



RoboCup@Home

Rules & Regulations

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About this rulebook

This is the official rulebook of the RoboCup@Home competition 2020. It has been written by the 2020 RoboCup@Home Technical Committee with the special collaboration of (in alphabetical order):

How to cite this rulebook

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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 robots abilities and performance in a realistic non-standardized home environment setting. Focus lies on the following domains but is not limited to: 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. It is collocated with the RoboCup symposium.

1.3 Organization

1.3.1 Executive Committee — ec@robocupathome.org

The *Executive Committee* (EC) consists of members of the board of trustees, and representatives of each activity area. Members representing the @Home league:

- Alexander Moriarty (Boston Dynamics, USA)
- Hiroyuki OKADA (Tamagawa University, Japan)
- Justin Hart (University of Texas at Austin, USA)
- Mauricio Matamoros (University of Koblenz, Germany)

1.3.2 Technical Committee — tc@robocupathome.org

The *Technical Committee* (TC) is responsible for the rules of each league. Members of the RoboCup@Home Technical Committee for 2020:

- Carlos Quintero (Rice University, Colombia)

- Jianghao Huo (Tsinghua University, China)
- Johannes Kummert (Bielefeld University, Germany)
- Luis Contreras (Tamagawa University, Japan)
- Nathalie Connolly (Hekaton Studio, Canada)
- Nick Walker (University of Washington, USA)
- Patrik Schmidt (University of Koblenz, Germany)
- Pedro Peña (University of Miami, USA)
- Yuqian Jiang (University of Texas at Austin, USA)

The Technical Committee also includes the members of the Executive Committee.

1.3.3 Organizing Committee — oc@robocupathome.org

The *Organizing Committee* (OC) is responsible for the organization of the competition. Members of the RoboCup@Home Organizing Committee for 2020:

- **[Chair]** Maxime St-Pierre (Clearpath Robotics, Canada)
- Colm Flanagan (University New South Wales, Australia)
- David Garcia (Colombia)
- Fagner Pimentel (FEI University Center, Brazil)
- Florian Lier (Bielefeld University, Germany)
- Jeffrey Cousineau (Canada)
- Jose Garcia (Colombia)
- Shengxin Luo (University of Miami, USA)
- Sven Wachsmuth (Bielefeld University, Germany)
- Thierry Pouplier (École de Technologie Supérieure, Canada)

The Local Organizing Committee (LOC) is responsible for the set up and organization of the venue.

- **[Local Chair]** Fabrice Jumel (University of Lyon; France)
- **[Local Co-chair]** Humbert Fiorino (Grenoble Alpes University, France)
- **[Local Co-chair]** Sébastien Loty (Centre Aquitain des Technologies de l'Information et Electroniques, France)
- **[Local Co-chair]** Damien Pellier (Grenoble Alpes University, France)

1.4 Infrastructure

1.4.1 RoboCup@Home Mailinglist

The official *RoboCup@Home mailing list* can be reached at

robocup-athome@lists.robocup.org

You can register to the email list at:

<http://lists.robocup.org/cgi-bin/mailman/listinfo/robocup-athome>

1.4.2 RoboCup@Home Web Page

The official *RoboCup@Home website* that also hosts this RuleBook can be found at:

<https://athome.robocup.org/>

1.4.3 RoboCup@Home Rulebook Repository

The official *RoboCup@Home Rulebook Repository* is where rules are publicly discussed before applying changes to the rulebook. The entire RoboCup@Home community is welcome and encouraged to actively participate in creating and discussing the rules. The repository can be reached at:

<https://github.com/RoboCupAtHome/RuleBook/>

Although opening issues with inconsistencies, questions, clarifications, and suggestions is highly appreciated, the best way to contribute is by making pull requests with fixes and proposed changes.

1.4.4 RoboCup@Home Telegram Group

The official *RoboCup@Home Telegram Group* is a communication channel for the RoboCup@Home community where rules are discussed, announcements are made, and questions are answered. Beyond supporting the technical aspects of the competition, the *Telegram 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>

1.4.5 RoboCup@Home Wiki

The official *RoboCup@Home Wiki* is meant to be a central place to collect information on all topics related to the RoboCup@Home league. It was set up to simplify and unify the exchange of relevant information. This includes but is certainly not limited to hardware, software, media, data, and alike. The *wiki* can be reached at:

<https://github.com/RoboCupAtHome/AtHomeCommunityWiki/wiki>

1.5 Leagues

RoboCup@Home is divided in three Leagues. Two of them are *Standard Platform Leagues* for which all competitors use the same robot, and one that grants complete freedom to all competitors. The official leagues and their names are:

- the *RoboCup@Home Domestic Standard Platform League*,
- the *RoboCup@Home Social Standard Platform League*, and
- the *RoboCup@Home Open Platform League*

Each league points out to a different aspect of service robotics, reason for which they target specific abilities.

1.5.1 Domestic Standard Platform League

The *Domestic Standard Platform League* (DSPL) has as main goal to assist humans in a domestic environment, paying special attention to elderly people and people suffering of illness or disability. In consequence, the DSPL focuses on Ambient Intelligence, Computer Vision, Object Manipulation, Safe Indoor Navigation and Mapping, and Task Planning.

The robot to be used in the DSPL is the Toyota HSR, shown in Figure 1.1.



Figure 1.1: Toyota HSR

1.5.2 Social Standard Platform League

With a 180 degree turn in Human Robot Interaction, the *Social Standard Platform League* (SSPL) takes robots away from the traditional passive servant role, for now the robot is the one who will actively look for interaction. From a party waiter in a home environment to a hostess in a museum or shopping mall, in *SSPL* look for the next user who may require its services. Hence, this league focuses on Human-Robot Interaction, Natural Language Processing, People Detection and Recognition, Reactive Behaviors, and Safe Outdoor Navigation and Mapping.

The robot to be used in the SSPL is the Softbank/Aldebaran Pepper, shown in Figure 1.2.

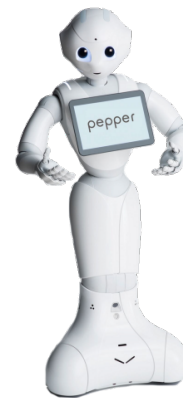


Figure 1.2: Softbank / Aldebaran Pepper

1.5.3 Open Platform League

The *Open Platform League* (OPL) has the same modus operandi used since the foundation of RoboCup@Home till 2017 when Standard Platform Leagues were created. With no hardware constraints, OPL is the league for teams who want to test their own robot designs and configuration, as well as for old at-homers. In this league robots are tested to their limits without having in mind design restriction, although the scope is similar to the DSPL.

1.6 Competition

The competition consists of 2 *Stages* and the *Finals*. Each stage consists of a series of *Tests* that are being held in a daily life environment. The best teams from *Stage I* advance to *Stage II* which consists of more difficult tests. The competition ends with the *Finals* where only the two highest ranked teams of each league compete to select the winner.

1.7 Awards

All the awards need to be approved by the RoboCup Federation (RCF). Based on RCF's decisions, some of them may not be given.

The RoboCup@Home league features the following *awards*.

1.7.1 Winner of the competition

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

1.7.2 Best Human-Robot Interface award

To honour outstanding Human-Robot Interfaces developed for interacting with robots in the @Home league, a special *Best HR Interface award* may be given to one of the participating teams. Special attention is being paid to making the interface open and available to the @Home community.

The *Executive Committee* (EC) members from the RoboCup@Home league nominate a set of candidates for the award. The *Technical Committee* (TC) elects the winner. A TC member whose team is among the nominees is not allowed to vote.

There is no Best HR Interface award in case no outstanding interface and no nominees, respectively.

1.7.3 Best Poster

To foster scientific knowledge exchange and reward the teams' effort to present their contributions, as of 2017 all scientific posters of each League will be evaluated, having the chance of receiving the award for the *Best RoboCup @Home DSPL Poster*, the *Best RoboCup @Home OPL Poster*, or the *Best RoboCup @Home SSPL Poster*, respectively.

Candidate posters must present innovative and State-of-the-Art research within a field with direct application in RoboCup @Home in an appealing, easy-to-read way; demonstrating successful and clear results. In addition to be attractive and well-rated in the Poster Session (see Section 4.3), the explained research must have impact in the team's performance during the competition.

The *Executive Committee* (EC) members from the RoboCup@Home league nominate a set of candidates for the award. The *Technical Committee* (TC) elects the winner. A TC member whose team is among the nominees is not allowed to vote.

1.7.4 Open Challenge award

To encourage teams to present their research in off-hours of the competition to the rest of the teams, RoboCup@Home grants the *open challenge award* to the best open demonstration presented during the competition. This award is granted only if there a team has demonstrated innovative research that is related to the global objectives of RoboCup@Home. Thus, this award may be not be granted.

The *Technical Committee* (TC) members from the RoboCup@Home league, with recommendations from team leaders, nominate a set of candidates for the award (a TC member whose team is among the nominees is not allowed to nominate). The *Executive Committee* (EC) decides if the award should be granted and elects the winner.

1.7.5 Skill Certificates

The @Home league features certificates for the robots best at the skills below:

- Navigation
- Manipulation
- Speech Recognition
- Person Recognition

A team is given the certificate if it scored at least 75% of the attainable points for that skill. This is counted over all tests and challenges, so e.g. if the robot scores manipulation points during the Help-me-Carry test to open the door, that will count for the Manipulation-certificate. The certificate will only be handed out if the team is *not* the overall winner of the competition.

1.7.6 Open-source software award

Traditionally –since Nagoya 2017– RoboCup@Home awards the best contribution to the community by means of open source software solutions. The software must be easy to read, properly documented, follow standard design patterns, be actively maintained, and meet IEEE software engineering metrics of scalability, portability, maintainability, fault tolerance, and robustness. In addition, the open sourced software must be made available as a framework-independent standalone library so it can be reused with any software architecture.

Candidates must send their application to the *Technical Committee* (TC) at least one month before the competition by means of a short paper (max 4 pages) following the same format used for the *team description paper* (see Section 3.1.4), 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 that are also using the software being described.

The *Technical Committee* (TC) members from the RoboCup@Home league nominate a set of candidates for the award. The *Executive Committee* (EC) elects the winner. A EC/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 builds the basis for the RoboCup@Home Competitions. These criteria are to be understood as a common agreement on the general concept of the competition. The concrete rules are listed in Chapter Section 3.

2.1 Lean set of rules

To allow for different, general and transmissible approaches in the RoboCup@Home competitions, the rule set should be as lean as possible. Still, to avoid rule discussions during the competition itself, it should be very concrete leaving no room for diverse interpretation.

If, during a competition, there are any discrepancies or multiple interpretations, a decision will be made by the *Technical Committee* (TC) and the referees on site.

Note: Once the test scoresheet has been signed or the scores has been published, the TC decision is irrevocable.

2.2 Autonomy & Mobility

All robots participating in the RoboCup@Home competition have to be *autonomous* and *mobile*.

An aim of RoboCup@Home is to foster mobile autonomous service robotics and natural human-robot interaction. As a consequence humans are not allowed to directly (remote) control the robot. This also includes verbally remote controlling the robot.

Furthermore, the specific tasks must not be solved using *open loop control*.

2.3 Aiming for applications

To foster advance in technology and to keep the competition interesting, the scenario and the tests will steadily increase in complexity. While in the beginning necessary abilities are being tested, tests will focus more and more on real applications with a rising level of uncertainty. Useful, robust, general, cost effective, and applicable solutions are rewarded in RoboCup@Home.

2.4 Social relevance

The competition and the included tests should produce socially relevant results. The aim is to convince the public about the usefulness of autonomous robotic applications. This should

be done by showing applications where robots directly help or assist humans in everyday life situations. Examples are: Personal robot assistant, guide robot for the blind, robot care for elderly people, etc. Such socially relevant results are rewarded in RoboCup@Home.

2.5 Scientific value

RoboCup@Home should not only show what can be put into practice today, but should also present new approaches, even if they are not yet fully applicable or demand a very special configuration or setup. Therefore high scientific value of an approach is rewarded.

2.6 Time constraints

Setup time as well as time for the accomplishment of the tests is very limited, to allow for many participating teams and tests, and to foster simple setup procedures.

2.7 No standardized scenario

The *scenario* for the competition should be simple but effective, available world-wide and low in costs. As uncertainty is part of the concept, no standard scenario will be provided in the RoboCup@Home League. One can expect that the scenario will look typical for the country where the games are hosted.

The scenario is something that people encounter in daily life. It can be a home environment, such as a living room and a kitchen, but also an office space, supermarket, restaurant etc. The scenario should change from year to year, as long as the desired tests can still be executed.

Furthermore, tests may take place outside of the scenario, i.e., in an previously unknown environment like, for example, a public space nearby.

2.8 Attractiveness

The competition should be attractive for the audience and the public. Therefore high attractiveness and originality of an approach should be rewarded.

2.9 Community

Though having to compete against each other during the competition, the members of the RoboCup@Home league are expected to cooperate and exchange knowledge to advance technology together. The *RoboCup@Home mailing list* can be used to get in contact with other teams and to discuss league specific issues such as rule changes, proposals for new tests, etc. Every team is expected to share relevant technical, scientific (and team related) information there and in its *team description paper* (see Section 3.1.4) through the team's website.

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

This is a list of the current desired technical abilities which the tests in RoboCup@Home will focus on.

- 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
RoboCup@Home is aiming for applications of robots in daily life.
- Ambient intelligence, e.g., communicating with surrounding devices, getting information from the internet etc.

Chapter 3

General Rules & Regulations

These are the general rules and regulations for the competition in the RoboCup@Home league. Every rule in this section can be considered to implicitly include the term “*unless stated otherwise*”, meaning that additional or contrary rules in particular test specifications have a higher priority than those mentioned herein in the general rules and regulations.

3.1 Team Registration and Qualification

3.1.1 Registration and Qualification Process

Each year there are four phases in the process toward participation:

1. *Intention of Participation* (optional)
2. *Preregistration*
3. *Qualification* announcements
4. Final *Registration* for qualified teams

Positions 1 and 2 will be announced by a call on the *RoboCup@Home mailing list*. Preregistration requires a *team description paper*, a *video* and a *website*.

3.1.2 Qualification Video

As a proof of running hardware, each team has to provide a *qualification video* showing at least two from the following abilities (minimum requirement):

- Human-Robot interaction
- Navigation (safe, indoors with obstacle avoidance).
- Object detection & manipulation.
- People detection
- Speech recognition.
- speech synthesis (clear and loud).

Showing some of the following abilities is recommended:

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

Videos should be self-explanatory and designed for a general audience, showing the robot solving complex tasks. The minimum to qualify requires proving the robot is able to solve successfully at least one test of the current or last year's rulebook. For robots moving slowly, we suggest to speed-up videos. When doing so, please specify the speed factor being used (e.g. 2x, 5X, 10X). The same applies for slow motion scenes. Videos should not exceed the average time for a test (max. 10 min).

3.1.3 Team Website

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

1. **Multimedia:** As many photos and videos of the robot(s) as possible.
2. **Language:** The team website has to be in English. Other languages may be also available, but English must be default language.
3. **Team:** Comprehensive list of the team members including brief profiles.
4. **RoboCup:** Link to the league website and previous participation of the team in RoboCup.
5. **Scientific approach:** Include research lines, description of the approaches, and information on scientific achievements.
6. **Publications:** Relevant *publications* from 5 years up to date. Downloadable publications are scored higher during the qualification process.
7. **Open source material:** Blueprints, datasets, repositories or any kind of contribution to the league is highly scored during qualification process.

3.1.4 Team Description Paper

The *team description paper* (TDP) is an 8-pages long scientific paper which must have a explained description of your main research, including the scientific contribution, goals, scope, and results.

Preferably, it should also contain the following:

- 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 the real world
- photo(s) of the robot(s)

As addendum in the 9th page (after references) please include:

- Team name
- Contact information
- Website url
- Team members' names
- photo(s) of the robot(s), unless included before.
- description of the hardware used
- Brief, compact list of *external devices* (See Section ??), if any.

- Brief, compact list of 3rd party reused software packages (e.g. ROS' `object_recognition` should be listed, but not OpenCV).
- **[Open Platform League only]** Brief description of the hardware used by the robot(s).

The TDP has to be in English, up to eight pages in length and formatted according to the guidelines of the RoboCup International Symposium without altering margins or spacing. It goes into detail about the technical and scientific approach.

Please notice that, during qualification process, TDP will be scored by its scientific value, novelty and contributions.

3.1.5 Qualification

During the *qualification process* a selection will be made by the *Organizing Committee* (OC) Taken into account and evaluated in this decision process are:

- The content on the team website, scoring higher publications and open source resources;
- the number of abilities shown in the qualification video,
- the complexity of the tasks shown in the qualification video, and
- the scientific value, novelty and contributions in the *team description paper*.

(Additional) evaluation criteria are:

- the performance in previous competitions,
- the relevant scientific contributions and publications, and
- the contributions to the RoboCup@Home league.

Important note to Standard Platform Leagues: Only unmodified robots may compete in Standard Platform Leagues. Any *slight* modification made to the robot found in the Qualification Material will automatically disqualify the team, for which registration to the international competition will not be possible (See Section 3.4.3).

3.1.6 Participation confirmation

In order to max out the number of participating teams, qualified teams *must* contact the *Organizing Committee* (OC) to confirm (or cancel) participation.

Confirming attendance implies that the team has sufficient resources to register, and commits to attend to the event. Qualified teams missing the *Participation Confirmation* may be disqualified.

3.1.7 Task Selection Announcement

To facilitate scheduling of test slots during the competition, teams are required to notify the *Organizing Committee* (OC) which tasks will be tested in each scenario/stage two weeks before the competition. This should be considered as "soft" list, meaning, teams are not obligated to test all the tasks they notify; they are free to opt-out of the task during the competition. However, teams cannot test a task they did not notify beforehand; they are not able to opt-in.

Table 3.1: Maximum number of eligible tests in Sydney 2019

	Housekeeper	Party Host
STAGE I	3	3
STAGE II	2	2

The tasks a team can select should be according to the number and type of test slots of the competition (see [Section 3.6.2](#) and [table 3.1](#)).

[H]

Task selection announcement is a non-binding decision, meaning that teams can opt-out from some tasks. However, it is not allowed to opt-in later on, as it is forbidden to do it for all tasks, since there are more tasks than testing slots.

3.2 Audience interaction

Direct interaction with the audience is not a part of most challenges, though some explicitly require it in an effort to make robots step out of the laboratory.

Informing the audience however is important for the league.

3.2.1 Vizbox

The objective of RoboCup is to “promote robotics and AI research, by offering a publicly appealing, but formidable challenge” ¹.

Part of making RoboCup@Home appealing, is to show the audience what is going on, what the robots should do and what they are doing.

To this end, robots in RoboCup@Home are expected run the RoboCup@Home [VizBox](#)².

This is a web server to be run on a robot during a challenge. The page it serves can be displayed on a screen, visible to the audience, via a secondary computer in or around the arena, connected to the web server via the wireless network.

All robots are expected to run the *VizBox*; the audience expects to know what all the robots are doing and what each challenge entails.

The *VizBox*’s code is hosted <https://github.com/LoyVanBeek/vizbox>. We want to show the audience a consistent presentation, so ideally, all teams run the same VizBox code. Sharing your changes back in the form of a Pull Request is much appreciated so all teams can benefit.

The *VizBox* has the following visualization capabilities:

- Images of what the robot sees or a visualization of the robot’s world model, eg. camera images, it’s map, anything to make clear what is going on to the audience.
- Show an outline of the current challenge and where the robot is in the story of the current challenge.
- Subtitles of what the robot and operator just said; their conversation

¹<http://robocup.org/objective>

²<https://github.com/LoyVanBeek/vizbox>

Additionally, the *VizBox* offers a way to **input** a text command to the robot, to bypass automatic speech recognition if need be.

The exact documentation is maintained in the repository of the *VizBox* itself.

3.3 Scenario

The tests take place in the *RoboCup@Home arena*. Nonetheless, some tests can take place outside the arena, in a previously unknown public place. Rules in this section are related to the *RoboCup@Home arena* and its contents.

3.3.1 RoboCup@Home arena

The *RoboCup@Home arena* is a realistic home setting (apartment) consisting of inter-connected rooms. The minimal configuration consists of

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

Depending on the Local Organization, there may be multiple apartments which may be different to each other. Robot must be prepared to perform any task in any arena, not the same arena every time.

The arena is decorated and dressed to resemble a typical apartment in the hosting country, including all necessities and decorations one can find in a normal house. Please do note that what is considered as “normal” may greatly vary by culture and on the location where the RoboCup event is hosted. Decorations include, but are not limited to: plants, mirrors, paintings, posters, plates, picture frames, wall clocks, candles with holders, and books. For a description of objects, please refer to Section [3.3.5](#)

3.3.2 Walls, doors and floor

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

1. **Walls:** Walls have a minimum height of 60 cm. A maximum height is not specified, but must allow the audience to watch the competition.
Walls are fixed and not to be modified during the competition (see Section [3.3.4](#)).
2. **Doors:** There will be at least two *doors*, an entrance and an exit, to be used as starting points for the robots (see Section [3.7.9](#)). Inside the arena rooms are connected by doors (at least one). All doors have handles, not knobs. Doors can be closed at any time, and it is expected that robots be able to open them.
3. **Floor:** The floor of the arena as well as the doorways of the arena are even. That is, there will be no significant steps or even stairways. However, minor unevenness such as carpets, transitions in floor covering between different areas, and minor gaps (especially at doorways) can be expected.



Figure 3.1: Scenario examples: (a) a typical arena, and (b) typical objects.

4. **Appearance:** Floor and walls are mainly uni-colored but can contain texture, e.g., a carpet on the floor, or a poster or picture on the wall.
Although being unlikely at the moment, transparent elements are also possible.

3.3.3 Furniture

The arena will be equipped with typical objects (furniture) that are not specified in quantity and kind.

The minimal configuration consists of:

- a bed,
- a couch,
- a small table,
- a small dinner table with two chairs,
- two trash bins,
- an open cupboard or small table with a television and remote control,
- a cupboard with drawers, and
- a bookcase or shelf with doors and some books inside

Likewise the arena's kitchen must have:

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

A typical arena setup is shown in Figure 3.1a.

Cupboard

The cupboard can be any shelf-like furniture in which objects can be placed.

Doors: The cupboard may have doors.

Drawers: The cupboard must have at least two drawers between 90cm and 120cm from floor level.

Shelves: The minimum distance between shelf or layers is 30cm.

Shelf

A shelf, rack, or bookcase is required in RoboCup@Home. The shelf can be any shelf-like furniture in which objects can be placed.

Doors: The shelf must have at least one door (preferably a vertical one) covering up to one half of it.

Drawers: The shelf must have no drawers.

Shelves: The shelf must have 5 shelves or layers between 0.0m and 1.80m from the ground, with a minimum distance of 30cm between shelves or layers.

Fridge

Fridges must not be smaller than 120cm. At least one powered and functioning fridge is required.

3.3.4 Changes to the arena

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

1. **Major changes:** The arena is meant to be a simulated apartment. The furniture might be moved around between tests. This includes furniture that is a named location (see Section 3.3.9). As in a normal home, furniture is not very likely to move from one room to another and is unlikely to be moved to the other side of a room. However, a couch or table may be rotated, moved to its side etc. Walls will stay in place and rooms will not change function. Passages might be blocked and cleared. One hour before a test slot begins no *major changes* will be made. This time will be shortened in the future.
2. **Minor changes:** In contrast to major changes, *minor changes* like, for instance, slightly moved chairs cannot be avoided and may happen at any time (even during a test).

3.3.5 Objects

Some tests in the RoboCup@Home league involve recognizing and manipulating *objects* (See Figure 3.1b). The TC will compile a list of at least 30 objects for this purpose, assigning them official names. Most objects are likely to be lightweight and easy to grasp with one hand. Each object has assigned a category (e.g. an *apple* and a *banana* belong to the *fruits* category). Each *object category* has assigned a *predefined location* (e.g. an *fruits* can be found in the *kitchen table*). Assignments are announced during setup days (See Section 4). An exemplar of each object is provided before the competition for training.

There are two types of objects:

1. **Known objects:** Objects previously known by the robot and that it can identify and manipulate. There are two kinds of known objects:
 - 1.1. **Regular objects:** Objects with no noticeable difference among peers (e.g. soda can, cereal box, cutlery, etc).
 - 1.2. **Alike objects:** Objects which are different one from another, but still considered by people to be the same (e.g. apple, sandwich, cloth, etc.).

2. **Unknown objects:** Any other object that is not known beforehand but can be grasped or handled.

Remark: Most (known) objects used in the competition are chosen from the YCB dataset (see <http://www.ycbbenchmarks.com/object-set/>). These objects are considered standard, and can be acquired and trained in advance. Additional information about which *standard objects* were chosen, their official names, categories, and how to acquire them, can be found in the RoboCup@Home Official Website <https://athome.robocup.org/standard-objects> no later than 6 months prior to the 2020 competition.

3.3.6 List of Predefined Objects

The minimal configuration consists of:

- **Tableware:** Dish, bowl, cup (or mug), and napkin.
- **Cutlery:** Fork, knife, and spoon.
- **Trash Bags:** Big plastic trashbags, preferably with handle.
- **Bags:** Lightweight. With stiff, vertical handles.
- **Disks or books:** A set of 10 discs (LP, CD, DVD, or BluRay) or books, all of the same kind.
- **Coat rack:** A rack or pole to hang coats and other clothes.
- **Trays:** A transport object like a tray or basket. Intended for two-handed manipulation.
- **Pourable:** An object whose content can be poured (e.g. muesli, cereal, etc.).
- **Heavy object:** Weight between 1.0kg and 1.5kg.
- **Tiny object:** A lightweight object with no bigger than 5cm (e.g. paper, teabag, pen).
- **Fragile object:** An easy-to-break object, (e.g. chocolate egg).
- **Amorphous object:** An flexible object that may take an infinite number of shapes (e.g. cloth, magnetic puzzle, etc.).
- **Garbage bag:** A tie-able garbage bag.

Important note: It is not allowed to modify any of the objects provided for training. Teams are not allowed to keep more than 5 the objects provided for training at a time nor retaining it for more than one hour.

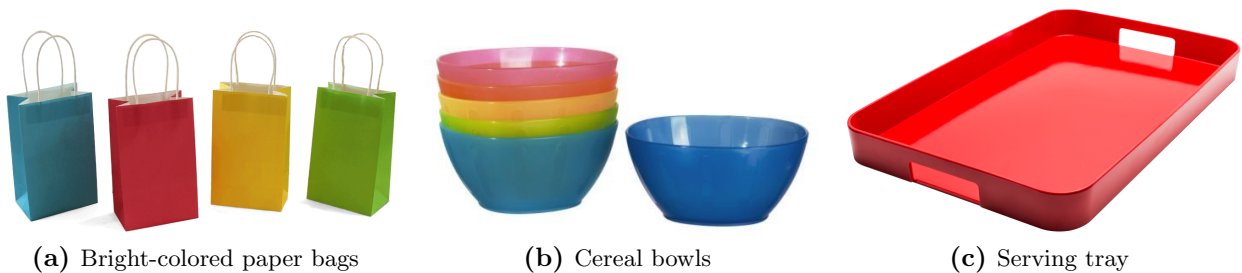


Figure 3.2: Example of object containers

3.3.7 Attributes of Predefined Objects

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

- Color (e.g. red, blue, black with white dots, etc.).
- Relative estimated size (smallest, largest, big one, etc.).
- Relative estimated weight (lightest, heaviest).
- Relative position (left of, right most, etc.).
- Object description (is fragile, is container, can be poured, requires two hands, etc.).

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

3.3.8 Predefined rooms and locations

Some tests in the RoboCup@Home league involve *predefined locations* where people or objects can be found. The TC will compile a list of predefined locations that may include furniture (e.g. bookshelf), decorations (e.g. plant, mirror), and doors. Each *predefined location* has assigned a *location class* (e.g. an *coach* and a *arm chair* belong to the *seat* class). Room names, predefined locations, and location classes are announced during setup days (See Section 4).

3.3.9 Predefined (person) names

Some tests in the RoboCup@Home league involve memorizing a person name. All people in the arena has an assigned *predefined name*. The TC will compile a list of 20 *predefined names*. The names are 25 % male, 25 % female, and 50 % gender-neutral, taken from the list of most common used names in the United States. Predefined names are announced during setup days (See Section 4).

3.3.10 Wireless network

For wireless communication, an *arena network* is provided. The actual infrastructure depends on the local organization. The organizers do NOT guarantee reliability and performance of wireless communication. Teams required to start must do so regardless the availability of the network infrastructure.

The following rules apply:

- Only the *arena network* can be used during tests.
- During the competitions, only the active team is allowed to use the *arena network*.
- The *arena network* provides one Virtual Local Area Networks (VLANs) per team.
- Each VLAN is most likely to have its own SSID/password.
- VLAN traffic is separated from any other team, routed to the team's network cable (team area).
- Each VLAN is also connected to the Internet.

Remark: Teams broadcasting unauthorized (aka rogue) wireless networks will be disqualified from the competition, and have their devices confiscated by the OC. This includes smartphones and concealed SSIDs. It is advised to verify your devices.

3.4 Robots

3.4.1 Number of robots

1. **Registration:** The maximum *number of robots* per team is *two* (2).
2. **Regular Tests:** Only one robot is allowed per test. For different tests different robots can be used.
3. **Open Demonstrations:** In the *Finals* both robots can be used simultaneously.

3.4.2 Appearance and safety

Robots should have a nice product-like appearance, be safe to operate, and should not annoy people. The following rules apply to all robots and are part of the *Robot Inspection* test (see Section 4.4).

1. **Cover:** The robot’s internal hardware (electronics and cables) should be covered in an appealing way. The use of (visible) duct tape is strictly prohibited.
2. **Loose cables:** Loose cables hanging out of the robot are not permitted.
3. **Safety:** The robot must not have sharp edges or elements that might harm people.
4. **Annoyance:** The robot must not be continuously making loud noises or use blinding lights.
5. **Marks:** The robot may not exhibit any kind of artificial marks or patterns.
6. **Driving:** To be safe, the robots should be careful when driving (obstacle avoidance is mandatory).

3.4.3 Standard Platform Leagues

RoboCup@Home features two Standard Platform Leagues adhering to the rules listed above.

Modifications

Standardized platforms allow teams to compete in equality of conditions by eliminating all hardware-dependent variables. Therefore, modifications and alterations to the robots are strictly forbidden; including, but not limited to attaching, connecting, plugging, gluing, and taping components into and onto the robot, as well as modifying or altering the robot structure. Voiding this rule leads to immediate disqualification from the competition and penalty for the team (see Section 3.9.2).

During the *Robot Inspection* test (see Section 4.4), the TC will verify that the robot is in proper state for the competition; presenting no alterations and a neat condition. EC and TC members may request re-inspection of a SPL robot at any time during the competition.

Clothing, coloring, and stickers: Robots are allowed to “wear” clothes, as well as have stickers (e.g., a sticker exhibiting the logo of an sponsor). Painting the robot with another color or design is also allowed. However, artificial markers (e.g. bar codes, QR codes, OpenCV markers) are strictly forbidden. Teams should contact the robot provider before altering the robot’s appearance.

3.4.4 Robot Specifications for the Open Platform League

Robots competing in the RoboCup@Home Open Platform League must comply with security specifications in order to avoid causing any harm while operating in human environments.

Size and weight of robots

1. **Dimensions:** The dimensions of a robot should not exceed the limits of an average door, which is 200 cm by 70 cm in most countries.
The TC may allow the qualification and registration of larger robots, but due to the international character of the competition it cannot be guaranteed that the robots can actually enter the arena. In case of doubt, contact the local organization.
2. **Weight:** There is no specific weight restriction. However, the weight of the robot and the pressure it exerts on the floor should not exceed local regulations for the construction of buildings which are used for living and/or offices in the country where the competitions is being held.
3. **Transportation:** Team members are responsible for quickly moving the robot out of the arena. If the robot cannot move by itself (for any reason), the team members must be able to transport the robot away with an easy and fast procedure.

Emergency stop button

1. **Accessibility and visibility:** Every robot has to provide an easily accessible and visible *emergency stop* button.
2. **Color:** It must be coloured red, and be the only red button on the robot. The TC may ask the team to tape over or remove any other red button present in the robot.
3. **Robot behavior:** When the *emergency stop* button is pressed, the robot and all its parts must stop moving immediately.
4. **Inspection:** The emergency stop button is tested during the *Robot Inspection* test (see Section 4.4).

Start button

1. **Requirements:** As stated in Section 3.7.8, teams that aren't able to carry out the default start signal (opening the door) have to provide a *start button* that can be used to start tests. Teams need to announce this to the TC before every test that involves a start signal, including *Robot Inspection*.
2. **Definition:** The start button can be any “one-button procedure” that can be easily executed by a referee (e.g. releasing of the *emergency button* (Section 3.4.4), a green button, or a software button in a Graphical User Interface).
3. **Inspection:** The start button is tested during the the *Robot Inspection* test (see Section 4.4).

Appearance

Open Platform Robots should have a neat appearance that resembles more a safe and finished product than an early stage prototype, paying special attention in completely cover the robot's

internal hardware (electronics and cables) in an appealing way. Although covering the robot's internal hardware with a T-Shirt is not forbidden (for now) it is strongly unadvised.

3.5 External devices

Everything which 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 *Technical Committee* (TC) specifies whether an external device can be used freely, under referee supervision, and its impact on scoring. In general, external devices must be removed quickly after the test.

Remark: The use of *wireless devices* is strictly prohibited. *External microphones*, hand microphones, and headsets are not allowed in OPL and its use is discouraged in DSPL and SSPL.

3.5.1 On-site external computing

Computing resources that are not physical attached to the robot are considered *external computing resources*. The use of up to 5 external computing resources is allowed, but only through the arena network (see Section 3.3.10) and with the previous approval of the *Technical Committee* (TC). Teams must announce the use of any external computing resource at least 1 month before the competition to the *Technical Committee* (TC).

External Computing Devices must be placed in the *External Computing Resource Area* (ECRA) which is announced by the *Technical Committee* (TC) during setup days. A switch connected to the arena wireless network will be available to teams in the ECRA. It is strictly forbidden to connect any kind of device or peripheral (e.g. screens, mouses, keyboards, etc.) to the computers in the ECRA during the competition.

A maximum of two laptops and two people from different teams is allowed at any time in the ECRA. Teams using laptops as External Computing Devices must remove the device immediately after the test. Once a test has started, all people must stay at least 1 meter from the ECRA. Interacting with computers in the ECRA after the Referee has given the start signal will cause the immediate disqualification of the team.

Remark: Robot operation must be able to operate safely when *external computing resources* are unavailable.

3.5.2 On-line external computing

Robots are allowed to use “Cloud services”, “Internet API’s”, and any other type of *external computing resource*. Same restrictions for on-site external computing resources apply.

Remark: The competition organization doesn't guarantee or take any responsibility regarding the availability or reliability of neither the network nor Internet connection. Teams' use of external computing resources is at their own risk.

3.5.3 Official Standard Laptop for DSPL

In the Domestic Standard Platform League, teams must use the *Official Standard Laptop* (OSL) connected to the Toyota HSR via Ethernet cable, safely located in the TOYOTA HSR *Mounting Bracket* provided by TOYOTA for this purpose.

Any laptop fitting inside the TOYOTA HSR *Mounting Bracket* is allowed, regardless of its technical specification. All competing robots must have mounted an OSL, whether they use it or not, so all TOYOTA HSRs have the same load restrictions.

3.5.4 Authorized add-ons for DSPL

In the Domestic Standard Platform League, teams are allowed to attach the following devices to either the Toyota HSR or the *OSL*.

- One USB audio-output device such as:
 - USB power speaker.
 - Sound card (dongle).
- One USB-powered IEEE 802.11ac (or newer) compliant device (Wi-Fi adapter).
- One USB-powered IEEE 802.3ab (or newer) compliant device (Gigabit Ethernet Switch).

In all cases, the number of attached devices can never be more than three, and the sum of the linear dimensions of each device is limited to 15cm, except for the speaker which is limited up to 30cm.

Devices attached to the *OSL* must fit inside the TOYOTA HSR *Mounting Bracket* and not increase the dimensions of the robot. For this purpose, using short cables (no longer than 20cm) and attaching the device to the OSL is advised. We encourage teams to conceal such devices between the robot and the OSL.

Remark: Please mind the appearance of the robots. Hanging wires and taped devices (e.g. duct-tape) are **NOT** allowed.

3.6 Organization of the competition

3.6.1 Stage system

The competition features a *stage system*. It is organized in two stages each consisting of a number of specific tasks. It ends with the *Finals*.

1. **Robot Inspection:** For security, robots are inspected during setup days. A robot must pass *Robot Inspection* test (see Section 4.4) in order to compete.
2. **Stage I:** The first days of the competition called *Stage I*. All qualified teams can participate in *Stage I*. The same task can be performed multiple times (See Section 3.6.3).
3. **Stage II:** The best 50% of teams³(after Stage I) advance to *Stage II*. Here, tasks require more complex abilities or combinations of abilities.
4. **Final demonstration:** The best *two teams* of each league, the ones with the highest score after Stage II, advance to the final round. The final round features only a single task integrating all tested abilities. In order to participate in the Finals, a team must have solved at least one task of the Stage II.

³If the total number of teams is less than 12, up to 6 teams may advance to Stage II

In case of having no considerable score deviation between a team advancing to the next stage and a team dropping out, the TC may announce additional teams advancing to the next stage.

Each *stage* comprehends a set of tasks grouped in two thematic scenarios. The *Housekeeper* scenario features tasks related to cleaning, organizing, and maintenance. The *Party Host* scenario focuses on providing general assistance during a party by attending the needs of the guests.

3.6.2 Schedule

1. **Thematic scenario blocks:** Two blocks are scheduled per day, lasting between two and three hours. All teams have assigned at least 2 *testing slots* per block in which they can test any *task* of their choice from the block's assigned scenario.
2. **Slots:** In principle, all teams get the same amount of *testing slots* with a minimum of 2 per block. If there is sufficient unoccupied remaining time for all the teams in a league, a referee can open an extra testing slot, allowing an extra run for all.
3. **Tests:** Teams must inform the OC in advance which tasks will be tested in each block. Only one task can be attempted per test slot.
4. **Participation is default:** Teams have to indicate to the *Organizing Committee* (OC) when they are *skipping* a testing slot. Without such indication, they may receive a penalty when not attending (see Section 3.9.1).

	Day 1	Day 2	Day 3	Day 4
Block 1 (9:00–12:00)	Housekeeper Test slot 1, team i Test slot 2, team j ⋮ Test slot n, team i	Housekeeper Party Host	Restaurant	
	Lunch			Finals
Block 2 (14:00–17:00)	Party Host Test slot 1, team i Test slot 2, team k ⋮ Test slot n, team i	Party Host	Housekeeper	
	Stage 1	Stage 2		

Table 3.2: Example schedule. Each team has assigned at least two test slots in every block. At least two blocks are scheduled per day with an assigned theme. A team can choose a different task in each test, meaning at least 4 different tests per stage.

Remark: The *Organizing Committee* (OC) announces the schedule during the setup days (see Table 3.2).

3.6.3 Score system

Each task has a main objective and a set of scoring bonuses. To score in a test, a team must successfully accomplish the main objective of the task; bonuses are not considered otherwise. Overall scoring is calculated as the sum of the maximum score obtained in each ability.

The *score system* (h)as the following constrains

1. **Stage I:** The maximum total score per task in *Stage I* is *1000 points*.
2. **Stage II:** The maximum total score per task in *Stage I* is *2000 points*.
3. **Finals:** Final score is normalized and a special evaluation is used.
4. **Minimum score:** The minimum total score per test in *Stage I* and *Stage II* is *0 points*. Teams cannot receive negative points.
5. **Penalties:** An exception to *minimum score* rule are penalties. Both penalties for not attending (see Section 3.9.1) and extraordinary penalties (see Section 3.9.2) can cause a total negative score.

3.7 Procedure during Tests

3.7.1 Safety First!

1. **Emergency Stop:** At any time when operating the robot inside and outside the scenario the owners have to stop the robot immediately if there is a remote possibility of dangerous behavior towards people and/or objects.
2. **Stopping on request:** If a referee, member of the Technical or Organizational committee, an Executive or Trustee of the federation tells the team to stop the robot, there will be no discussion and the robot has to be stopped *immediately*.
3. **Penalties:** If the team does not comply, the team and its members will be excluded from the ongoing competition immediately by a decision of the RoboCup@Home *Technical Committee* (TC). Furthermore, the team and its members may be banned from future competitions for a period not less than a year by a decision of the RoboCup Federation Trustee Board.

3.7.2 Maximum number of team members

1. **Regular Tests:** During a regular test, the maximum number of team members allowed inside the arena is *one* (1). Exceptions are tests that explicitly require volunteer assistance.
2. **Setup:** During the setup of a test, the number of team members inside the arena is not limited.
3. **Open Demonstrations:** During the *final demonstration* (Finals), the number of team members inside the arena is not limited.
4. **Moderation:** During a regular test, one team member *must* be available to host and comment the test (see Section 3.7.13).

3.7.3 Fair play

Fair Play and cooperative behavior is expected from all teams during the entire competition, in particular:

- while evaluating other teams,
- while refereeing, and
- when having to interact with other teams' robots.

This also includes:

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

Disregard of this rule can lead to penalties in the form of negative scores, disqualification for a test, or even for the entire competition.

3.7.4 Expected Robot's Behavior

Unless stated otherwise, it is expected that the robot always behave and react in the same way a polite and friendly human being would do. This applies also to how robots try solve the assigned task. As rule of thumb, one may ask any non-scientist how she would solve the task.

Please consider that average users will not know the specific procedure to operate a robot. Hence, interaction should be as with any other human being.

3.7.5 Robot Autonomy and Remote Control

1. **No touching:** During a test, the participants are not allowed to make contact with the robot(s), unless it is in a “natural” way and 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 also includes pressing buttons, or influencing sensors on purpose.
5. **Penalties:** Disregard of these rules will lead to disqualification for a test or for the entire competition.

3.7.6 Collisions

1. **Touching:** Gently *touching* objects is tolerated but unadvised. However, robots are not allowed to crash with something. The “safety first” rule (Section 3.7.1) overrides any other rule.
2. **Major collisions:** If a robot crushes into something during a test, the robot is immediately stopped. Additional penalties may apply.
3. **Functional touching:** Robots are allowed to apply pressure on objects, push away furniture and, in general, interact with the environment using structural parts other than their manipulators. This is known as *functional touching* (.). However, the robot must clearly announce the collision-like interaction and kindly request not being stopped.
Remark: Referees can (and will) immediately stop a robot in case of suspicion of *dangerous* behavior.
4. **Robot-Robot avoidance:** If two robots encounter each other, they both have to actively try to avoid the other robot.
 - 4.1. A robot which is not going for a different route within a reasonable amount of time (e.g., 30 s) is removed.
 - 4.2. A non-moving robot blocking the path of another robot for longer than a reasonable amount of time (e.g., 30 s) is removed.

3.7.7 Removal of robots

Robots not obeying the rules are stopped and removed from the arena.

1. It is the decision of the referees and the TC member monitoring the test if and when to remove a robot.
2. When told to do so by the referees or the TC member monitoring the test, the team has to immediately stop the robot, and remove it from the arena without disturbing the ongoing test.

3.7.8 Start signal

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

1. **Door opening:** The robot is waiting behind the door, outside the arena and accompanied by a team member. The test starts when a referee (not a team member) opens the door.
2. **Start button:** If the robot is not able to automatically start after the door is open, the team may start the robot using a start button.
 - 2.1. It must be a physical button on the robot (e.g. a dedicated one or releasing the eStop).
 - 2.2. It is allowed to use the robot's contact/pressure sensors (e.g. pushing the head or an arm joint).
 - 2.3. Using a start button needs to be announced to the referees before the test starts.
 - 2.4. There may be penalties for using a start button in some tests
3. **Ad-hoc start signal:** Other means of triggering robot to action are allowed but must be approved by the *Technical Committee* (TC) during the Robot Inspection (see Section 4.4). These include:
 - QR Codes
 - Verbal instructions
 - Custom HRI interfaces (apps, software, etc.)

Remark: There may be penalties for using Ad-hoc start signals in some tests. The use of mouses, keyboards, and devices attached to ECRA computers is strictly forbidden.

3.7.9 Entering and leaving the arena

1. **Start position:** Unless stated otherwise, the robot starts outside of the arena.
2. **Entering:** The robot has to autonomously enter the arena.
3. **Success:** The robot is said to *have entered* when the door used to enter can be closed again, and the robot is not blocking the passage.

3.7.10 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 TC member monitoring the test. Gestures should not involve more than the movement of both arms. This includes e.g. 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 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 additionally guide the operator, e.g., tell the operator to come closer, speak louder, or to 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.

3.7.11 Referees

All tests are monitored by a referee and one member of the *Technical Committee* (TC). The following rules apply:

1. **Selection:**
 - Referees are chosen by EC/TC/OC.
 - Referees are announced together with the schedule for the test slot.
2. **Not showing up:** Not showing up for refereeing (on time) will result in a penalty (see Section 3.9.2).
3. **TC monitoring:** A TC member acts as main referee.
4. **Referee instructions:** Right before each test, referee instructions are conducted by the TC. The referees for all slots need to be present at the arena where the referee instructions are taking place. When and where referee instructions are taking place is announced together with the schedule for the slots.

3.7.12 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. Penalty may apply when using a custom operator.

3.7.13 Moderator

The LOC is responsible of organizing test moderation in the local language. The OC may request the participating teams to provide a team member for moderation. Candidates have to be fluent in the moderation language (default is English).

Responsibilities: The moderators have to:

- Do **NOT interfere** with the performance
- Explain the tasks being performed
- Comment on the performance of the competitor

- Follow the instructions of the referee.

Not showing up: Not showing up for moderation (on time) will result in a penalty (see Section 3.9.2).

3.7.14 Time limits

1. **Stage I:** Unless stated otherwise, the time limit for each test in *Stage I* is *5 minutes*.
2. **Stage II:** Unless stated otherwise, the time limit for each test in *Stage II* is *10 minutes*.
3. **Inactivity:** Robots are not allowed to stand still or get stuck into endless loops. A robot not progressing in the task execution (and obviously not trying to), is consider as inactive. Robots must be removed after 30 seconds of inactivity.
4. **Requesting time:** A robot (not the team) can request referees to make exception from the 30-seconds inactivity time limit. In its request, the robot has to clearly state for how long it will be performing a time-consuming process (e.g. 60 seconds). This time cannot exceed 3 minutes and cannot be used more than once per test.
5. **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 former team.
6. **Time-up:** When the time is up, the team has to immediately remove their robot(s) from the arena. No more additional score will be giving.
7. **Show must go on:** On special cases, the referee may let the robot continue the test for demonstration purposes, but no additional points will be scored.

3.7.15 Restart

Some tasks allow a single restart, a procedure in which the team is allowed to quickly fix any issue with the robot. Restarts can be requested only when the test slot permits it, and when the amount of remaining time is greater than 50% of the total. The procedure is as follows:

1. The team request a restart.
2. The robot is taken to the initial position (e.g. outside the arena) and gets fixed.
3. When the robot is ready, the team informs the referee.

The following rules apply:

1. **Number of restarts:** When allowed, the maximum number of restarts is one (1).
2. **Early request:** Restart is **NOT** allowed after the first 50% of the allotted time has elapsed.
3. **Time:** The timer is neither restarted nor stopped.
4. **One-minute Setup** The team has 1 minute to fix the robot counting when the referee announces th restart. If the robot is not ready, the test is considered finished.
5. **Scoring:** If the score of the second attempt is lower than the score of the first one, the average score of first and second run is taken.

3.8 Deus ex Machina: Bypassing features with human help

Because the show must go on

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

3.8.1 Procedure

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

1. **Request help:** The robot must indicate loud and clear that it requires human assistance. It must be clearly stated:
 - The nature of the assistance
 - The particular goal or desired result
 - How the action must be carried out (when necessary)
 - Details about how to interact with the robot (when necessary)
2. **Supervise:** The robot must be aware of the human's actions, being able to tell when the requested action has been completed, as well as guiding the human assistant (if necessary) during the process.
3. **Acknowledge:** The robot must politely thank the human for the assistance provided.

Example

In this example the robot has to clean the table but is unable to grasp the spoon.

R: I am sorry but the spoon is too small for me to take.
 Could you please help me with it?
 Please say "robot yes" or "robot no" to confirm.
 H: *Robot, yes!*
 R: Thank you! Please follow my instructions.
 Please take the purple spoon from the table. It is on my left.
 H: (Referee takes green fork)
 R: You took the wrong object.
 Please take the purple spoon from the table. It is on my left.
 H: (Referee takes purple spoon)
 R: I saw you took the spoon.
 Would you be so kind of following me to the kitchen?
 Please keep the spoon visible in front of you so I can track you. Thank you!
 R: You can stop following me now.
 As you can see, the dishwasher is already open.
 Please place the spoon in the gray basket on the lower tray.
 R: Lovely! Thanks for your help human.
 I'll let you know if I need further assistance.

3.8.2 Scoring

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

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

3.8.3 Bypassing Automatic Speech Recognition

Giving commands to the robot is essential in many tests. When the robot is not able to receive spoken commands, teams are allowed to provide means to bypass ASR via an Alternative method for HRI (see Section 3.8.3). Nonetheless, Automatic Speech Recognition is preferred.

The following rules apply in addition to the ones specified in section Section 3.8.2

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. **QR Codes:** A reduction of 30% of the maximum attainable score is applied when a QR code is used to instruct the robot.
5. **Alternative Input Method:** A reduction of up to 30% of the maximum attainable score is applied when a *alternative HRI interface*, is used to instruct the robot. Alternative HRI interfaces (see Section 3.8.3) must be previously approved by the TC during the Robot Inspection (see Section 4.4).

Alternative interfaces for HRI

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

- **Intuitive to use and self-explanatory:** a manual should not be needed. Teams are not allowed to explain how to interface with the robot.
- **Effortless use:** Must be as easy to use as uttering a command.

- **Is smart and preemptive:** The interface adapts to the user input, displaying only the options that make sense or that the robot can actually perform.
- Exploits the best of the device being used (eg. touch screen, display area, speakers, etc.)

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

Award: The best alternative is awarded the Best Human-Robot Interface award (Section 1.7.2).

3.9 Special penalties and bonuses

3.9.1 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 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 starts, the team is not allowed to participate in the test anymore. If the team has not announced that it is not going to participate, it gets a penalty of *250 points*.

3.9.2 Extraordinary penalties

1. **Penalty for cheating:** If a team member is found cheating or breaking the Fair Play rule (see Section 3.7.3), the team will be automatically disqualified of the running test, and a penalty of *500 points* is handed out. The *Technical Committee* (TC) may also disqualify the team for the entire competition.
2. **Penalty for faking robots:** If a team starts a test, but it does not solve any of the partial tasks (and is obviously not trying to do so), a penalty of *250 points* is handed out. The decision is made by the referees and the monitoring TC member.
3. **Extra penalty for collision:** In case of major, (grossly) negligent collisions the *Technical Committee* (TC) may disqualify the team for a test (the team receives *0 points*), or for the entire competition.
4. **Not showing up as referee or jury member:** If a team does not provide a referee or jury member (being at the arena on time), the team receives a penalty of *250 points*, and will be remembered for qualification decisions in future competitions.
Jury members missing a performance to evaluate are excluded from the jury, and the team is disqualified from the test (receives *0 points*).
5. **Modifying or altering standard platform robots:** If any unauthorized modification is found on a Standard Platform League robot, the responsible team will be immediately disqualified for the entire competition while also receiving a penalty of *500 points* in the overall score. This behavior will be remembered for qualification decisions in future competitions.

3.9.3 Bonus for outstanding performance

1. For every regular test in *Stage I* and *Stage II*, 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 thinks that it deserves this bonus, it should announce (and briefly explain) this to the *Technical Committee* (TC) beforehand.
4. It is the decision of the *Technical Committee* (TC) if (and to which degree) the bonus score is granted.

3.10 General Instructions for Organizing Committee

Although there are instructions for the OC are specified per test, there are several aspects that the OC requires to carry out for competition in general:

During competition:

- Provide TC and referees with scoring sheets, pens, clipboards, stopwatches and other material relevant of carrying out the scoring.
- Post time schedules in the allotted spaces for the team's knowledge.

1h before each test:

- Organize referees.

Chapter 4

Setup and Preparation

Prior to the RoboCup@Home competition, all arriving teams will have the opportunity to setup 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, i.e., when the venue opens and the teams arrive. During the setup phase, teams can assemble and test their robots. On the last setup day, a *welcome reception* will be held. To foster the knowledge exchange between teams a conference-like *poster session* takes place during the reception. All teams have to get their robots inspected by members of the TC to be allowed to participate in the competition.

Regular tests are not conducted during setup & preparation. The competition starts with Stage I (see Section 5).

Table 4.1: Stage System and Schedule per League (distribution of tests and stages over days may vary)

Setup & Preparation	Stage I	Stage II	Finals
	<i>advance</i> →	<i>advance</i> →	<i>advance</i> →
	All teams that passed Inspection	Best 10 (< 6) or best 50% (≥ 12)	Best 2 teams

4.1 General Setup

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

1. **Start:** Setup & Preparation starts when the venue opens for the first time.
2. **Intention:** During Setup & Preparation, teams arrive, bring or receive their robots, and assemble and test them.
3. **Tables:** The local organization will setup and randomly assign team tables.
4. **Groups:** Depending on the number of teams, the *Organizing Committee* (OC) may form multiple groups of teams (usually two) for the first (and second stage). The OC will assign teams to groups and announce the assignment to the teams.
5. **Arena:** The arena is available to all teams during Setup & Preparation. The 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 last works are 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 3.3.5). Note, however, that the objects may not be available at all times and not from the beginning of Setup & Preparation.

4.2 Welcome Reception

Traditionally –since Eindhoven 2013– the RoboCup@Home holds an own *welcome reception* in addition to the official opening ceremony. During the welcome reception, a *poster session* is held in which teams present their research foci 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 RoboCup@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 & poster session including
 - 4.1. organizing poster stands (one per team) or alternative to present the posters,
 - 4.2. organizing the snacks and drinks,
 - 4.3. inviting officials, sponsors, local organization and the trustees of the RoboCup Federation to the event.
5. **Poster presentation:** During the welcome reception, the teams give a poster presentation on their research focus, recent results, and their scientific contribution. Both the poster and the teaser talk are evaluated by a jury (see Section 4.3).

4.3 Poster Teaser Session

Before the welcome reception & poster session, a *poster teaser session* is held. In this teaser session, each team can give a short presentation of their research and the poster being presented at the poster session.

4.3.1 Poster teaser session

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

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

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

- 7. **Sheet collection:** Evaluation sheets are collected by the OC at a later time (announced beforehand by the OC), allowing teams to continue knowledge exchange during the first days of the competition (Stage I).
- 8. **OC Instructions:**
 - Prepare and distribute evaluation sheets (before the poster teaser session.)
 - Collect evaluation sheets.
 - Organize and manage the poster teaser presentations and the poster session.

4.4 Robot Inspection

Safety is the most important issue when interacting with humans and operating in the same physical workspace. Because of that all participating robots are inspected before participating in RoboCup@Home. Every team needs to get its robot(s) inspected and approved for participation.

- 1. **Procedure:** The *robot inspection* is conducted like a regular test, i.e., starts with the opening of the door (see Section 3.7.8). One team after another (and one robot after another) has to enter the arena through a designated entrance door, move to the *examination point*, and leave the arena through the designated exit door. In between entering and leaving the robot is inspected.
- 2. **Inspectors:** The robots are inspected by the *Technical Committee* (TC).
- 3. **Checked aspects:** It is checked if the robots comply with the rules (see Section 3.4), checking 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 3.8.3).
 - **Standard Platform robots**
 - Neat appearance
 - No modifications have been made
 - Specifications of the *Official Standard Laptop* (OSL) (if required)
 - **Open Platform robots**
 - robot speed and dimension

- start button (if the team is going to require it)
 - robot speaker system (plug for RF Transmission)
 - other safety issues (duct tape, hanging cables, sharp edges etc.)
4. **Re-inspection:** If the robot is not approved in the inspection, it is the responsibility of the team to get the approval (later). Robots are not allowed to participate in any test before passing the inspection by the TC.
 5. **Time limit:** The robot inspection is interrupted after three minutes (per robot). When told to 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.
 6. **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.
 7. **Accompanying team member:** Each robot is accompanied by only one team member (team leader is advised).
 8. **OC instructions (at least 2h before the Robot Inspection):**
 - Announce the entry and exit doors.
 - Announce the location of the *examination point* into the arena.
 - Specify and announce where and when the poster teaser and the poster presentation session take place.
 - Prepare and distribute poster session evaluation sheets.

Chapter 5

Tests in Stage I

Housekeeper tasks

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Party Host tasks

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5.1 Carry My Luggage [Party Host]

The robot helps the operator to carry some luggage to the car which is parked outside.

Main Goal

The robot helps the operator to carry a bag to the car parked outside.

Reward: 500pts.

Bonus rewards

1. Reentering the arena (100 pts).
2. Avoid all obstacles (400 pts, 100pts per obstacle).

Setup

- **Location:** The test takes place inside and outside the arena.
- **Start Location:** The robot starts at a predefined location in the living room.
- **Bags:** At least two bags are placed between nearby the operator (within 2m distance and visible to the robot).
- **Operator:** The operator is standing in front of the robot pointing at the bag to be carried out.

Additional rules and remarks

1. **Deus ex Machina:** Score reduction for requesting human assistance is applied as follows.
 - Handing-over the bag (-100 pts).
 - Finding the operator while following her
 - Natural interaction (e.g. wave and calling) 100pts score reduction.
 - Non-natural interaction (e.g. raising both hands and jumping) 200pts score reduction.
 - Touching the robot (e.g. pulling the robot's hand) 400pts score reduction.
2. **Obstacles:** The robot will face 4 obstacles along its way in any order: (a) a crowd obstructing path, (b) a small object on the ground, (c) a hard-to-see 3D object, and (d) a small area blocked using retractable barriers.
3. **Car Location:** There is no car outside. Instead, a fixed location is supposed as a car location outside the arena.
4. **Reaching the Car:** The robot can reach the car's location only by following the operator.
5. **Following the Operator:** The robot should indicate the operator when it is ready to follow. The operator walks naturally towards the car. After reaching the car, the operator takes the bag back from the robot and thanks the robot.

Referee instructions

The referees need to

- Select one volunteer as the operator.
- Select three to four people to obstruct robot's path outside.

- Choose bags' positions and assign a bag to the operator.
- Choose which obstacles the robot will face outside while following the operator.
- Choose the car's location.
- Mind the robot when it goes outside the arena.

OC instructions

2h before test:

- Select and announce the robot's starting point.
- Select which bags will be used.

Score sheet

The maximum time for this test is 5 minutes.

Action	Score
<i>Main Goal</i>	
Take the bag to the car	500
Hand-over the bag	-200
Regain operator's track by natural interaction	5×-100
Regain operator's track by non-natural interaction	5×-200
Regain operator's track by direct contact	5×-400
<i>Bonus rewards</i>	
Reentering the arena	100
Avoid the crowd obstructing path	100
Avoid the small object on the ground	100
Avoid the hard-to-see 3D object	100
Avoid the area blocked with retractable barriers	100
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	100
Total score (excluding penalties and standard bonuses)	1000

5.2 Clean Up [Housekeeper]

Inside one room in the arena are some misplaced objects. The robot has to tidy up that room, throwing to the garbage the unrecognized ones.

Main Goal

Find all misplaced objects in a room and bring them to their predefined locations.

Reward: 500pts (100pts per object).

Bonus Rewards

1. Opening the entrance door autonomously (200pts)
2. Moving a *tiny* object (150pts)
3. Moving a *heavy* object (150pts)

Setup

- **Location:** A random room in the arena.
- **Instruction:** Nearby the entrance, an operator tells the robot which room to clean.
- **Objects:** There are 5–10 misplaced objects at random locations in the room.

Additional Rules and Remarks

1. **Objects:** Objects can be anywhere, including the floor, seats, and on furniture. All objects are clearly visible (i.e. no occlusions) and can be:
 - *Known objects:* Regular and alike objects.
 - *Unknown objects:* Garbage lying around at grasping distance (2–3 objects).
2. **Deus ex Machina:** Score reduction for requesting human assistance is applied per object as follows:
 - Telling the robot where an object can be found causes a reduction of 30% in scoring for that particular object.
 - Pointing at an object to be picked up causes a reduction of 40% in scoring for that particular object.
 - Guiding the robot nearby the location where an object can be found causes a reduction of 20% in scoring for that particular object.
 - Telling the robot where the object should be placed or the object's category causes a reduction of 30% in scoring for that particular object.
 - Having a human physically interacting with an object causes a reduction of 60% in scoring for that particular object.
3. **Heavy and tiny objects:** Objects used in this test are lightweight and average-sized. The team leader can, however, request a tiny and a heavy object to be used and score additional points for picking them.
4. **Bin:** Objects must be placed inside the bin, not thrown or dropped.

Referee instructions

The referee needs to

- Place the objects in the room.
- Recover disposed objects from the bin.
- Ask teams whether they want a heavy or tiny object.

OC instructions

2 hours before the test:

- Announce the starting location of the robot.

Score sheet

The maximum time for this test is 5 minutes.

Action	Score
<i>Main Goal</i>	
Place an object at the appropriate location	5×100
Receiving human help (telling where an object can be found)	5×-30
Receiving human help (pointing out object to be moved)	5×-40
Receiving human help (Guiding the robot near an object to be moved)	5×-20
Receiving human help (telling robot which category an object is or where to place it)	5×-30
Receiving human help (physically interacting with object)	5×-60
<i>Bonus rewards</i>	
Opening entrance door without human help	200
Moving a <i>tiny</i> object	150
Moving a <i>heavy</i> object	150
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	100
<hr/>	
Total score (excluding penalties and standard bonuses)	1000

5.3 General Purpose Service Robot [Housekeeper]

Similar to a modern smart-speaker, the robot can be asked to do anything from the Stage I of this rulebook or any previous rulebook.

Main Goal

Execute each of the 3 commands requested by the operator.

Reward: 750pts (250 points per command)

Bonus rewards

1. Understand a command given by naive operator (50pts, each).
2. Provide audio recording and transcript (100pts each).
3. Autonomously leaving the arena (150pts).

Setup

1. **Location:** The task takes place inside the arena (some commands might require the robot to go out). The arena is in its normal state.
2. **Start location:** The robot starts outside the arena. When the door opens, the robot moves towards the *Instruction Point*.
3. **Operators:** A *professional operator* (i.e. the referee) commands the robot to execute a task.

Additional rules and remarks

1. **Command Generator:** Tasks will be generated using the official *GPSR Command Generator* available 2 months prior to the competition in the official repository.
2. **Naive Operators:** Optionally, commands can be issued by a *Naive Operator*, i.e. a person from the audience with no background on robotics. The referee gives the command to the *Naive Operator*, who will then issue it to the robot (rephrasing is allowed). If the robot consistently fails to understand the naive operator (e.g. 3 times or more), teams can default to a custom operator.

Remark: Referees are not allowed to instruct naive operators on how to operate the robot. **Teams attempting to instruct or bias the operator will be disqualified.**

3. **Data Recording:** Only when using Naive Operators, a team can get an additional scoring bonus by providing the recording and transcript of the issued commands.
4. **Deus ex Machina:** Score reduction applies per given command as follows:
 - **Custom operator:** Providing a custom operator causes 50pts score reduction.
 - **Further assistance:** Helping a robot to accomplish a task causes 50–200pts score reduction, based on referee criterion.
 - **Bypassing commands:** A robot instructing a human assistant on how to accomplish the whole task receives no points for the command.

5. **Instruction Point:** At the beginning of the test, and after finishing the first and second command, the robot moves to the *Instruction Point*.
6. **Leaving the arena:** A bonus scoring of 150pts can be earned if the robot autonomously leaves the arena after successfully executing all three given commands.

OC instructions

2 hours before the test

- Pre-generate and conceal commands for the robots.
- Announce the location of the instruction point.
- Recruit volunteers to assist during the test.

During the test

- Rearrange the arena to its normal condition.

Referee instructions

- Provide the commands to the operators.

Score sheet

The maximum time for this test is 5 minutes.

Action	Score
<i>Main Goal</i>	
Perform each task	3×250
Using custom operator or bypassing ASR	3×-50
<i>Bonus rewards</i>	
Understand command given by naive operator	3×100
Provide audio recording and transcript	3×100
Autonomously leaving the arena	150
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	150
<hr/>	
Total score (excluding penalties and standard bonuses)	1500

5.4 Receptionist [Party Host]

The robot has to take two new guests to the living room to introduce them and offer a free place to sit.

Main Goal

Introduce and usher two newcomers to a party.

Reward: 500pts (250pts per guest).

Bonus rewards

1. Opening the entrance door to a guest (200pts each)
2. Describe the first guest to the second guest (100pts)

Setup

- **Location:** The test takes place in the living room.
- **John:** John is already known to the robot and is sitting in the living room.
- **Start Location:** The robot starts inside the arena at a predefined location near the entrance door.

Additional rules and remarks

1. **Deus ex Machina:** Score reduction for requesting human assistance is applied per guest.
2. **Guests:** Each guest has a predefined name and favorite drink. At least one guest is female.
3. **Repeating names:** The robot may ask to repeat the name if it has not understood it.
4. **Misunderstood names:** If the robot misunderstands the name and continues, the wrongly understood name is used in the remainder of the test. A score reduction of 50pts is applied.
5. **Entrance:** The entrance door is open by default. The team leader can request to close the door for the robot to score additional points by opening it for the guests.
6. **Meeting guests:** An arriving guest will step in front of the robot when the door is open or knock on the closed door. The robot can ask the operator to tell when someone is at the door. Upon meeting the guest the robot can ask for their name and favorite drink.
7. **Describing the first guest:** The robot can earn bonus points by describing the first guest to the second one. At least 4 characteristics have to be named, i.e. color of clothes, color of hair, gender, age.
8. **Introducing guests:** When introducing guests, the robot must point out the person who is being introduced, stating her name and favorite drink. It must be clear to the persons who the robot is referring to. Introducing two people always means to introduce them to each other.
9. **Sitting people:** The robot must point at a place or location where the guest can sit.
10. **Switching places:** Every time a new guest arrives, people in the living room change places.

Referee instructions

The referees need to

- Assign name and drink to 3 volunteers.
- Arrange (and re-arrange) people in the living room.
- Ask team leader whether to close the door.

OC instructions

2h before test:

- Announce starting position.
- Select and announce a volunteer as *John* and their favorite drink.

Score sheet

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

Action	Score
<i>Main Goal</i>	
Introduce the 1st guest to John	100
Offer an empty seat to the 1st guest	150
Introduce the 2nd guest to John and 1st guest	100
Offer an empty seat to the 2nd guest	150
Misunderstanding the name of a guest	2×−50
<i>Bonus rewards</i>	
Opening the entrance door to a guest	2×200
Describing the first guest to the second guest	100
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	−500
Using start button (see sec. 3.4.4)	−100
Outstanding performance (see sec. 3.9.3)	100
<hr/>	
Total score (excluding penalties and standard bonuses)	1000

5.5 Storing Groceries [Housekeeper]

The robot stores groceries into a pantry shelf while paying attention to sorting objects in their appropriate place, i.e. storing an apple next to other fruits.

Main Goal

Move objects 5 from a table into a shelf, grouping them by category or similarity.

Reward: 500pts (100pts per object).

Bonus rewards

1. Opening the shelf door (300pts)
2. Moving a *tiny* object (100pts)
3. Moving a *heavy* object (100pts)

Setup

1. **Location:** The testing area has a shelf and a table nearby.
2. **Shelf:** The shelf contains objects arranged in groups either by category or likeliness.
3. **Shelf door:** The shelf door is open by default. The team leader can request the door to be closed and score additional points for opening it. If the robot fails to open the door, it must clearly state it and request the referee to open it.
4. **Objects:** Some of the objects are placed behind the door and cannot be accessed unless the door is open.
5. **Table:** The table has 5–10 objects placed on it and the robot can choose which ones to grasp and in what order. On small tables, objects will be added as the robot frees up space.

Additional rules and remarks

1. **Deus ex Machina:** Score reduction for requesting human assistance is applied per object as follows:
 - Telling or pointing out to the robot where to place an object results in a score reduction of 30pts.
2. **Table** The table's rough location will be announced beforehand, having its position either left, right, or behind the robot.

OC instructions

2 hours before the test

- Announce which table and shelf will be used in the test.
- Announce a rough location for the table.

Referee instructions

The referee needs to

- Place objects in the shelf, grouping them by likeliness.
- Open the door of the shelf.
- Place 5–10 objects on the table.

Score sheet

The maximum time for this test is 5 minutes.

Action	Score
<i>Main Goal</i>	
Move an object next to their peers in the shelf	5×100
Receiving human help (point at target location)	5×-30
Receiving human help (move object)	5×-100
<i>Bonus rewards</i>	
Opening the shelf door without human help	300
Moving a <i>tiny</i> object	100
Moving a <i>heavy</i> object	100
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	100
Total score (excluding penalties and standard bonuses)	
	1000

Chapter 6

Tests in Stage II

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6.1 Clean the Table [Housekeeper]

The robot has to remove all dishes from a table (presumably after dinner) and place them into the dishwasher.

Main Goal

All the tableware and cutlery on the table is placed inside the dishwasher.

Reward: 1000pts

Bonus rewards

1. Opening the dishwasher door (300pts)
2. Pulling out the dishwasher racks (300pts)
3. Placing the Dishwasher Tab inside the dishwasher (300pts)
4. Leaving the arena (100pts)

Setup

- **Location:** This test takes place in the arena. A dining table is located close to the dishwasher.
- **Tray:** A plastic tray is located either on top of the dishwasher, or onto one of its racks. The tray may have tableware and cutlery placed inside already.
- **Table setting:** The table has a total of 6 objects disposed in a typical setting for a meal for one person. Distribution is as follows:
 - *Silverware:* Any two objects (fork, knife, spoon).
 - *Tableware:* Any three objects, excluding silverware. At least one must be a dish.
 - *Dishwasher Tab:* One Dishwasher Tab.

Additional rules and remarks

1. **Deus ex Machina:** The following reductions apply:
 - **Handover:** Handing over an object causes a score reduction of 100pts.
 - **Showing objects:** Pointing, or telling to the robot where an object is causes a score reduction of 50pts.
 - **Placing tableware:** Having a human assistant placing tableware inside the dishwasher causes a score reduction of 200pts.
 - **Placing cutlery:** Having a human assistant placing cutlery inside the dishwasher causes a score reduction of 250pts.
2. **Safe placing:** Objects must be placed with care. It must be clear that the robot is trying to place the object, not throwing or dropping it.
3. **Dishwasher:** The team decides whether the robot will place the objects in the dishwasher's rack or in the official tray.
4. **Dishwasher door:** The dishwasher door is open and with the racks pulled out by default. The team leader can, however, request the dishwasher to be closed and score additional points for opening it. If the robot fails to open the door, it must clearly state it and request the referee to open it.

Referee instructions

The referee needs to

- Place the table setting.
- Place the tray on the dishwasher or onto the rack, as requested by the team.

OC instructions

During Setup days:

- Provide official cutlery and tableware for training.

2 hours before the test:

- Announce the predefined location to take the command.
- Announce the predefined location of the Dishwasher Tab.

Score sheet

The maximum time for this test is 10 minutes.

Action	Score
<i>Main Goal</i>	
Place all tableware and cutlery inside the dishwasher	1000
Pointing at object	5×−50
Handover an object	5×−150
Bypassing tableware storage	3×−200
Bypassing cutlery storage	2×−250
<i>Bonus rewards</i>	
Opening the dishwasher door	300
Pulling out the dishwasher racks	300
Placing the Cascade Pod inside the dishwasher	300
Pointing at the Cascade Pod	−100
Handover the Cascade Pod	−200
Autonomously leaving the arena	100
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	−500
Using start button (see sec. 3.4.4)	−100
Outstanding performance (see sec. 3.9.3)	200
Total score (excluding penalties and standard bonuses)	2000

6.2 Enhanced General Purpose Service Robot [Housekeeper]

Similar to a modern smart-speaker, the robot can be asked to do anything, in plain English, from either Stage of this and former rulebooks.

Main Goal

Execute at least one of the 3 commands requested by the operator.

Reward: 1500pts (500 points per task)

Bonus rewards

1. Attend when called (125pts).
2. Understand a command given by naive operator (150pts, each).
3. Provide audio recording and transcript (100pts each).
4. Autonomously leaving the arena (150pts).

Setup

1. **Location:** The task takes place inside the arena (some commands might require the robot to go out). The arena is in its normal state.
2. **Start location:** The robot starts outside the arena. When the door opens, the robot moves towards the *Standby Point*.
3. **Operators:** A *professional operator* (i.e. the referee) commands the robot by default.

Additional rules and remarks

1. **Partial scoring:** The main task allows partial (per *completed* command) scoring.
2. **Command Generator:** Tasks will be generated using the official *GPSR Command Generator* available 2 months prior to the competition in the official repository. Commands for EGPSR are either Stage II tasks, complex commands requiring to perform chains of subtasks in sequence, or *incomplete* commands lacking relevant information to succeed.
3. **Naive Operators:** Commands can be issued by a *Naive Operator* who receives a note-card with the summarized command from the referee and rephrases it.
Remark: Teams attempting to instruct or bias the operator will be disqualified.
4. **Custom Operator fallback:** If the robot consistently fails to understand the naive or professional operator (i.e. 3 times), the referee will request a custom operator.
5. **Data Recording:** Only when using Naive Operators, a team can get an additional scoring bonus by providing the recording and transcript of the issued commands.
6. **Deus ex Machina:** Score reduction applies per given command as follows:
 - **Custom operator:** Providing a custom operator causes 150pts score reduction.
 - **Further assistance:** Helping a robot to accomplish a task causes 50–400pts score reduction, based on referee criterion and number of bypassed subtasks.
 - **Bypassing commands:** A robot instructing a human assistant on how to accomplish the whole task receives no points for the command.

7. **Attending when called:** The robot should approach to the operator when called (e.g. by saying *Robot, I need help!*). The operator may call the robot from a different room.
8. **Robot Standby Point:** At the beginning of the test, and after finishing the first and second command, the robot moves to the *Robot Standby Point*.
9. **Leaving the arena:** A bonus scoring of 100pts can be earned if the robot autonomously leaves the arena after successfully executing all three given commands.

OC instructions

2 hours before the test

- Generate the commands and prepare the note-cards, hiding them from teams.
- Announce the location of the *Standby Point*.
- Recruit volunteers to assist during the test.

During the test

- Rearrange the arena to its normal condition.

Referee instructions

- Provide the note-cards to the operators.
- Tell the operator from where to call the robot.

Score sheet

The maximum time for this test is 10 minutes.

Action	Score
<i>Main Goal</i>	
Perform each task	3×500
Using custom operator or bypassing ASR	3×-150
<i>Bonus rewards</i>	
Understand command given by naive operator	3×150
Provide audio recording and transcript	3×100
Find the operator when called	150
Autonomously leaving the arena	100
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	250
Total score (excluding penalties and standard bonuses)	2500

6.3 Hand Me That [Party Host]

A guest at the party speaks English, but with only a limited vocabulary. The robot will assist them in obtaining things that they gesture for.

Main Goal

The robot identifies (touching or naming) each object at which the operator is pointing at.

Reward: 2500pts (500pts per object)

Setup

1. **Location:** This takes place in a room in the arena.
2. **Starting position:** The robot and the operator stand in a predefined location announced beforehand
3. **Groups of Objects:** There are five groups of 2–5 objects randomly placed along the room
4. **Deck:** The referee has a deck of objects to request, one per group, sorted by distance.

Procedure

1. **Pick an object** The robot asks the operator: *what do you need?*. Then
 - 1.1. The operator walks near to the object and points at it.
 - 1.2. The asks as many questions as necessary.
 - 1.3. The operator replies to each question (most likely with *yes*, *no*, *I don't know*, etc).

Remark: The operator does not know the name of the object.
2. **Repeat** Repeat up to 5 times for the maximum score.

Additional rules and remarks

1. **Keep going:** The robot should keep trying to determine the referred to object until they score or run out of time.
2. **Skipping groups:** The robot may say *Pass* or *I give up* to try with the next object.
3. **Incorrect guesses:** Incorrect guesses reduce the value of the correct guess by 200 points, each, the first two times. Guessing correctly on the third or fourth attempt is worth 100 points. After the fourth guess is worth no points.
4. **Colors and categories:** Asking for the color or category of a pointed object applies a penalty of 400 points for that particular object.
5. **Uneducated operator:** The referee may instruct the operator to answer *I don't understand* or *I don't know* if the robot asks complex questions or is attempting blind guessing.
6. **Groups of Objects:** A group consists of 2–5 random standard objects (see Section 3.3.5), separated one from another for about 2.5–10cm. The average distance between the starting position and each group ranges between 50cm and 150cm.

Referee instructions

The referee needs to

- Rearrange and mix groups between runs
- Verify that the operator is pointing at the right item

OC instructions

During Setup days:

- Announce the starting position of the robot.

Score sheet

The maximum time for this test is 10 minutes.

Action	Score
<i>Group 1</i>	
Name/touch the object being pointed	500
Asking clarifying question	3× -150
Incorrect guess	2× -200
<i>Group 2</i>	
Name/touch the object being pointed	500
Asking clarifying question	3× -150
Incorrect guess	2× -200
<i>Group 3</i>	
Name/touch the object being pointed	500
Asking clarifying question	3× -150
Incorrect guess	2× -200
<i>Group 4</i>	
Name/touch the object being pointed	500
Asking clarifying question	3× -150
Incorrect guess	2× -200
<i>Group 5</i>	
Name/touch the object being pointed	500
Asking clarifying question	3× -150
Incorrect guess	2× -200
<i>Special penalties & standard bonuses</i>	
Not attending (see sec. 3.9.1)	-500
Using start button (see sec. 3.4.4)	-100
Outstanding performance (see sec. 3.9.3)	250
Total score (excluding penalties and standard bonuses)	2500

6.4 Restaurant

The robot retrieves and serves orders to several customers in a real restaurant previously unknown to the robot.

Main Goal

Take and serve an order to a customer.

Reward: 500pts.

Bonus rewards

1. Detect a customer's service request: 200pts (100pts each)
2. Reach a customer's table without prior guidance/training: 200pts (100pts each)
3. Use an unattached tray to transport an order: 500pts (250pts each).

Setup

- **Location:** A real restaurant fully equipped and in business. There may be real customers and waiters around.
- **Start Location:** The robot starts next to the *Kitchen-bar*.
- **Professional clients:** There are at least three tables occupied with professional operators. At least two have orders.
- **Kitchen-bar:** A table located near the restaurant's kitchen.
- **Barman:** A *Professional Barman* (member of the TC) awaits at the other side of the *Kitchen-bar* for orders to be placed. The *Professional Barman* assists the robot on request.
- **Objects:** Objects to fulfill orders are located on the Kitchen-bar.

Procedure

1. **Placement:** The referee requests the team to move the robot to the start location.
2. **Start:** The referee gives the start signal and starts the timer. The team leaves the area (touching the robot causes immediate disqualification).
3. **Instruction:** The robot may use up to one minute to instruct the *Professional Barman*.
4. **Fetching and delivering orders:** When a customer calls the robot, it has to get close and take her order, place the order, and deliver it.

Additional rules and remarks

1. **Safety First!** This test takes place in a public area. The robot is expected to not even slightly touch anyone or anything and is immediately stopped in case of danger.
2. **Fair play:** Upon arrival to the restaurant, only the team leader is allowed next to the robot for watching and charging. Tweaking, coding, debugging, or mapping the area in place will lead to immediate disqualification.
3. **Orders:** Orders have between one and three objects randomly chosen. All edible/drinkable objects from the list of standard objects (see Section 3.3.5) are eligible to be part of the orders.

4. **Calling customers:** Customers may call the robot any time, even simultaneously. Robots can choose to take several orders and place them later on, place an order and pick the next one while the former is being served, or dispatch one order at a time.
5. **Placing orders:** By default, the barman will place the order in a basket or tray for the robot to deliver it.
6. **Delivering orders:** The robot can either transport each object individually, or using a tray. All delivered objects must be placed on the customer's table.
7. **Referees and guidance:** The robot can request to be guided to a customer's table. While guiding, a TC member follows the robot ready to press the emergency stop button.
8. **Deus ex Machina:** Score reduction for requesting human assistance is applied per order as follows.
 - Being guided to a table causes a score reduction of 200.
 - Each object handover causes a score reduction of 50pts.
 - Bypassing manipulation causes a score reduction of 100pts per object.
 - Not making *eye* contact with a customer while taking an order causes a score reduction of 100pts.
 - Being told/pointed where is a table/*Kitchen-bar* causes score reduction of 25pts.
9. **Location:** *Restaurant* takes place in a real restaurant. When this is not possible, the test can be conducted in any place with the appropriate locations other than the arena. In addition, the *Restaurant* location will remain secret until the start of the test.
10. **Power outlets, WiFi and ECRA:** The availability of wireless, external computing devices, or electrical outlets can't be guaranteed. Assume unavailability.
11. **Disturbances from outside:** If a person from the audience (severely) interferes with the robot in a way that makes it impossible to solve the task, the teams may repeat the test immediately.
12. **Instruction:** The robot interacts with the operators, NOT THE TEAM. The team is not allowed to instruct anyone. All instructions should be provided by the robot itself.

Referee instructions

The referee needs to

- Prepare orders for each client.

OC instructions

During Setup days:

- Check with local (security) management if the possible location, including a sufficient queuing area, can be used for the restaurant test.

1 hour before the test:

- Gather all teams and robots to move to some nearby queuing area and instruct the teams how/when to move to the actual test location.

Score sheet

The maximum time for this test is 15 minutes.

Action	Score
Main Goal	
Take and serve an order	500
Being guided to the <i>Kitchen-bar</i> or to a customer's table	2×−200
Not making eye-contact when taking an order	−100
Bypassing object manipulation (handover)	4×−50
Bypassing object manipulation	5×−100
Second order (bonus reward)	
Take and serve an additional order	500
Being guided to the <i>Kitchen-bar</i> or to a customer's table	2×−200
Not making eye-contact when taking an order	−100
Bypassing object manipulation (handover)	4×−50
Bypassing object manipulation	5×−100
Additional bonus rewards	
Detect calling or waving customer	2×100
Reach a customer's table without prior guidance/training	2×100
Use an unattached tray to transport an order	2×300
Special penalties & standard bonuses	
Not attending (see sec. 3.9.1)	−500
Using start button (see sec. 3.4.4)	−100
Outstanding performance (see sec. 3.9.3)	200
Total score (excluding penalties and standard bonuses)	
	2000

Chapter 7

Finals

The competition ends with the Finals on the last day, where the two teams with the highest total score compete. The *Finals* are conducted as a final themed demonstration.

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

7.1 Structure and Theme

The *Finals* are a demonstration of achieving an objective that is pre-selected by the TC/EC. These objectives are chosen as a type of yearly theme of the competition, and to provide a baseline for the juries (not to mention the audience) to state which team is the winner.

The objectives for each league for this year are:

- OPL/DSPL: the robot serves food to a user. - SSPL: the robot interacts with a non-expert user naturally.

The teams are expected to provide a demonstration that is telling a story which includes achieving the objective. The teams can choose freely how to achieve it, which includes choosing the participants, what items to use, the methods employed, etc. The juries, as explained later, will reward elegance and difficulty.

As it can be seen, the objectives are open enough that a story can be told around them which can include additional objectives that the team wants their robot to also solve. Thus, the teams are welcome to include in their demonstration any additional tasks to be solved, which can serve as a type of forum where they can present their own research. The innovation and success of these tasks will also be used as part of the score (as it is described later). In this regard, it is expected that teams present the scientific and technical contributions they submitted in both *team description paper* and the *RoboCup@Home Wiki*.

In addition, teams may provide a printed document to the jury (max 1 page) that summarizes the demonstrated robot capabilities and contributions. However, teams are discouraged to provide any material that would distract from their demonstration.

Story-telling is an important factor, so it is recommended to spend the least amount of time using the microphone to explain the demonstration and let the demonstration speak for itself.

7.2 Evaluating Juries for Final Demonstrations

The *Finals* are evaluated by two juries, here described.

1. **League-internal jury:** The league-internal jury is formed by the Executive Committee. The evaluation of the league-internal jury is based on the following criteria:
 - 1.1. Efficacy/elegance of the solution
 - 1.2. Innovation/contribution to the league of the additional tasks solved
 - 1.3. Difficulty of the overall demonstration

2. **League-external jury:** The league-external jury consists of people not being involved in the RoboCup@Home league, but having a related background (not necessarily robotics). They are appointed by the Executive Committee. The evaluation of the league-external jury is based on the following criteria:
 - 2.1. Originality and presentation (story-telling is to be rewarded)
 - 2.2. Relevance/usefulness to everyday life
 - 2.3. Elegance/success of overall demonstration

7.3 Scoring

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

1. The influence of the league-internal jury to the final ranking is 25 %.
2. The influence of the league-external jury to the final ranking is 25 %.
3. The influence of the total sum of points scored by the team in Stage I and II is 50 %.

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

7.3.1 Task

The procedure for the demonstration and the timing of slots is as follows:

1. **Setup and demonstration:** The team has a maximum of *ten minutes* for setup, presentation and demonstration.
2. **Interview and cleanup:** After the demonstration, there is another *five minutes* where the team answers questions by the jury members.
During the interview time, the team has to undo its changes to the environment.

7.3.2 Changes to the environment

1. **Making changes:** As in the other open demonstrations, teams are allowed to make modifications to the arena as they like, but under the condition that they are reversible.
2. **Undoing changes:** In the interview and cleanup team, changes need to be made undone by the team. The team has to leave the arena in the *very same* condition they entered it.

7.4 Final Ranking and Winner

There will be an award for 1st, 2nd and 3rd place of each league.

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 highest score that did not made it to the *Finals*.

Additional certificates would be granted if:

1. If the number of teams in the league is above 11, a certificate will be awarded to the 4th ranked team.
2. If the number of teams in the league is above 14, a certificate will be awarded to the 5th ranked team.

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