Sweden Autonomous Robot Challenge

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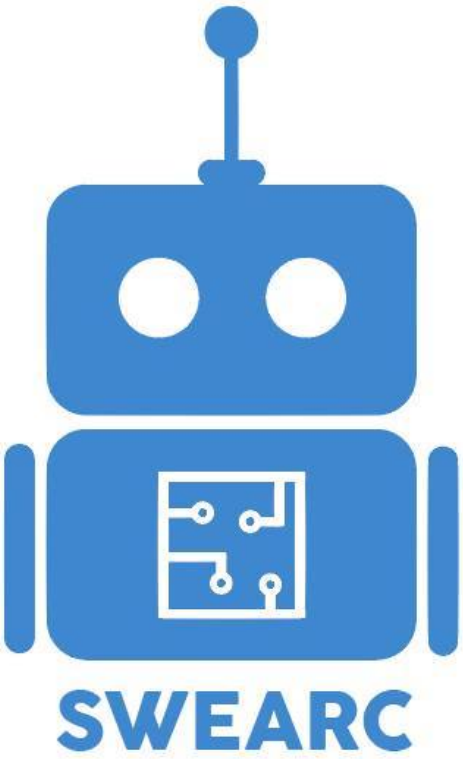


Contents

This document is written for SweArc, the "Sweden Autonomous Robot Challenge".

If you find an error or inconsistency, please email the Contest Organization at info@swearc.se

1 General

These rules change every year. Each team is responsible for reading these rules and building a robot that complies with them. Robots designed for previous contests may not be acceptable under the current rules.

Any substantial changes since the last published version will be marked with red color like this.

1.1 Multiple entries

The challenge for contestants is to prepare a unique robot of their own design. However, we realize that some teams may wish to enter a kit-based robot or a robot that shares many design features with another robot entered in the contest.

Each robot must differ visibly and significantly from other robots in at least some aspects of electronics or mechanics. Team may thus not register multiple identical robots as separate entries.

1.2 Spirit

The purpose of the SweArc contest is to encourage innovation by roboticists of all ages and skill levels by creating an atmosphere of friendly and cooperative competition. The contest foster creativity, cooperation and achievement by the contestants themselves. The contest's highest priority is education, not winning.

The event has succeeded when teams and individuals invent their own autonomous robots and learn from their successes and failures during that process and the contest weekend, not when they blindly assemble components and programs designed by others.

1.3 Judge's Rulings

The Chief Judge is the final and absolute authority on the interpretation of all rules and decisions.

A team may challenge any ruling or scoring of the Arena Judges by stating that they wish to appeal the problem to the Chief Judge. The Chief Judge will then be called in to decide the matter.

The challenge must be made before the team leaves the arena after the completion of a trial.

All results, scores, and decisions become irrevocable after the team leaves the arena.

1.4 Safety

Any Contest official may stop any robot at any time if, in their opinion, it is performing or is about to perform any action that could be dangerous or hazardous to people, facilities, or other equipment.

1.5 Environmental Conditions

The goal of the contest is to make a robot that can operate successfully in the real world, not just in the laboratory. Such a robot must be able to operate successfully where there is uncertainty and imprecision, not just under ideal conditions. Therefore, the arena dimensions and other specifications listed below will not be precisely what the robots will encounter at the contest: they are provided as general aids.

Although the robot contest arenas present an idealized version of the real world, you must not assume:

- Exactly square corners
- Precisely vertical walls
- Perfectly flush joints
- Recessed fasteners and brackets
- Uniformly colored surfaces
- And so forth and so on...

Every robot must successfully handle small misalignments, inaccuracies, discolorations, and other arena imperfections. You must test your robot under less-than-ideal conditions and verify that it works properly.

Teams should expect environmental conditions at a tournament to be different than at their home practice field.

Lighting conditions will certainly vary in the arena. Teams must therefore come prepared to calibrate their robot-based on the lighting conditions at the venue.

NOTE Flash photography *will occur* during the entire contest. Your robot must withstand frequent sensor glitches from IR and UV impulses. If your robot operates incorrectly due to external interference, *it will not be given another trial*.

Teams should design their robots to cope with variations in environmental conditions and come prepared to calibrate their robots to contend with the alternate environmental conditions found at the venue.

NOTE We strongly recommend that your robot should not depend on precise dimensions. Our experience shows that the intensity of a protest based on arena dimensions corresponds directly with the robot's failure to operate at all.

NOTE Remove your shoes before stepping into the arena! Shoes produce hard-edged dust marks on the floor. The arena must be left in the same state as when you entered it.

1.6 Practice Time

The teams will have opportunity to test there robots in the competition arena before the competitions starts.

You should use the practice time to calibrate sensors for the conditions in the arena and to troubleshoot any last minute problems. It is not likely that you will manage to do any extensive coding or construction work during the competition day. After the first competition rounds have started there will be no possibilities to practice in the arena.

1.6.1 Damage During Practice

Several robots will be permitted on the arena at the same time during practice. Since we will not monitor practice, you are responsible for the safety of your robot at all times.

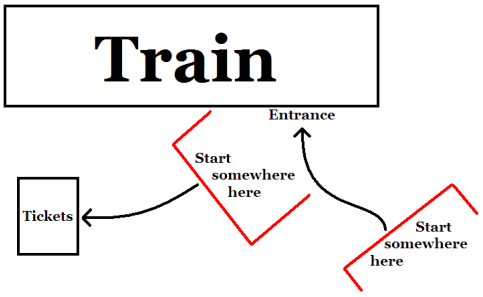
If two or more robots damage each others during practice, the contest officials must be contacted immediately to decide the following:

- damage to a robot
- which team is responsible for any damage
- which teams (if any) may compete
- which teams (if any) will be disqualified
- and all similar questions

The decisions of the contest officials are final and can not be appealed.

NOTE If you put your robot in an arena where another team is practicing with their robot with the intent to deliberately harm the enemy team or their robot; your team will be disqualified.

1.7 Starting the Trial



When arriving at the arena the team will place the robot in the starting zone. No part of the robot are allowed to be outside this zone, when looked from above, before the trial starts. See figure 1.7 for an example of how the starting zones can be located relative the objects.

NOTE If you are not ready at the assigned starting time of your trial, you will miss your turn.

Team members must not touch the robot after placing it in the starting zone.

The team must not transfer any information to the robot regarding the layout of the arena, the starting position, or the position of any objects after placing the robot in the starting zone. The team must download any required programs or firmware to the robot before arriving at the arena.

The Judges will randomize the arena configuration, and place the objects in the arena. The team must not request special placement of objects or changes to the robot's placement.

The Judge will determine when the trial begins and will activate the robot using the Start Button.

1.7.1 Failing to Start

If the robot fails to start when activated with a start button, the Judges will wait for 30 seconds, then record a failed trial. Teams may decide

that the robot will not move and terminate the trial before that time by informing the Judge.

This applies regardless of the reason the robot does not start. All that matters is that the robot does not begin moving after the Judge presses the Start Button.

Teams must not request a re-run following a failure to start.

1.7.2 Premature Start

If a robot begins moving after being placed in the starting zone, but before the Judge presses the Start Button, it has failed the trial.

Teams must not request a re-run following a premature start.

1.7.3 Start Orientation

The team may choose in which direction they want their robot to be placed in.

NOTE The alterations in the arena will be made AFTER the team has chosen the start orientation. The team can not change the orientation after the alterations are made.

1.8 Robot

The robot hardware requirements, and performance specifications are absolute and will be enforced by the Judges.

1.8.1 Robot kits

Any robot kit or building blocks, either available on the market or built from raw hardware, may be used, as long as the design and construction of the robot are primarily and substantially the original work of the participants.

1.8.2 Value of robot

To have a fair competition you are only allowed to buy software and hardware for the robot for at most 10 000 SEK. Everything you use on the robot during the competition will be considered parts of the robot and belong to the robot after the competition.

You are encouraged to use old equipment and spare parts that you have at home (see section 5.2) but these will then be donated to the robot. Alternatively you can sell them to the robot, and the price will then be included in the maximum budget of 10 000 SEK. For example if you use a laptop as part of your robot this laptop will then be considered as a part of your robot. Debugging tools not used during the competition such as oscilloscope, multimeter or an external computer for programming is not to be considered part of the robot.

1.8.3 Operation

Once turned on, the robot must be autonomous: self-controlled without any human intervention. Firefighting robots must not be manually controlled.

A robot may bump into or touch the walls of the arena as it travels, but it cannot mark, dislodge, or damage the walls in doing so. The robot must not make any marks on the floor of the arena that aid in navigation as it travels. Any robot that, in the Judge's opinion, deliberately damages the contest arena (including the walls) will fail that trial. This does not include any accidental marks or scratches made in moving around.

NOTE Although a robot may bump the arena walls as it moves, it should not repeatedly crash into the walls at high speed. "Navigation by crashing" would not be acceptable in an actual house and is discouraged in this contest. If the robot crashes hard enough to move the arena walls, it will fail that trial.

1.8.4 Robot Dimensions

There is no fixed size restrictions of the robot, however it must fit through the door of the train if it should be eligible for the door task.

There are no restrictions on robot weight or materials.

1.8.5 Start Button

All robots must have exactly one Start Button switch that starts the robot with one single press.

The start button must be clearly marked and easily accessed without using any tools. It must also be placed so that there is no risk for the

judge to be in the way of fans or other mechanical parts of the robot or to get injured in any other way, when pressing the button.

The team must inform the judge how to start the robot before it is placed in the arena.

1.8.6 Stop Button

All robots must have exactly one Stop Button switch that stops the robot immediately with one single press.

The stop button must be clearly marked and easily accessed without using any tools. It must also be placed so that there is no risk for the judge to be in the way of fans or other mechanical parts of the robot or to get injured in any other way, when pressing the button.

The judge may press the stop button at any time.

1.8.7 Communications

The robot may not receive any signal from outside of the arena in any way. This is to ensure that the robot operates autonomously and to avoid any kind of human control or tampering with the robot. Internal, short-range communication within the robot itself is allowed.

The judges will determine if a robot is communicating with anything outside of the arena.

1.8.8 Streaming

One of the goals with the competition is to demonstrate what the companies and students in the region is able to achieve! We want to give you the best possibilities to do this.

Talk with us before the competition and we can provide tools to stream the information given by the robot through microphones, wireless cameras or other devices. We wont force any team to attach other devices to their robot, but it can be fairly easy to have a 3.5mm audio outlet for a transmitter, or having the possibility to connect the robot to visualisation softwares such as rViz.

Since the robot are not receiving any information from the outside this doesn't violate section 1.8.7.

1.8.9 Sensors

There is only one restriction on the type of sensors that may be used as long as they do not violate any of the other rules or regulations.

The restriction is the following: For safety reasons robots are only allowed to use lasers of class 1 and class 2. Any mounted laser must be pointed along the floor-plane or angled towards the floor. It may not be angled towards the ceiling. This ensures the safety of participants, judges, spectators and any other person near the event.

Contestants are not allowed to manually place any markers, beacons or reflectors on the walls or floors, whether inside or outside of the arena, to aid in the robot's navigation. The robot itself may leave and use these kind of things as long as they obey the rules stated in Section 1.8.7.

2 Gameplay

The challenge consists of 5 tasks, where you select which tasks you want to focus on. Each task may consists of one or more subtask where each successfully negotiated subtask will give your team points. You don't need to try to solve all the tasks.

Each team will get at least two trials on each task. Depending on the amount of registered teams you may get more than two trials. The worst trial is discarded and only the best ones are used to form a total score for each task. The total score consists of the score for each subtask and the time used to complete the task.

Each task will be ran in one go, i.e. there will not be any pauses between each subtask. Each trial is a new rerun of the whole task, the team will never has the chance to just rerun a specific subtask.

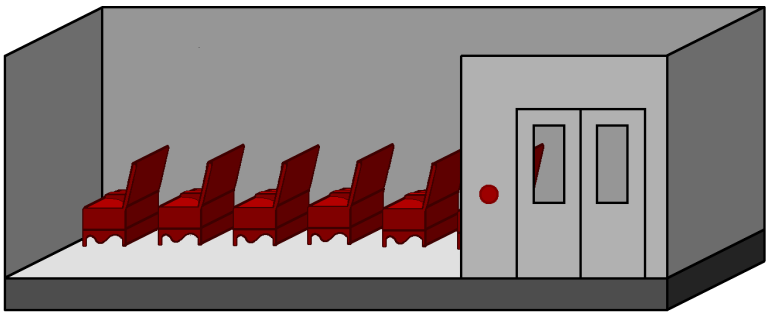


Figure 1: Model of the train

2.1 Modifications between rounds

It should be the same robot that solve all the tasks. You are not allowed to change tools or do substantial modifications to the robot.

However you are allowed to reset the robot or prepare it for the different tasks, for example windup chains/ropes or move arms to other positions. Even small modifications may be allowed, but check with the organizer if you are unsure about a specific modification.

2.2 Human interaction

In some of the challenges the robot should communicate with its surroundings. The main purpose of this is to allow the judge to determine what the robot has detected or deduced from its environment. Before the competition starts the team should inform the judge how the robot will communicate, this is the only form of communication the judge will look at. This method is called the standard communication method below.

The teams are also encouraged to deliver the information in multiple ways. For example at a display mounted in the robot or through speech synthesis, see 1.8.8 for more information. If the robot are giving conflicting information, for example saying left but pointing to the right, the judge will only consider the standard communication method.

NOTE The judge will try his/her best not to be in the way of the robot when the robot is moving and working, but (s)he needs to be close to the robot to see what the robot negotiate successfully. The judge will never prevent the robot intentionally. Please talk with the judge during the task if you think (s)he is doing any harm, however the judge has permission to stand wherever (s)he want.

2.3 QR codes

In several of the tasks below the robot will need to recognize a QR code. They will contain json encoded data. The QR codes used will be generated by using the Google Chart API, for an example see `http://chart.googleapis.com/chart?cht=qr&chs=500x500&choe=UTF-8&chld=H&chl={%22id%22:%2012,%20%22data%22:%20%22a%20text%20string%22}`

NOTE The QR code will change density depending on how long the encoded json string is.

2.4 Arena dimensions

Object dimensions are generally given as length x width x height, as the robot encounters the object. All measurements are given in centimeters, unless otherwise stated.

- Length is front-to-back
- Width is side-to-side
- Height is top-to-bottom.

The arena dimensions and specifications listed below are not exactly what will be encountered at the contest: they are provided as general aids. See section 1.5 for more details. Angle brackets supporting a wall may extend into the hall or room, with screws into the wall and floor.

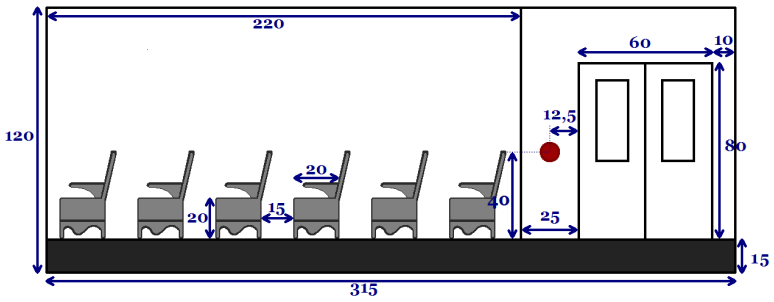


Figure 2: Measurements of the train, side view

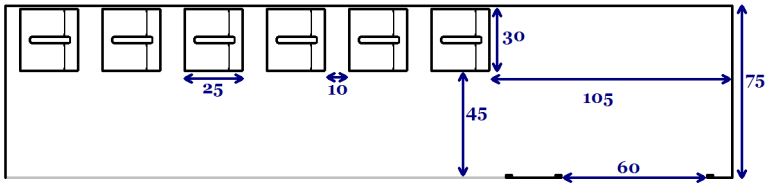


Figure 3: Measurements of the train, top down view

3 Tasks

In the following tasks this icon will indicate what the robots should do to obtain the score listed under scoring 4.

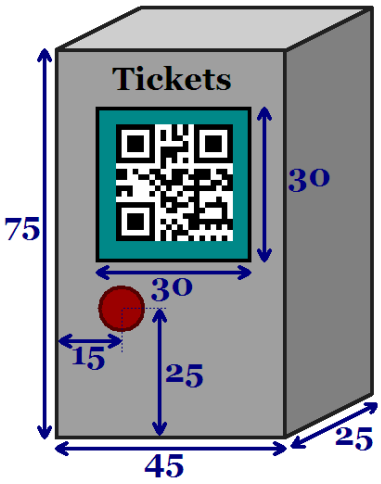


Figure 4: Measurements of the vending machine.

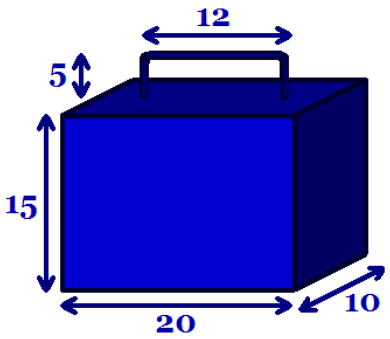


Figure 5: Measurements of the luggage

3.1 Task 1 - Buy ticket

The robot should find the ticket vending machine and buy a ticket. The ticket will be provided as a QR code on a screen that the robot should read.

3.1.1 Subtask 1.1 - Press the button

Locate the vending machine and the "buy" button. Press the button. See figure 4 for an illustration of the the vending machine. The button will be colored red and have a fixed location. The button may be recessed into the wall.

The robot should press the button firmly.

3.1.2 Subtask 1.2 - Interpret the ticket

A QR code will be displayed on the screen.

The QR code will contain JSON data:

```
{"id": 41241,
"train": 418,
"car": 2,
"seat": 5,
"platform": 1,
"time": 1451393947}
```

where

id is a identifier that you don't have to care about

train is the train number

car is the wagon where you have your seat

seat is the seat number

platform is the platform where the train will leave the station

time is the time when the train leaves the station, in epoch time

 The robot should inform the judge (with the standard communication method) when the train will leave and where he has his seat.

3.2 Task 2 - Carry luggage

The robot should locate a human that needs help with his luggage. The robot should ask the person where he want his luggage and transport it accordingly.

There will be 4 delivery places each 2x2 meters, see figure 6. They will be orientated perpendicular to each other, but not necessarily according to the compass. They will have a fixed offset, depending on the competition venue, to the true compass orientation.

Outside (on the side of the square furthest away from the human) of each delivery place will be a sign indicating the location, see figure 7 for an example. The signs will have one letter each ("N", "E", "S", "W") and the sign will be fixed to each delivery place, i.e. not change after you have placed your robot in the starting zone.

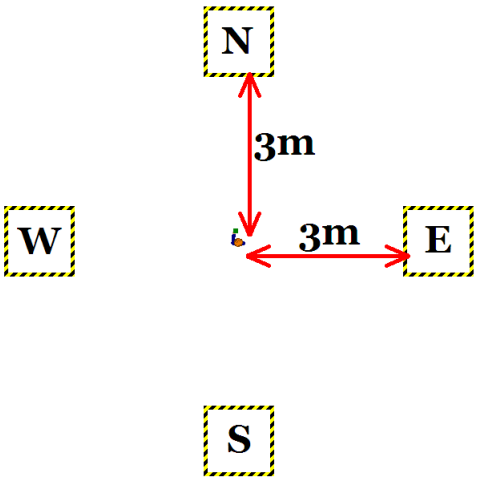


Figure 6: Diagram of the delivery places and a human with the luggage in the middle

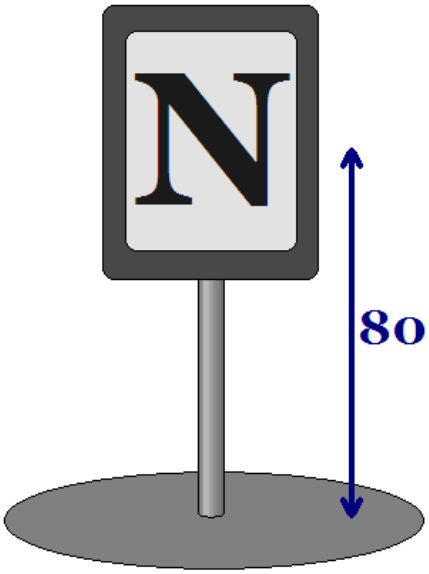


Figure 7: Sign indicating which delivery place this is.

3.2.1 Subtask 2.1 - Locate human

There will be one human inside the competition field of 10x10 meters, limited by the delivery places. The robot needs to find the human and drive to him.

NOTE This task will take place outside, and the ground surface will not be completely even.

NOTE The human will be located more or less in the middle of the competition field.

 The robot will get score if the robot is within 1 meter of the correct human.

3.2.2 Subtask 2.2 - Identify the destination

This subtask has two possibilities. The robot can either interact with the judge, or read the package by itself. Or do both options as a confirmation, but you will only get score for one.

If the robot has voice recognition the judge will tell the robot where the package should be delivered. You as a team are not allowed to tell the judge beforehand on how (s)he should talk with the robot. The robot can also tell the judge a series of command it understands and the judge will use them. If the robot ask for confirmation the judge will interact with the robot. An example of commands can be "North", "South", "East" and "West" or "Top", "Bottom", "Right" or "Left" to indicate which direction the package should be delivered.

If the robot doesn't have speech recognition he can look at the package and read which location it should be delivered to. The luggage will have a 10x10cm QR code on the front- and back side containing the following information:

id a unique identifier of this package

weight the weight in kg of this package

destination the destination of this package

owner the id of the owner of this package

The luggage will be a rectangular block of 10x20x15 cm and be lightweight ($<$ 1kg). The luggage will have a handle, see figure 5.

NOTE The destination will be randomized when the robot start the task, and may be different each trial. The QR code will change for each trail so it will correspond to a correct luggage and destination.

 Will get the score if the robot can tell where the luggage should be transported. This should be communicated by using the standard communication method.

3.2.3 Subtask 2.3 - Lift the luggage

The robot should lift the the luggage above the ground not to damage the package during transportation. The luggage will have a handle that can be used, but the robot are allowed to lift the luggage in other ways.

 Will get the score if no part of the luggage is touching the ground.

3.2.4 Subtask 2.4 - Navigation

The robot should be able to navigate to the correct location, using the information obtained in subtask 2.2 (section 3.2.2). The robot are allowed to use the signs, see figure 7, to navigate towards them.

NOTE Even if you lose the luggage during the transportation you will get the navigation points.

NOTE If you can't lift the luggage you can still get the score for correct navigation.

 Will get the score if the robot is within the correct location. Just a part of the robot needs to have crossed the border of the location.

3.2.5 Subtask 2.5 - Deliver the luggage

NOTE You can deliver the luggage even if you don't lift it. The robot can push the luggage to the correct location. However keep in mind that the luggage doesn't have wheels.

 Will get the score if part of the luggage is within the correct location, when looking from above.

3.3 Task 3 - Open the door

3.3.1 Subtask 3.1 - Press the button

The robot should find the button and press it. See figure 1.

 Receives the score when the button is pressed firmly.

3.4 Task 4 - Get in the train

3.4.1 Subtask 4.1 - Enter the train

The robot should enter the train. There will be a step of up to 15 cm to get into the train.

NOTE The robot does not need to open the door first. Before this task starts the door will be manually opened.

 Will get the score when no part of the robot is outside of the outer wall of the train. You should be able to look alongside the train and not see anything protruding outside of the train.

3.5 Task 5 - Find an empty seat

The robot should search through the train for an empty seat and inform the judge on where he could sit.

3.5.1 Subtask 5.1 - Find an empty seat

The robot will start on the train and should navigate inside the train alongside the seats. It should detect which seats are occupied and which are free. At least one of the seats will be free. The robot should stop in front of a free seat, but the team are encouraged to also indicate this information by speech or text somehow.

An occupied seat will have an object on the horizontal seat area. The object will be at least 10x20x15.

NOTE The seat has nothing to do with the seat received in subtask 1.2 (see 3.1.2), but will be randomized when the team start the task.

NOTE The train will have one open side, just as in figure 1 and the robot may fall of the train if it is too close to the outer side. The edge will not be marked in any way.

 Receives score when the robot stops (and are stationary for ever) in front of a free seat. In front means that the robot are clearly closer to a unique seat, it will not get any score if it stops in between of two seats.

4 Scoring

See table 4 for scoring.

The table also contains maximum available time for each subtask. If they don't fulfill the subtask within the specified time the whole task is stopped there. They will get the scoring obtained so far in the task.

Each team will get at least two trials at each task. The worst trial for each task is discarded and the sum of the best trials will be calculated. The sum of all tasks are then added together to get the total score.

The time for each task is also added together. If two teams have the exact same numerical score, it will be the time that decide the winner.

Table 1: Scoring and maximum time for each subtask. The exact scoring values below are subject for changes.

Subtask	Score	Maxtime [minutes]
1.1 - Press the button	50	10
1.2 - Interpret the ticket	10	5
2.1 - Locate human	50	10
2.2 - Identify the destination	20	5
2.3 - Lift the luggage	20	5
2.4 - Navigation	80	10
2.5 - Deliver the luggage	20	4
3.1 - Press the button	50	10
4.1 - Enter the train	80	20
5.1 - Find an empty seat	80	20

5 Prices

There will be multiple chances to win prices in the competition.

5.1 The challenges

The team with the best total score is the winner of the challenges. The score is calculated according to section 4.

5.2 The scrapyard prize

To save the environment it is important to recycle and reuse materials and products. We should strive not to throwaway things but instead use

them in new manners.

We encourage all teams to reuse materials and equipments that they have nearby. For example wheels from a office chair, optical encoders from printers, or metal sheets from the case of a VHS player.

Document your work during the project, in particular when you are reusing old equipment in your robot. You will have access to the web page `http://swearc.se` where you can write about your progress and how you are working on the robot during the project.

We will use this information when we evaluate how well you have reused old equipment in new ways. Be innovative and think about how you can use broken things.

5.3 The audience award

The ultimate goal is that the robots will be able to work together with humans in the society. But to achieve this, we need both technical and social improvements. Today many people are afraid of robots. When we develop new technologies we need to think about who will use them, and how they will use them.

In this competition it is required that your robot isn't dangerous, but also of importance that it is attractive for the general public.

Because we in the organizing committee are already used to robots, we don't have the possibility to judge this kind of values. Instead we will ask the general public for help to evaluate the robots. The persons visiting the competition will vote for the robot they appreciate the most.

You should design your robot to be attractive and charming, think also about how you communicate information, see section 1.8.8.