



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 Presentation 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, like a personal robot assistant.

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)
- 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

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

- a living room,

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

There are usually two competition arenas.

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 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 pantry (tall cupboard with shelves) with a minimum shelf spacing of 30 cm,

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



Figure 3.1.: An example of a *RoboCup@Home* scenario

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. These are published and available for testing and training on the first setup day.
 - 1.1.1. **Common Objects:** All the Common objects, for teams to acquire and train on beforehand.

- 1.1..2. ***YCB Objects***: Objects chosen from the *YCB Dataset*¹.
- 1.1..3. ***Local Objects***: Local household items bought during the competition.
- 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).
- 2. ***Unknown Objects***: Any other object not in the object list but can be grasped or handled (e.g., *Arena* decorations).

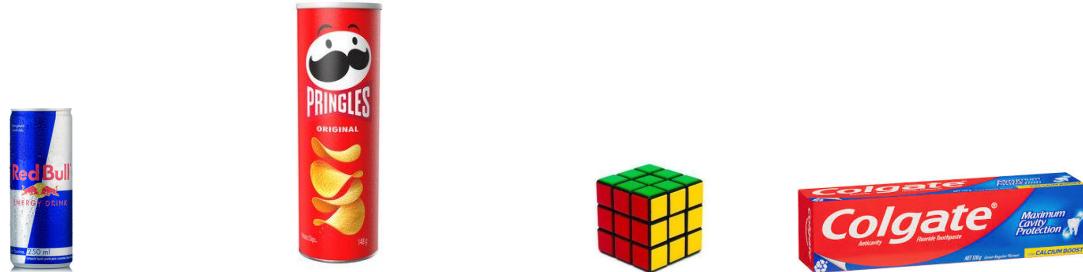


Figure 3.2.: Worldwide available objects

The minimal configuration of *Known Objects* consists of:

- ***Tableware***: Dish, bowl, cup (or mug), and napkin.
- ***Cutlery***: Fork, knife, and spoon.
- ***Bags***: Lightweight and with stiff, vertical handles.
- ***Trays***: A transport objects like trays or baskets, intended for bimanual manipulation.
- ***Pourable***: An object whose content can be poured (such as a cereal box).
- ***Heavy object***: Weighing between 1.0 kg and 1.5 kg.
- ***Tiny object***: A lightweight object not larger than 5 cm (such as a strawberry or a dice).
- ***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).
- ***Laundry***: T-shirt to be used for folding.
- ***Laundry basket***: A wide, lightweight laundry basket, intended for bimanual manipulation. (see Figure 3.3a for an example).
- ***Common Objects***: A Red Bull can, a red Pringles container, a solved Rubik's cube and a Colgate toothpaste box. These objects must be commonly available worldwide. (see Figure 3.2).

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



(a) Example Laundry Basket

Figure 3.3.: Additional scenario objects

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

1. **Cover:** All internal hardware (electronics and cables) must be fully enclosed to ensure safety.
2. **Appearance:** Robots should present a product-like, finished appearance rather than an early-stage prototype. While improvised coverings (e.g. a t-shirt) are not explicitly prohibited, they are strongly discouraged.
3. **Loose cables:** No loose cables should hang out of the robot.
4. **Safety:** The robot must not have sharp edges or protruding parts that could harm people.
5. **Annoyance:** The robot must not emit continuous loud noises or use blinding lights.
6. **Marks:** The robot must not display any artificial marks or patterns.
7. **Driving:** Obstacle avoidance is mandatory to ensure safe movement.

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

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) allows 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.

Emergency Stop Button

1. **Accessibility and visibility:** Each robot must have an easily accessible and visible *Emergency Stop* button.
2. **Color:** *Emergency Stop* buttons must be colored red and must be the only red buttons 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 an *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 1 m 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. **Restaurant Task:** The Restaurant task is held only once during the competition, prior to the *Final*. It takes place outside the main arena in a location that is not disclosed in advance. Preferably in a real restaurant, or otherwise in a restaurant-like environment. Due to scheduling constraints, participation in the Restaurant task may require prior registration and may be limited based on the current classification (e.g., score or ranking achieved before the task).
4. **Final:** The top 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. The number of teams advancing to the *Final* is determined by the total number of participating teams, as follows:
 - Up to 9 teams: top 3 teams advance to the *Final*
 - 9 to 14 teams: top 4 teams advance to the *Final*
 - 15 to 20 teams: top 5 teams advance to the *Final*

- More than 20 teams: top 6 teams advance to the *Final*

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 1	Restaurant
				—Break—
				Finals
Block 2 (13:00–15:00)	Task 3	Task 4	Task 3	Task 4
				—Break—
Block 3 (17:00–19:00)			Task 1	Task 2
				—Break—
			Task 3	Task 4

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

	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.

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 evaluates robot performance based on task completion. Some objectives include optional modifiers and penalties. Modifiers apply only to the specific objective and cannot reduce its score below zero.

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, special penalties may result in a total score below zero. Specifically, penalties can be applied for not attending a test (see Section 3.8.1) or 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),
- not intentionally causing other robots to fail.

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

Right before starting a task, a start signal is given to the robot to indicate the robot must start performing the task. For tasks where the robot starts outside the arena and must enter the arena, the start signal is the door opening. For tasks where the robot starts inside the arena or the task does not involve entering the arena, the start signal must be manual and performed by the referee.

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. **Manual start signal:** After a team member positioning the robot in the correct location and starting the robot, the referee must perform a manual start signal previously approved on Robot Inspection (see Section 4.4). When the robot is ready to start a task, it must clearly inform the referee it is ready to start, and what it needs to do to activate the start signal. Some examples of possible manual start signals are:
 - Pressing a physical button on the robot (must be easily accessible and clearly marked as the start button)
 - Releasing the emergency stop button
 - Applying pressure to the robot's contact/pressure sensors (e.g., pushing the head, gripper or an arm joint).
 - Verbal instructions
 - Hand gesture
 - Custom HRI interfaces (touchscreen, apps, software, etc.)

Start signals that involve the referee usage of mouses or writing on keyboards are forbidden. Other start signals may be allowed, but must be authorized by the *technical committee* (TC) during the Robot Inspection (see Section 4.4).

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. **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.
2. **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.
3. **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.

4. **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.
5. **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. Bypassing Features With Human Help

Because the Show Must Go On

Robots are expected to autonomously complete all task objectives. However, when progress is prevented by a malfunction or limitation, robots may request human assistance to allow the test to continue.

Human assistance is intended as a last resort. Robots should first attempt to skip or defer subtasks they cannot complete and continue with other achievable parts of the task. Assistance should only be requested when the robot cannot make further meaningful progress otherwise.

3.7.1. Procedure

The robot must **clearly and explicitly indicate** that it is requesting human assistance.

If a task explicitly defines allowed forms of human assistance, the robot may request such assistance using simplified or task-specific instructions. However, vague or ambiguous requests may be interpreted incorrectly by the human assistant and are not guaranteed to be executed as intended.

Regardless of how the request is phrased, the robot is expected to confirm that the requested action has been carried out as intended (e.g. through dialogue, perception, or other appropriate feedback).

In the lead-up to RoboCup, assistance types not explicitly listed in the task description may be proposed for inclusion in the Rulebook via pull request or issue.

During RoboCup, any assistance not explicitly listed in the task description must be approved during the Team Leader Meeting prior to the test. Such assistance must follow the procedure below:

1. **Request help:** The request must specify:
 - the type of assistance required, and
 - the intended outcome of the action.
2. **Supervise:** The robot should actively supervise the assistance and be able to:
 - recognize whether the requested action has been performed, and
 - determine whether the outcome matches the intended request.
3. **Verify:** The robot must not assume success without confirmation through perception or explicit interaction.

Requests that do not comply with these requirements may be rejected or terminated by the referee without further notice.

3.7.2. Scoring

Any task element completed through human assistance is scored as zero points, unless explicitly stated otherwise in the task description.

3.7.3. Referee Intervention

The referee may stop the task at any time if:

- Assistance is requested that was not explicitly allowed in the description for the task.
- Assistance is requested that was not announced during the Team Leader Meeting.
- The robot is not making reasonable progress on the task despite being assisted.
- From the second human assistance request onwards, repeated or excessive requests without demonstrating autonomous action may lead the referee to immediately stop the task.

Example

Example (non-exhaustive):

- Requesting a human to hand over an object instead of picking it up, and later requesting the human to place the same object instead of placing it autonomously may result in immediate termination of the task.

3.7.4. 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. 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 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.

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 *500 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. **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.
3. **Not showing up as referee or assistant:** If a team does not provide a referee or assistant who is present at the Arena on time, the team receives a penalty of *250 points*.

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 Presentation Session* will also be held. 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 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.

- Start:** The *Setup & Preparation* starts when the venue opens for the first time.
- Intention:** During the *Setup & Preparation*, teams arrive, bring or receive their robots, and assemble and test them.
- Tables:** The local organization will set up and randomly assign team tables.
- 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.
- 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. A *Poster Presentation 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 Presentation Session*, including:
 - 4.1. Organize poster stands (one per team) or alternatives for presenting the posters,
 - 4.2. Organize snacks and drinks,
 - 4.3. Invite officials, sponsors, the local organization, and the trustees of the RoboCup Federation to the event.
5. **Poster presentation:** Teams give a poster presentation on their research focus, recent results, and their scientific contribution. Both the poster and the presentation talk are evaluated by a jury (see Section 4.3).

4.3. Poster Presentation Session

At the *Poster Presentation Session*, each team can give a short presentation of their research and the poster being presented at the poster session.

4.3.1. Poster presentation session

1. **Presentation:** Each team has a maximum of three minutes to give a short presentation of their poster.
2. **Time:** The *Poster Presentation Session* timing is defined by LOC.
3. **Place:** The *Poster Presentation Session* may be held in or around the *Arena*, depending on venue announced during setup days, but should not interfere with the *Robot Inspection* (see Section 4.4).
4. **Evaluation:** The poster 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 Presentation 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, presentation talk, and discussion during the *Poster Presentation 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 Presentation Session*.
- Collect the evaluation sheets.
- Organize and manage the poster presentations.

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 3.7.4).
 - robot speed and dimension
 - manual start signal (used to signal the robot to start its navigation to exit door, after reaching inspection point) (see Section 3.6.8).
 - 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 Presentation Session* takes place.
 - Collect the evaluation sheets

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 offers them a seat, while 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 sitting area.
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 in the living room. The robot must inform the host that it has a bag and ask the host for guidance. When the robot is ready to follow, it should inform the host. The host then walks naturally toward the designated bag drop location. Once at the correct location, the host informs the robot that it should place the bag on the floor.

Additional rules and remarks

1. **Opening Door Timing:** The time of the test 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. **Human Assistance:** 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.
 - **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)
6. **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, an additional penalty is applied. To score the maximum amount of points:
 - The robot must clearly signal its readiness to receive the item (e.g., by holding its manipulator still, using lights, audio cues, or verbal prompts).
 - The manipulator must be positioned at least within 10 cm of the operator's hand.
 - The operator can complete the handover; the robot should not reach, grasp, or initiate dangerous movement toward the human.
 - Explicit verbal guidance from the operator (e.g., "*Place the item in my gripper, I'll close it in 3...2...1*") will result in penalties.
 - The robot may, however, issue safety cues such as: "*I detect the object in my hand. I will close my gripper in 3 seconds, please be careful.*".

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
Say name and favorite drink of each guest (during introduction)	4×30
While introducing guests, look to the correct guest while talking about the other guest	2×50
Extra Rewards	
Detect the doorbell sound as a signal that a guest has arrived	2×30
Open the entrance door for a guest	2×200
Tell a visual attribute of the first guest to the second guest	
Correct attribute	$4 \times +20$
Incorrect attribute	4×-20
Not asking non essential questions to confirm or correct information	4×15
Guiding	
Grab the bag via natural handover from the guest	50
Following the host to the bag drop area	200
Drop the bag while following the host	-50
Rediscovering the operator by natural interaction	-50
Asking the operator to wait	-50
Guiding the robot with physical contact (take by the hand)	-150
Drop the bag in the correct area	50
Penalties	
Wrong guest information was memorized	4×-40
Alternative HRI	6×-20
Not recognizing people	2×-200
Ask the guest to place the bag somewhere on the robot	-25
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. Pick and Place Challenge

This challenge evaluates manipulation capabilities through cleaning and organizing the kitchen and preparing a simple breakfast.

Main goals:

1. Tidy up all objects on the dining table:
 - 1.1. Place dirty tableware and cutlery inside the dishwasher.
 - 1.2. Place designated trash items in the trash bin.
 - 1.3. Store other objects in the cabinet, grouping them with similar items.
2. Set up breakfast on a clean area of the dining table, including a bowl, spoon, cereal, and milk.

Optional goals:

1. Pick up trash from the floor.
2. Open and close the dishwasher door.
3. Pull and push the dishwasher rack.
4. Place a dishwasher tab inside the dishwasher.
5. Pour milk and cereal into the breakfast bowl.

Focus

Object perception, manipulation in narrow spaces, and task planning.

Setup

• Locations:

- **Start Location:** The robot waits outside the arena and enters when the door is opened.
- **Test location:** The test takes place in the kitchen.

• People:

- No people are involved unless the robot explicitly requests assistance.

• Furniture:

- **Dishwasher:** Located near the dining table. Closed by default; the robot may request help to open or close doors or racks.
- **Dining table:** A table in the kitchen with objects to clean up.
- **Side table:** A fixed position side table with common objects (worldwide available objects). (see Figure 3.2).
- **Cabinet:** The cabinet contains objects arranged by category or similarity on different shelves.
- **Trash bin:** A trash bin is located in the kitchen.

• Objects:

- **Dining table setting:** Six objects arranged on the dining table in a typical post-meal setting, possibly stacked:
 - * **Cutlery:** One piece (fork, knife, or spoon).

- * *Tableware*: One mug or cup and one plate.
- * *Trash*: One trash item. One object category will be treated as trash for this task.
- * *Other objects*: Two known objects not belonging to the above categories.
- **Side table setting**: Two objects from the common objects set (see Figure 3.2) are arranged on the side table.
- **Breakfast items**: The breakfast items are: a bowl, a spoon, milk and cereal. The object distribution is as follows:
 - * *Bowl and Spoon*: On top a designated surface in the kitchen.
 - * *Milk and Cereal*: Inside the cabinet, next to their respective categories.
- **Cabinet objects**: A doorless cabinet. Each side of the shelves contains objects arranged in groups, either by category or likeliness.
- **Dishwasher tab**: The tab can be found on top of a designated surface and should be placed inside the dishwasher slot.
- **Floor Object**: One trash item will be placed near the trash bin.

Procedure

1. **Test start**: The robot moves to the kitchen when the arena door is open.
2. **Dining table clean up**: The robot tidies up the dining table by putting: the cutlery and tableware items inside the dishwasher, the trash in the trash bin and the other objects in the cabinet, grouping them by category or similarity.
3. **Serve breakfast**: The robot sets the breakfast by placing the bowl, spoon, cereal and milk on the dining table in a typical setting for a meal. There needs to be a comfortable amount of free space around the served breakfast items.
4. **Side table clean up**: A side table, fixed to the floor, will have 2 objects from the common objects set. These set of objects will purposely be in an easier setting. In the table clean up, two objects must be placed in the cabinet grouping them by category or similarity. The two objects in the side table replace the two objects in the dining table setting. The goal is for teams that can not handle the full set of objects to still participate in the challenge with the common objects, which are known in advance, set in the rulebook.
5. **Sequence**: The robot is free to determine the order and method for performing the pick-and-place tasks. There is no predefined sequence, the robot may execute them in any way it finds optimal.

Additional Rules and Remarks

1. **First Pick Bonus**: To encourage manipulation, the robot receives an additional bonus for successfully picking the first object during the test. This bonus is awarded only once.
2. **Designated Location**: All objects designated location correspond to the appropriate furniture, either on top of or inside.
3. **Safe placing**: Objects must be placed with care, namely the robot should place rather than throw or drop objects.
4. **Dishwasher door**: The dishwasher door is closed by default. The robot may ask for help to open or close the door or racks at any time during the task. If the robot fails to open/close the door/rack, it must clearly state this and request the referee to open/close the door/rack.

5. **Correct dishwasher item placement:** Items must be correctly positioned in the rack, as a human would place them and cleanable by the machine.
6. **Use common items:** The robot must choose either the two items in the dining table or the side table. The side table objects, are common objects (see Figure 3.2), previously known and in a easier setup. However, a penalty is applied if the side table objects are used instead of the dining table objects.
7. **Incorrect cabinet category categorization:** Objects must be grouped with similar items. Misplaced items incur score reductions. Objects that do not semantically belong to any of the categories represented on the shelves should put in an empty part of the shelf.
8. **Breakfast placement:** The table must be set in a typical setting for a meal. The spoon must be placed next to the bowl, and the cereal and milk must be placed next to each other.
9. **Breakfast area cleanliness:** The area immediately surrounding the breakfast items on the dining table must be kept clear of any other objects. Items too close at (5cm) or cluttering the space, will result in a score penalty for the breakfast placement.
10. **Pouring:** A significant amount of the milk and cereal must be poured, Pouring a couple of drops of milk or bits of cereal is not enough.
11. **Trash:** One object category will be treated as trash for this task. Announced during *Setup Days*.
12. **Human Assistance:** Scores are reduced if the robot receives help, such as pointing to objects, handing objects to the robot, repositioning items or changes to the environment. Assistance with opening the milk container or moving parts of the dishwasher does not incur a penalty. If a robot requests human assistance for environment changes (such as chairs, decorations, ...), the score reduction is applied per item. For example, if the robot requests chairs to be moved for easier access to the dining table, a score reduction is applied per chair. For decorations, the score reduction is applied per group of nearby items moved (if three candles are touching or close to each other is considered one item, however if there is a candle on each side of the dining table and robot requests a move on both, it is considered two items).
13. **Communicating Perception:** The robot must clearly indicate its perception to the referee. Pointing, attempting to pick objects, or visualizing one object at a time is sufficient. If visualization is utilized, the surrounding scene must remain visible and the robot needs to announce and confirm the referee perceived the visualization.

OC Instructions

During the *Setup Days*:

- Provide official cutlery and tableware.
- Provide official objects.
- Designate a trash category.
- Announce the dining table, side table and cabinet used for the test.
- Announce locations of dishwasher tab, bowl, and spoon. (in the kitchen)

Referee Instructions

The referee needs to:

- Place dining table objects (1 cutlery, 1 plate, 1 mug or bowl, 1 trash, 2 other objects).
- Place side table objects (2 common objects).
- Place one trash on the floor (near trash bin).
- Arrange cabinet objects by category or similarity.
- Place the bowl and spoon and dishwasher tab.
- Place the milk and cereal inside the cabinet next to their respective category.

Scoresheet

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

Action	Score
Navigate to the table	15
Correctly recognize an object	12×10
Perceive objects on a shelf and indicate the correct placement	2×30
Picking	
Picking up an object for transportation	12×50
First Pick Bonus	+100
From the floor	+30
Cutlery	2×+50
Plate	+100
Dishwasher tab	+100
Common object from auxiliary table	2×-20
Placing	
Place an object in its designated location	12×40
Correctly in the dishwasher	3×+70
Next to similar objects in the cabinet	2×+20
Area around breakfast items is not cleaned	4×-30
In the dishwasher tab slot inside the dishwasher	+160
Common object from auxiliary table	2×-20
Extra Rewards	
Pull or push the dishwasher rack	2×100
Open or close the dishwasher door without assistance	2×200
Open milk container without assistance	400
Pour cereal or milk into the bowl without assistance	2×200
Penalties	
Objects thrown or dropped while placing	12×-40
Breakfast not served in a typical meal setting	-50
Objects dropped on the floor	12×-40
Spilling cereal and milk while pouring	2×-100
Human assistance: object repositioned by a person	12×-30
Human assistance: handover	24×-100
Human assistance: environment changes (per item)	-40
Human assistance: opening milk container	-0
Human assistance: moving dishwasher door or rack	-0
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)	351

Total Score (excluding special penalties & standard bonuses) 3515

5.3. General Purpose Service Robot Challenge

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.

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 all the commands.

- **People:**

- **Professional Operator:** The referee issues standard commands to the robot. If the robot consistently fails to understand the command (e.g. after three tries), teams can use a custom operator.

Procedure

1. **Instruction point:** At least two hours before the test, the referees announce the location of the *Instruction Point*.
2. **Command execution:** The robot will decide how the commands will be issued and advise the operator, i.e., either consecutively or one-by-one. If the commands are issued one-by-one, the robot must return to the operator after completing each task.
3. **Back to the instruction point:** The robot goes back to the *Instruction Point* after completing all the commands given by the operator.
4. **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. **Interleaved Task Bonus:** The robot receives an additional bonus if it successfully completes commands in an interleaved order rather than strictly consecutively. This bonus is awarded only when all three commands are received at once. The interleaved execution

must be meaningful, for example by saving time or reducing unnecessary movements. *Example:* The robot first picks up an object, then performs another task along the way, and only afterward delivers the object to its original destination.

2. **Partial Scoring:** The solution allows partial scoring.
3. **Command generator:** Tasks will be generated using the official command generator¹. Once a command has been generated it will be entered into an LLM to re-generate a similar phrase, e.g. the generated command is "get me a coke from the kitchen" re-phrased command is "Go to the kitchen, find a coke, and bring it to me". Each command may be re-phrased up to 3 times getting simpler with each rephrasing.
4. **Test start:** The robot moves to the *Instruction Point* when the arena door is open.
5. **Team Coaching:** Teams are not allowed to coach, or instruct the operators. Doing so results in disqualification from the task.
6. **Custom Operators:** If a custom operator is used they can only choose between the three re-phrased commands to give.
7. **Autonomy Skip:** Score reductions apply in the following cases:
 - Use of a custom operator.
 - Bypassing speech recognition.
 - Receiving human assistance to accomplish a command.
 - Instructing a human assistant to perform the whole task.
 - QR codes will not be available.

Referee Instructions

- Provide the commands to the operators.

OC Instructions

At least two hours before the test:

- Generate the robot commands and pass through LLM to get a similar command (do not reveal them to the teams).
- Announce the location of the instruction point.
- Recruit volunteers to assist during the test.

During the test:

- The arena will be setup for all command executions.

Score Sheet

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

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

Action	Score
Main Goal	
Understand the spoken command	3×80
Using a custom operator	3×-20
Request a rephrasing	6×-30
Demonstrate a plan has been generated	3×100
Solving the first command	250
Solving the second command	250
Solving the third command	250
Solving part of a command will apply a percentage penalty according to similar scores in other tests.	
Extra Rewards	
Interleaved Task Bonus	200
Penalties	
Bypassing speech recognition	3×-50
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)	149
Total Score (excluding special penalties & standard bonuses)	1490

5.4. Doing Laundry Challenge

The robot assists with laundry by retrieving clothes from a washing machine and folding them neatly on a table. This test evaluates deformable object manipulation, appliance interaction, and task sequencing.

Main goal: Transport clothes to a table, and fold them.

Optional goals:

1. Opening the washing machine door
2. Retrieving clothes from inside the washing machine
3. Using a laundry basket for transportation
4. Folding multiple pieces of clothing and stacking them

Focus

Deformable object manipulation, bimanual grasping.

Setup

- **Locations:**

- **Start location:** Before the test, the robot waits outside the *Arena* and navigates to the laundry area when the door is open.
- **Test locations:** The testing area contains a washing machine, a folding surface nearby, and a laundry basket.

- **People:**

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

- **Furniture:**

- **Laundry basket:** A lightweight basket requiring two arms to carry, placed near the washing machine. The basket already has 6–8 pieces of clothing placed inside.
- **Washing machine:** Positioned with its door closed at the start. Clothes are placed inside. There are 2–4 pieces of clothing in the washing machine.
- **Table:** Positioned near the washing machine. Used as the folding surface. There is a single piece of clothing loosely placed (or bunched up) on the table.

- **Objects:**

- **Clothes:** A set of 8–12 pieces of laundry made from cloth or other deformable fabric.

Procedure

1. **Location announcement:** At least two hours before the test, referees announce which washing machine and table will be used, along with the approximate location of each.
2. **Test start:** The robot enters the testing area once the arena door is opened.
3. **Retrieving laundry:** The robot retrieves the clothes from the laundry basket or directly from the washing machine and places them on the table.
4. **Folding:** The robot attempts to fold at least one piece of clothing neatly.

Additional rules and remarks

1. **Laundry Types:** The laundry will consist exclusively of T-shirts.
2. **Cloth placement:** Clothes must be placed on the table before folding. Folding on the floor is not allowed.
3. **Folding quality:** Folding is evaluated by neatness and whether the cloth is flattened and stacked.
4. **Multiple items:** Additional points are awarded for folding multiple pieces of clothing and stacking them.
5. **Basket transportation:** Using the basket to transport clothing from the washing machine to the table. The basket must be placed in reach of the folding surface.
6. **Human Assistance:** Scores are reduced if human assistance is received, in particular for:
 - opening the washing machine door
 - handing clothes to the robot
 - **Folding:** Penalties are proportional to the amount of help provided:
 - Minimal help (e.g., smoothing wrinkles, stabilizing cloth): small penalty (100 points).
 - Partial folding (e.g., folding one half or aligning edges): moderate penalty (200 points).
 - Major help (e.g., completing entire fold/stack): maximum penalty.

OC Instructions

At least two hours before the test:

- Announce which washing machine and table will be used.

Referee Instructions

The referee needs to:

- Ensure the washing machine and basket contains the laundry before the test begins.
- Close the washing machine door at the start.
- Verify that the folding table is clear before the test.

Score sheet

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

Action	Score
Main Goal	
Navigating to the laundry area	15
Picking up a piece of clothing from the basket	100
Picking up multiple at once	-100
Folding a piece of clothing	800
Human assistance: Flattening/Arranging clothing before folding	-200
Human assistance during folding will apply a percentage penalty according to the amount of help	-800
Extra Rewards	
Opening the washing machine door	300
Removing one or more pieces of clothing from the washing machine	300
The clothing touches the floor	-200
Using the basket for transportation	300
Laundry is dropped or otherwise lost during transportation.	-200
Folding additional clothes (per item)	5×400
Human assistance: Flattening/Arranging clothing before folding	5×-200
Human assistance during folding will apply a percentage penalty according to the amount of help	5×-400
Stacking folded clothes neatly (per item)	6×100
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)	441
Total Score (excluding special penalties & standard bonuses)	4415

5.5. Restaurant Challenge

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 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 takes the customer's order, place the order, and deliver it.
7. **Optionally**, the robot may use an unattached tray to transport the order.

5.5.1. Restart

Teams are allowed a single restart during the restaurant task. The following rules apply:

1. The team must announce the restart to the referee.
2. Task time continues to run during the restart.
3. The robot must be returned to the designated starting location.
4. The team has a maximum of 2 min to complete the restart.
5. All points earned before the restart are voided; scoring resumes from zero after the restart.

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 human assistance 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 challenge.
- **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	2×100
Human Assistance: Being guided to a table	2×-100
Understand and confirm the order received to the customer	2×200
Not making eye-contact when taking the order	2×-80
Communicate the order to the barman	2×100
Picking up the requested items from the <i>Kitchen-bar</i>	2×200
Human assistance: Asking the Barman to handover object to the robot	4×-100
Return to the customer table with the order	2×100
Serve the order to the customer	2×200
Human assistance: Guest needing to take the object from a tray or the robot's hand	4×-100
<i>Extra Rewards</i>	
Use an unattached tray to transport	2×200
<i>Penalties</i>	
Not reaching the bar (barman has to move from behind the bar to interact with the robot)	2×-80
Human Assistance: Asking for directional confirmation	2×-40
Human Assistance: Being told/pointed where a table/ <i>Kitchen-bar</i> is located	2×-50
<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 top teams with the highest total score compete.

6.1. Scoring

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

1. The influence of this tests 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 in one *Arena*.

6.2. Task

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

Main Goal: Solve different problems in the arena.

Setup

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

- **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.
- **Closing Furniture:** The dishwasher door needs to be closed.
- **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.
- **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.

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 generator¹. Commands are generated as described in [5.3](#).
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. Commands are issued as described in [5.3](#).

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.

6.2.1. 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.

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

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
Find repeated problem category	-100
Human Assistance: Asking for location of a problem	-150
Solve a problem	10×650
Solving repeated problem category for the 2nd time	-300
Solving repeated problem category for the 3rd (or more) time	-500
Instructing a human to perform parts of the task will apply a percentage penalty according to similar scores in other tests.	-650
Solving only parts of a GPSR command will apply a percentage penalty according to similar scores in other tests.	
Opening the Door of the Apartment	600
Closing the Dishwasher	600
Custom Task	
Custom Task	
Custom Task	
<i>Penalties</i>	
Restart (only applies if the robot continues scoring afterwards)	-50
Total Score (excluding special penalties & standard bonuses)	8150

6.3. 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 third-highest score in the *Finals*. And so on.

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)

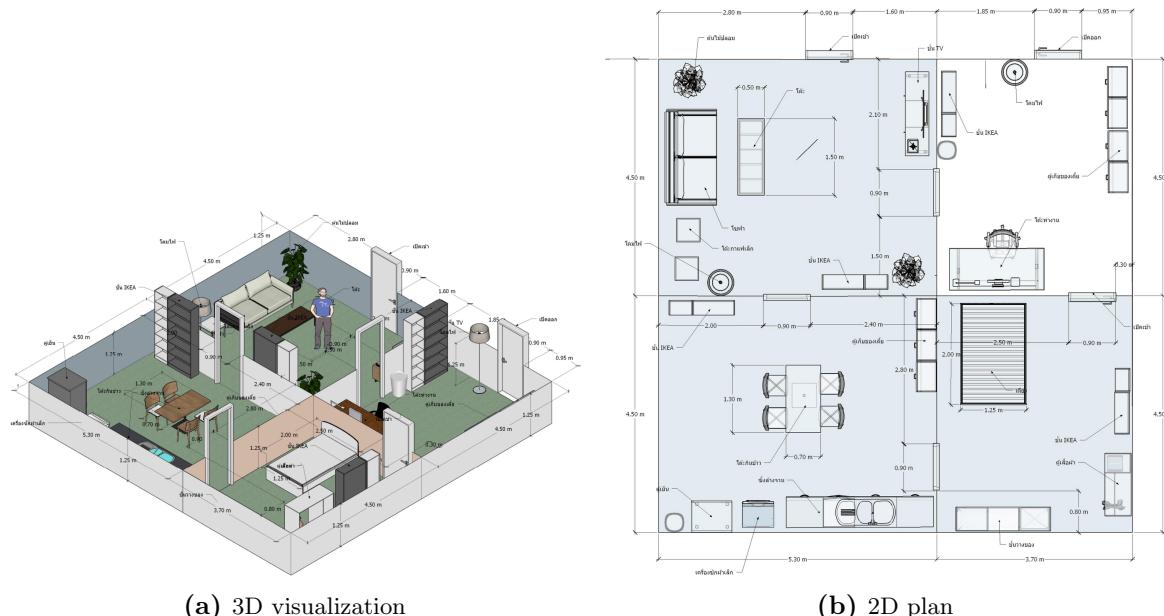


Figure A.1.: Sample Arena Setup

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 (plastic, lightweight, atleast 50 cm wide, two-handed carry),
- Pourable objects (e.g., cereal box),
- Heavy objects: 1kg to 1.5 kg,
- Tiny objects: 5 cm (e.g., paper, teabag, pen),
- Fragile objects: breakable (e.g., chocolate egg),q
- 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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