# RoboCup Logistics League

## Challenges

Rules and Regulations 2021

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The Technical Committee 2012–2021

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is this up-to-date?

# 1 Introduction

Our aim is to capture the main tasks from the RoboCup Logistics League in isolated challenges, which form an additional competition in the league. Main objectives of this new competition are:

- to provide a framework that allows teams to show and evaluate their progress in the individual tasks of the RCLL
- to ease the preparation for the main competition through providing a simplified cost- and space-efficient setup suitable for replication in local labs
- to be attractive for both RoboCup live events and online competitions, where teams can participate remotely from all over the world

# 2 Competition Area

## 2.1 Field Layout

The competition area for the main challenges consists of a $5\,\mathrm{m} \times 5\,\mathrm{m}$ area divided in square zones of $1\,\mathrm{m} \times 1\,\mathrm{m}$. Additional challenges that are not counting towards the scoring of the competition are carried out on a $7\,\mathrm{m} \times 8\,\mathrm{m}$ field instead (corresponding to halve the field of the regular RoboCup Logistics Leaugue (RCLL) field).

The entire area belongs to a single team. The bottom left-most $1\,\mathrm{m} \times 3\,\mathrm{m}$ area is called the insertion zone, It does not need to have partial walls around it and provides the starting positions for up to three robots.

## 2.2 Mockup Machines

In case no real modular production system (MPS) stations are available, replications (so called *mockup machines*) may be used, that do not need to physically perform the respective production steps. Instead, that work may be carried out by a human supervisor (see Section 3.3). The minimum requirements for a mockup machine are specified in the following.

Mockup machines are required to have the same box-like base-shape as specified in the RCLL rulebook. On top of the box a model of the conveyor belt has to be mounted, see On stations replicating a cap station (CS) a shelf as to be additionally mounted on the front right side of the box, see On stations replicating a ring station (RS) either a shelf may be mounted as well, or a model of the slide, which may be placed anywhere on the front right side of the box, such that it is accessible from the front.

The building materials for the models must be opaque, but may have any color.

In order to compete in all main challenges, a minimum number of 3 mockup machines are required. On higher difficulty some challenges may require 4 mockup stations and some secondary challenges require 7 stations.

## 2.3 Remote Setup

In case a competition is carried out remotely, a proper local setup has to be established and approved by the organizational committee Requirements include a proper camera setup that

covers the field sufficiently, such that external viewers can verify the integrity of each challenges, as well as an approval for every mockup machine and robot that is used.

# 3 Game Play

## 3.1 Competition Scope

X time slots of 10 minute setup time per team, followed by up to 20 minutes of game time. Each slot can be used to solve at most one challenge, a team can decide to fail a challenge and use another slot to improve. A team can use a single slot to try a challenge multiple times (with the same field layout) once a challenge counts, it cannot be attempted again (unless difficulty is increased).

All challenges (unless stated otherwise) are conducted while measuring the execution time. The execution time is measured by the RefBox. The fastest team in any challenge gains additional points.

## 3.2 Changes compared to the Main Competition

The tasks covered in the various challenges mostly obey the regular rules for the RCLL. However, some aspects are altered to simplify the setup. The changes are not affecting existing machine communication and processing steps, such that the challenges can be carried out on real machines as well as on mockup versions obeying the requirements outlined in Section 2.2.

**Product Delivery** The delivery procedure for finished products is altered compared to the RCLL rule set. In order to reduce the amount of machines required for participation, Deliveries are made by bringing the finished product to the insertion zone and dropping it there.

**Ring Payments** Easing the setup of mockup machines, it is not required to have a slide on ring stations. Instead, a shelf may be used to place payments at the corresponding station.

**Ring Color Assignment** The cost for mounting each ring color are fixed, the assignment of ring colors is semi-fixed as teams can choose between two different options for each challenge (`option1` or `option2` according to Table 1).

| | Ring Costs | | | | Color Assignment | |
|---|---|---|---|---|---|---|
| | Color | Price | Color | Price | | |
| | Yellow | 0 | Orange | 0 | RS1: $\mathcal{RC}_1$ | RS1: $\mathcal{RC}_2$ |
| | Green | 1 | Blue | 2 | RS2: $\mathcal{RC}_2$ | RS2: $\mathcal{RC}_1$ |
| Configuration | $\mathcal{RC}_1$ | | $\mathcal{RC}_2$ | | `option1` | `option2` |

Table 1: Materials

**Materials** The available material that can be used per challenge is restricted (unless stated otherwise) per machine according to the information in Table 2.

| Machine | Available Material |
|---|---|
| BS | 2 bases of each color |
| CS | 3 cap-carriers (cap color choices up to each team) |
| RS | 4 rings of each assigned color (8 in total) |

Table 2: Materials

**Orders** Unless specified otherwise, orders that have to be fulfilled in challenges are entered through the web shop by any member of the competing team.

In challenges where only one RS is present, teams are responsible to order products which can be assembled using the available stations only.

## 3.3 Field Operators

In challenges where mockup machines are used, the actual assembly stps have to be performed by human supervisors. Whenever a machine is instructed, the RefBox operator announces the required interaction. One field operator may proceed to enter the field in order to perform the interaction. Afterwards the field has to be left immediately. The usual rules for replenishing resources (respecting the limited materials Section 3.2) apply.

## 3.4 Available Challenges for the Primary Competition

Challenges have different types and variations (difficulty levels). The overall score of the competition is calculated by summing up the score in the highest difficulty achieved in each of the challenge types. The challenge types of the competition are described in Section 3.4.1-**??**

The RefBox is used to log the scores and data for each challenge. Once the competition is finished, 5 bonus points are awarded each time a team solved a challenge on a difficulty in the shortest amount of time.

### 3.4.1 Navigation Challenge

Basic navigation task with known obstacles.
**Task:** Drive three routes, each starting and ending in the insertion zone while covering a given set of target positions. At each target position the robot has to stand still (no moving or rotating) for at least 1 second.
Variations of this challenge depend on the number of available machines (see Table 3). Multiple robots may be used to simultaneously cover different routes. Partial points may be awarded in case only a subset of routes got covered.

| Machines | Scoring | |
|---|---|---|
| | first finished route | each other finished route |
| 2 | 10 | 2 |
| 3 | 20 | 2 |
| 4 | 25 | 2 |

Table 3: Navigation Challenge

### 3.4.2 Exploration Challenge

Replicate the RCLL exploration phase. Machine Marker detection as well as navigational skills are required to solve this challenge.
**Task:** Find and report all machines on the field (type and orientation).
Variable in the number of machines (see Table 4).

| Machines | Scoring |
|---|---|
| 2 | 10 |
| 3 | 20 |
| 4 | 30 |

Table 4: Exploration Challenge

### 3.4.3 Grasping Challenge

Simple grasping task. Each Machine has a base at output. Robots start at cell in front of a machine output.
**Task:** A robot brings a base from one machine's output back to it's input. A human supervisor places it back to the output. Repeat until all products were placed at the respective machines input 3 times and all robots returned to their starting positions.
Variations differ by number of machines, see Table 5. The $i$-th repetition is considered to be successful, once all bases were placed at the respective machine input at least $i$ times.

| Machines | Scoring | |
|---|---|---|
| | first repetition | each subsequent repititon |
| 1 | 10 | 2 |
| 2 | 20 | 2 |
| 3 | 25 | 2 |

Table 5: Grasping Challenge

### 3.4.4 Product Challenges

This section covers four types of challenges, instead of just a single one. Each challenge corresponds to the production of a product with one of the available complexities (C0, C1, C2, C3) in the RCLL using either one or two RS.
For complexities C1, C2 and C3 the accumulated cost for mounting the required rings must be equal to 1, 2 and 3, respectively. **Task:** Produce all posted orders.

### 3.4.5 Exploration + C0 Challenge

A simple production task on a field with unknown machine positions. The challenge is to produce a product of complexity C0 without receiving the machine positions at the start of the production phase, resembling a unified exploration and production phase.
**Task:** Produce all posted orders.
Beating this challenges yields 50 points.

| Machines | Challenge type | Scoring |
|---|---|---|
| 2 | C0 | 30 |
| 3 | C1 | 50 |
| 4 | C1 | 50 |
| 3 | C2 | 70 |
| 4 | C2 | 70 |
| 3 | C3 | 100 |
| 4 | C3 | 100 |

Table 6: CX Challenge

#### 3.4.6 RefBox Simulation Challenge

A competition on the agent level. The RefBox provides a set of actions that can be executed by sending dedicated commands to the refbox via protobuf. Hence no actual robot is required to participate. **Task:** Play a regular RCLL game through the RefBox simulation interface. Participating in this challenge yields points based on the achieved in-game points, see Table **??**. Additionally, the team scoring the highest points overall gets awarded another 10 points

| Points | Scoring |
|---|---|
| $[0, 50)$ | 0 |
| $[50, 150)$ | 20 |
| $[150, 250)$ | 40 |
| $[250, \infty)$ | 60 |

Table 7: CX Challenge

#### 3.4.7 Markerless Detection Challenge

Image recognition challenge to classify different machine types.
**Task:** Autonomously label the machines shown in a set of pictures
As a preparation for this challenge, a data set will be supplied to all participants which may be used for training and testing purposes. The evaluation set for the challenge consists of a set of separate images.

| % Correctly Classified | % Wrongly Classified | % Not Classified | Scoring |
|---|---|---|---|
| $x$ | $y$ | $z$ | $(x - y) \cdot 30$ |

Table 8: Machine Detection Challenge

### 3.5 Challenges for the Secondary Competition

#### 3.5.1 Full game

Play a full RCLL game on a field of $7\,\mathrm{m} \times 8\,\mathrm{m}$ with 7 machines (no machines from the opposing team).