruction Point* and waits for the next command.

5. **Pausing the Timer:** The referee pauses the timer as soon as the robot reaches the instruction point to reset the arena for the next command. The timer resumes once the referee signals the start of the next command.

Additional Rules and Remarks

1. **Partial scoring:** The main task allows partial scoring (per *completed* command).
2. **Command generator:** Tasks will be generated using the official command generator¹.
3. **Non-Expert Operators:**
 - Referees must not assist non-expert operators in phrasing the commands.
 - Teams are not allowed to coach, instruct, or bias non-expert operators. Doing so results in disqualification from the task.
4. **Deus ex Machina:** Score reductions apply in the following cases:
 - Use of a custom operator
 - Bypassing speech recognition with an alternative HRI.
 - Receiving human assistance to accomplish a command
 - Instructing a human assistant to perform the whole task

Referee Instructions

- Provide the commands to the operators.

OC Instructions

At least two hours before the test:

- Generate the robot commands (do not reveal them to the teams).
- Announce the location of the instruction point.
- Recruit volunteers to assist during the test.

During the test:

- Restore the arena to its nominal state before each command execution.

Score Sheet

The maximum time for this test is **5:00** minutes.

¹<https://github.com/RoboCupAtHome/CommandGenerator>

| Action | Score |
|---|-----------------|
| Main Goal | |
| Executing the task associated with each command | 3×400 |
| Bonus Rewards | |
| Understanding a command given by a non-expert operator | 3×100 |
| Deus Ex Machina Penalties | |
| Using a custom operator | 3×-50 |
| Bypassing speech recognition | 3×-50 |
| Instructing a human to perform parts of the task will apply a percentage penalty according to similar penalties in other tests. | 3×-400 |
| Special Penalties & Bonuses | |
| Not attending (see sec. 3.8.1) | -500 |
| Using alternative start signal (see sec. 3.6.8) | -100 |
| Outstanding performance (see sec. 3.8.3) | 150 |
| Total Score (excluding special penalties & standard bonuses) | 1500 |

5.4. Enhanced General Purpose Service Robot

The robot is asked to maintain the household by cleaning up the arena and assisting people.

Main Goal: Solve different problems in the arena.

Focus

Task planning, object/people detection and recognition, object feature recognition, object manipulation

Setup

The arena is in its default state apart from problems set up for the robot to solve:

1. Problems:

- **Trash:** Objects on the floor are to be thrown in the trash.
- **Objects:** Objects that are not in their default location should be returned to their default location (see [3.2.5](#)).
- **Persons:** Some persons in the arena will have requests for the robot. They will raise their hand if the robot is in the same room.

Procedure

1. **Test start:** The robot enters when the arena door is open.
2. **Finding Problems:** The robot has to find problems to solve on its own.

Additional rules and remarks

1. **Number of Problems:** The number of problems depends on the arena size the minimum count of generated problems is 8.
2. **Repeating Problem Category:** Solving the same Category of Problem incurs a penalty.
3. **Solving more:** You can continue solving problems to compensate for penalties.
4. **Partial Scoring:** The main task allows partial scoring (per *solved* problem).
 - 4.1. **Scores:** Score reduction is applied as a percentage depending on the solution.
 - 4.2. **Penalties:** The Repetition penalty is applied before any partial penalties
 - 4.3. **Example:** If picking up trash off the floor is valued as 60% of the solution, then requesting a handover should be a $650 \times 0.6 = 390$ points penalty for the first pick and $(650 - 300) \times 0.6 = 210$ for the second pick.
5. **Command Generator:** Problems and commands will be generated using the official command generator².
6. **Finding People:** Finding a person and stating they need help counts as finding the problem.
7. **Understanding Commands:** The robot must correctly interpret and repeat commands given by people. Correctly repeating the command given by a person counts as partially solving the problem.

²<https://github.com/RoboCupAtHome/CommandGenerator>

Referee instructions

- Set up the problems in the arena.
- Provide commands to volunteers.

OC instructions

At least two hours before the test:

- Generate the problems and commands (do not reveal them to the teams!).
- Recruit volunteers to assist during the test.

Score sheet

The maximum time for this test is **10:00** minutes.

| Action | Score |
|---|-----------------|
| <i>Main Goal (can be repeated unlimited times)</i> | |
| Find and clearly state an encountered problem | 3×150 |
| Solve a problem | 3×650 |
| <i>Penalties</i> | |
| Find repeated problem category | -100 |
| Solving repeated problem category for the 2nd time | -300 |
| Solving repeated problem category for the 3rd (or more) time | -500 |
| <i>These Penalties are applied before any percentage based Deus Ex Machina Penalties</i> | |
| <i>Deus Ex Machina Penalties</i> | |
| Asking for location of a problem | 3×-150 |
| Instructing a human to perform parts of the task will apply a percentage penalty according to similar penalties in other tests. | 3×-650 |
| <i>Special Penalties & Bonuses</i> | |
| Not attending (see sec. 3.8.1) | -500 |
| Using alternative start signal (see sec. 3.6.8) | -100 |
| Outstanding performance (see sec. 3.8.3) | 240 |
| Total Score (excluding special penalties & standard bonuses) | 2400 |

5.5. Restaurant

Description

The robot is required to retrieve and serve orders to customers in a real, previously unknown restaurant environment.

Main goal: Detect calling or waving customer, autonomously navigate to their tables, take their orders, and serve them accordingly.

Optional goal: Use an unattached tray to transport the order.

Focus

This task focuses on *Task planning*, *Online mapping*, *Navigation in unknown environments*, *Gesture detection*, *Verbal interaction* and *Object manipulation*.

Setup

- **Locations:**

- This task takes place in a real restaurant fully equipped and in business. If this is not possible, an alternative venue may be selected, provided it resembles a restaurant environment and is outside the *Arena*.
- The *Restaurant* location will remain undisclosed until the start of the test.
- The robot starts next to the *Kitchen-bar* (a designated table located near the restaurant's kitchen), facing the customer seating area (dining tables).

- **People:**

- A *Professional Barman* (member of the *technical committee* (TC)) awaits at the other side of the *Kitchen-bar* for orders to be placed. The *Professional Barman* assists the robot on request.
- There may be real customers and staff present.
- There are at least three tables occupied by professional customers (member of the *organizing committee* (OC), *technical committee* (TC) or other teams).
- There are at least two tables occupied with regular customers.
- Customers may call the robot any time, even simultaneously.

- **Furniture:** The furniture is not standardized and remains unchanged during the test.

- **Objects:**

- Objects to fulfill orders are located on the *Kitchen-bar*.
- Each order consists of 2–3 objects, randomly selected.
- All edible/drinkable objects from the list of standard objects (see Section 3.2.5) are eligible to be part of the orders.

Procedure

1. The referee instructs the team to bring the robot to the start location.
2. The referee gives the start signal and starts the timer.
3. The team leaves the area after the start signal.

4. A *technical committee* (TC) member follows the robot ready to press the emergency stop button.
5. The robot detects a calling or waving customer and navigates to their table.
6. The robot take the customer's order, place the order, and deliver it.
7. **Optionally**, the robot may use an unattached tray to transport the order.

Additional rules and remarks

- **Remarks:**

- This test occurs in a public area. Any physical contact with people or furniture results in immediate emergency stop.
- Since this task is performed outside the arena, the time limit may be longer than the others tasks.
- The availability of wireless, external computing devices, or electrical outlets can't be guaranteed. Assume unavailability.
- The robot must interact with the customers directly. Teams are not allowed to assist or instruct them.
- The robot may use up to two minutes to instruct the *Professional Barman* per order.
- Examples of instructions include, but are not limited to:
 - * Request guidance to a customer's table.
 - * Ask for pointing direction.
 - * Ask to press on the screen.
- The robot may:
 - * Take and place several orders before delivery,
 - * Alternate between order-taking and serving, or
 - * Handle one order at a time.
- The robot should politely confirm the order to the client when receiving it, keeping the guest pleased.
- The robot can either transport each object individually, or using a tray. All delivered objects must be placed on the customer's table.
- For tray delivery, the robot must:
 - * Place the items on the tray,
 - * Pick up and transport the tray,
 - * Deliver the items by either directly placing them on the table or placing the tray first.
- If requested, the *Professional Barman* will place the order in a basket or tray for the robot to deliver it.
- Only two team members are allowed near the robot upon arrival for watching and charging.
- If audience interference makes task execution impossible, the team may immediately repeat the test.
- Each Deus Ex Machina penalty for skipping manipulation is capped at twice per order so receiving an order with three objects is not more punishing.
- If the robot detects a customer but does not reach their table, it must clearly identify the person (e.g., show a picture) to earn partial points.

- When at the front of the queue, teams may begin startup procedures with the robot stationary. Once called, the robot must be brought directly and steadily to the start location—only minor adjustments are allowed (no back-and-forth or full turns).

- **Disqualification:**

- Touching the robot after the start signal.
- Mapping the environment in advance.

Instructions:

To Referee

The referee needs to:

- Prepare orders for each client.

To OC

The OC needs to:

- **During Setup days:** Check with local (security) management if the possible location, including a sufficient queuing area, can be used for the restaurant test.
- **1 hour before the test:** Gather all teams and robots to move to some nearby queuing area and instruct the teams how/when to move to the actual test location.

Score sheet

The maximum time for this test is **15:00** minutes.

| Action | Score |
|--|-----------------|
| <i>Regular Rewards</i> | |
| Detect calling or waving customer | 2×100 |
| Reach a customer's table without prior guidance/training | 2×100 |
| Understand and confirm the order received to the customer | 2×200 |
| Communicate the order to the barman | 2×100 |
| Picking up the requested item from the <i>Kitchen-bar</i> | 2×200 |
| Return to the customer table with the order | 2×100 |
| Serve the order to the customer | 2×200 |
| <i>Bonus Rewards</i> | |
| Use an unattached tray to transport | 2×200 |
| <i>Regular Penalties</i> | |
| Being guided to a table | 2×-100 |
| Not making eye-contact when taking an order | 2×-80 |
| Not reaching the bar (barman has to move from behind the bar to interact with the robot) | 2×-80 |
| Asking for directional confirmation | 2×-80 |
| <i>Deus ex Machina Penalties</i> | |
| Asking the Barman to handover object to the robot | 4×-100 |
| Guest needing to take the object from a tray or the robot's hand | 4×-100 |
| Being told/pointed where is a table/ <i>Kitchen-bar</i> | 2×-100 |
| <i>Special Penalties & Bonuses</i> | |
| Not attending (see sec. 3.8.1) | -500 |
| Using alternative start signal (see sec. 3.6.8) | -100 |
| Outstanding performance (see sec. 3.8.3) | 240 |
| Total Score (excluding special penalties & standard bonuses) | 2400 |

Chapter 6

Finals

The competition ends with the Finals on the last day, where the two teams with the highest total score compete.

Even though each league has its own first, second and third place, the *Finals* are meant to show the best of all leagues to the jury members as well as the audience and, thus, warrants a single schedule slot.

6.1. Scoring

The final score and ranking are determined by the jury evaluations and by the previous performance of the team, in the following manner:

1. The influence of the final ranking is 50 %.
2. The influence of the total sum of points scored by the team is 50 %.

There is no maximum score during the Final.

These demonstrations are carried out in a serialized fashion, one League performing after another in one *Arena*.

6.1.1. Task

The procedure for the demonstration is the same as for Enhanced General Purpose Service Robot (see Task 5.4) with the added tasks of:

1. **Closing Furniture:** Doors of the Cabinet as well as the Dishwasher need to be closed.
2. **Welcome Guest:** There is an additional person waiting behind the exit door. The person will state their request after being welcomed by the robot. The door must be opened without human assistance. As the position is known, there will be no points awarded for finding this person.
3. **Custom Tasks:** Additional reasonable household task.

Custom Tasks

1. **Requesting Additional Tasks:** Additional reasonable household tasks may be requested for scoring during the team leader meetings. These tasks must be approved by the *technical committee* (TC).
2. **Arena-Specific Tasks:** Depending on the arena setup, certain household chores may be delegated to the robot for completion. Examples of tasks that may be handled by the robot include, but are not limited to, window cleaning and picture alignment on the wall.
3. **Team-Supplied Items** In the event that additional items are necessary for the completion of a task (e.g., clothing for folding, watering cans), the requesting team is responsible for supplying these items.
 - 3.1. **Standardization** These items must be regular household items (no markers, no custom printed handles etc.).

3.2. Availability All requested items must be provided and made available to the competitors prior to the day of the final. At least two identical copies of each item must be supplied to ensure adequate access.

6.1.2. The Show Must Go On

To ensure a good experience for the audience the teams are allowed to restart the robot inside the arena.

1. All previously collected points will be kept.
2. The tasks may be rearranged by the Referee during a restart.
3. The restart penalty is only applied if the robot continues scoring afterwards.

6.1.3. Commentator

The team will be asked to provide a commentator to explain the robot's behavior and answer questions to produce a better viewing experience for the audience.

Score sheet

The maximum time for this test is **10:00** minutes.

| Action | Score |
|---|-----------------|
| Main Goal (can be repeated unlimited times) | |
| Find and clearly state an encountered EGPSR problem | 3×150 |
| Solve a EGPSR problem | 3×650 |
| Opening the Door of the Apartment | 600 |
| Closing the Dishwasher | 600 |
| Closing a Cabinet Door | 300 |
| Custom Task | |
| Custom Task | |
| Custom Task | |
| Penalties | |
| Find repeated EGPSR problem category | -100 |
| Solving repeated EGPSR problem category for the 2nd time | -300 |
| Solving repeated EGPSR problem category for the 3rd (or more) time | -500 |
| Deus Ex Machina Penalties | |
| Asking for location of a problem | 3×-150 |
| Restart (only applies if the robot continues scoring afterwards) | -50 |
| Instructing a human to perform parts of the task will apply a percentage penalty according to similar penalties in other tests. | 3×-650 |
| Total Score (excluding special penalties & standard bonuses) | 3900 |

6.2. Final Ranking and Winner

The winner of the competition is the team that gets the highest ranking in the *Finals*.

The second place will be the team that got the second-highest ranking in the *Finals*.

The third place will be the team with the lowest score in the *Finals*.

Appendix A

League Requirements

A.1. Competition Area

A.1.1. Arena Information

- Number of Competition Arenas: 2
- Space per Arena: 90 m^2
- Total Competition Area: 180 m^2 (plus 90 m^2 for Testing, if applicable)

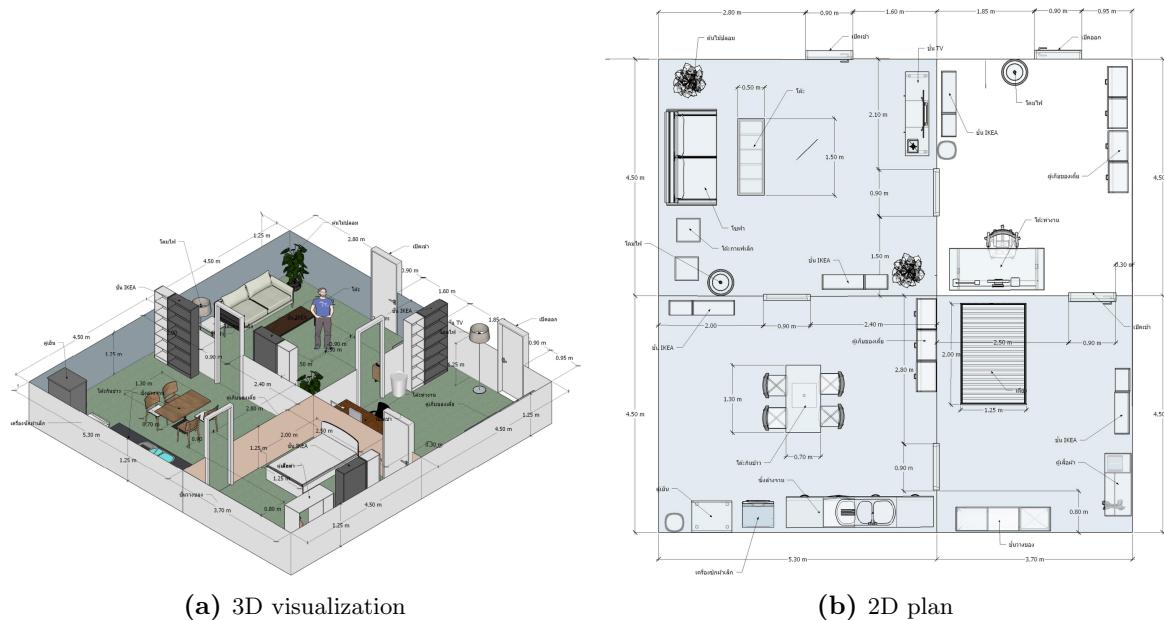


Figure A.1.: Sample Arena Setup

A.1.2. Detailed Setup

The RoboCup@Home Arena is a realistic home setting (apartment-like) consisting of interconnected rooms. A typical configuration is shown in Figure A.1. The **minimum arena configuration must include:**

- a living room,
- a kitchen,
- two additional rooms (e.g., bedroom, office, dining room, laundry room, childrens room).

There are usually two competition arenas and one additional Testing arena.

Dimensions Each arena should be around 90 m^2 to 120 m^2 . A minimum of 80 m^2 is acceptable if robot navigation space is ensured. Typical room sizes are approximately 20 m^2 to 30 m^2 . Robots typically have a base diameter of 70 cm, with extensions for manipulators. The arena must accommodate safe navigation.

Walls Walls are fixed and **must not be altered** during the competition.

- Minimum height: 60 cm.
- Maximum height: not specified, but audience visibility **should be ensured**.

Doors Each arena **must include**:

- At least one entrance door (opening inward).
- At least one exit door (opening outward).
 - The two doors (entrance and exit) cannot be in the same room.
- All doors with handles (not knobs), which can be closed.
- Minimum width: 90 cm, minimum height: 200 cm.
- Door thresholds must be smooth or very flat, without steps, lips, or obstacles that could impede robot movement.

If these requirements cannot be met, alternative solutions **must be discussed in advance** with the Technical Committee (TC).

Power Supply Each arena **must provide** at least one freely accessible power outlet. The outlet may be located either in a corner of the arena or immediately outside the arena boundary.

Floor The floor must be even, with minor irregularities allowed (e.g., carpets, transitions). It should not be excessively slippery. At least 1 m of free space is required around the arena for robot staging.

Appearance Walls and floors should be neutral (monochromatic or lightly textured). Decorative elements such as posters or carpets are allowed.

Additional Setup A table must be provided outside each arena for external computing devices of the active team.

Optional Equipment The following equipment is recommended for each arena to improve the competition experience but is not mandatory:

- Microphones or audio systems for announcements
- Additional display screens for spectators
- Computers and cameras for live broadcasting the competition

A.2. Environment Requirements

The arena must be decorated to resemble a typical apartment.

Mandatory Items

- Plants, mirrors, paintings, posters, picture frames, clocks, candles with holders, books.

Furnishings (minimum)

- a couch,
- a coffee or side table,
- a small dining table with two chairs,
- a trash bin,
- a bookcase (or similar shelving) with a minimum shelf spacing of 30 cm
- a front-loading washing machine,
- kitchen equipment including:
 - a dishwasher,
 - a sink,
 - a pantry (tall cupboard with shelves).

Optional Furnishings (recommended) These are not required but improve realism and expand task possibilities:

- a bed,
- a larger dining table with 4 chairs,
- additional side/coffee tables,
- refrigerator,
- kitchen countertop,
- microwave,
- portable stove with heating plate and pan,
- coat rack,
- open cupboard or TV stand with television and remote,
- cupboard,
- chest of drawers with at least two drawers positioned 90 cm to 120 cm from floor, with U-shaped handles
- doors for the bookcase, pantry and similar furnishing with U-shaped handles

A.3. Network Requirements

A.3.1. Wireless Communication

Each arena must have a dedicated WLAN access point.

- Only the official arena WLAN may be used during testing and competition.
- Only the currently active team may access the arena network.
- Each team has its own VLAN with separate SSID and password.
- Networks must be connected to both the Internet and a wired connection near the arena.
- Unauthorized networks (e.g., hotspots) are strictly prohibited and may result in disqualification.

Note: Wireless reliability may fluctuate due to the fair environment.

A.4. Best Practices

- Avoid uneven surfaces.
- Avoid cables running on the arena floor.
- Locate team tables near the arenas.
- Power outlets should provide sufficient capacity for robot operation; a recommendation is at least **1.8 kW** per team outlet.

A.5. Additional Equipment

These items are purchased by the *organizing committee* (OC) with the help of the *Local Organizing Committee* (LOC) on the first day of installation on site.

The following household objects must be available:

- Lightweight (0.5 kg) household objects of various categories (drinks, snacks, food, fruits, toys, cleaning supplies),
- Tableware: dish, bowl, cup/mug,
- Cutlery: fork, knife, spoon,
- Bags: lightweight with vertical handles,
- Trays: for bimanual manipulation,
- Laundry basket (wide, two-handed carry),
- Pourable objects (e.g., cereal box),
- Heavy objects: 1 kg to 1.5 kg,
- Tiny objects: 5 cm (e.g., paper, teabag, pen),
- Fragile objects: breakable (e.g., chocolate egg),
- Deformable objects: flexible (e.g., cloth),
- 8–12 Pieces of Laundry (T-Shirts)
- Garbage bag: tieable household garbage bag.

A.6. League Organization Area

Organizing Committee (OC) Requirements The OC area must include:

- 2 to 3 tables with two chairs each,
- Access to power outlets and LAN,
- Access to a printer (or paperless setup if agreed),
- A mobile display for announcements (poster stand or board as fallback).

A.7. Teams Area

Participation Area Each team must be provided with:

- One table per four members, with chairs,
- At least one power outlet and one Ethernet connection,
- 2 m² for robot storage,
- 1 m² to 2 m² for robot handling,
- 4 m² to 5 m² near team area for robot maneuvering,
- Adequate aisle space between tables for robot transport.
 - One poster stand per participating team, suitable for displaying an **A0-size portrait** poster,
or
 - sufficient free wall space to hang all team posters simultaneously.

A.8. Other Notes

- Changes compared to previous years:
 - Sub-Leagues have been dissolved.
 - Require free outlet in Arena.
 - Add Optional Section.

- Add requirements about posters.
 - A washing machine is now mandatory.
 - A bed is now optional.
- Additional information: TBD.

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