Audi Autonomous Driving Cup

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16 April 2018

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Audi Autonomous Driving Cup

2018 Rulebook

Version 1.0

Contents

Preamble

This document describes the sequence of events and the Rulebook for the Audi Autonomous Driving Cup 2018, and is created and issued by the Competition Committee. The entire 2018 competition is based on this document. Questions about this document or the rules can be asked on the relevant board in the forum of the competition website, www.audi-autonomous-driving-cup.com. Changes to the Rulebook can also be found on the competition website.

The terms and conditions of the Audi Autonomous Driving Cup 2018 also apply. The participation conditions and this Rulebook, in its most recent version as can be retrieved from the competition website, form the organisational and legal framework for the Audi Autonomous Driving Cup 2018.

1. The competition (general)

The Audi Autonomous Driving Cup is an international competition, aimed at student teams from the disciplines of computer science, electrical engineering, mechanical engineering, or similar. The competition objective is the development of fully automated driving functions and the software architectures required to support them. 1:8 scale model vehicles, developed specifically for the competition, are the hardware platform used.
The competition is made up of an application phase, an implementation phase with kick-off and a test event, and an event, consisting of tournament and final. In the tournament and the final, teams present the systems they have developed and compete against one another with them over a course. The driving performance of the vehicles and software, but also the elegance of the solution and its presentation, are evaluated.

1.1. Objective

The competition objective is the development of fully automated driving functions and the software architectures required to support them, from sensor data processing to vehicle actuator control. In order to allow the focus to remain on the software development, AUDI AG has developed 1:8 scale model vehicles, equipped with sensor technology and computer hardware, which allow access to vehicle actuators (engine/brakes, steering, lights). The Linux operating system and the ADTF development environment are used on the model vehicle computer. Access to sensor technology, vehicle actuators, etc., is implemented via a hardware abstraction layer, encapsulated in the system software.
During the competition, the vehicle, controlled by the software developed by the student teams, must accomplish various tasks, such as for example remaining in lane, parking, emergency braking, giving way, map/cloud-based functions, etc. Parts of the solution must also make explicit use of typical artificial intelligence (AI) approaches. The speed and quality of task accomplishment form one criterion for competition ranking. Other criteria are the elegance of the solution used, i.e., its architecture and software engineering implementation, as well as its presentation during the course of an academic lecture. The Competition Committee performs the evaluation.
The aim of the competition is not further development or improvement of the vehicle hardware or base software. These are kept identical to enable comparison between the teams.

1.2. Note

This Rulebook and legal relationship resulting from it are subject to Federal Republic of Germany law.

2. Overview of the 2018 competition

2.1. Changes to 2017 competition (excerpt)

2.1.1. Internationalisation

2.1.1.1. In 2018, the competition participant group has been expanded to Europe. Teams from European Universities are eligible.

2.1.2. Vehicle sensor technology

2.1.2.1. One of the main vehicle sensors is a new Laserscanner, the RPLIDAR A2.

2.1.2.2. Because of the Laserscanner in the front we replace the five ultrasonic sensors and the Intel R200 3D-camera.

2.1.2.3. The model car can be equipped with a roof box with light signal and sound to act like an emergency car.

2.1.2.4. The model car will be equipped with a microphone to detect / classify an emergency car.

2.1.3. miscellaneous

2.1.3.1. In 2018 we will provide map data of the whole parcours in openDrive format.

2.1.3.2. There will be a new scenario that is a ramp to drive up, driving in the second level and driving down. After driving down there will be a new merging scenario into the regular lane.

2.1.3.3. The focus of the free presentation is extended to “closed loop function, artificial intelligence and car2x”.

2.1.3.4. Only the Competition Committee is evaluating all the competition parts. No more team evaluation each other in the academic lecture and free presentation.

2.2. Team numbers

2.2.1. Number of nominated teams

2.2.1.1. Based on the applications, the jury will invite ten teams to take part. These teams will receive an invitation to the kick-off event and will be provided with the model vehicles. They will automatically take part in the test event with subsequent qualifiers.

2.2.2. Number of teams for tournament, final, and qualifiers

2.2.2.1. The number of teams that can take part in the tournament and final remains limited to eight teams. Team preselection and reduction will take place already at the October test event.

2.2.3. Eligibility of non-nominated teams to participate

2.2.3.1. This year again where teams that have applied, but not been nominated, will be given the opportunity to also take part. These teams have to apply for participation again. The Audi jury decides if this team is allowed to take part. These teams must firstly be self-financing, and will not be provided with model vehicles by Audi. They must also purchase the vehicles themselves, for example from BFFT Gesellschaft für Fahrzeugtechnik mbH. They are free to attend to the kick-off meeting. In this case their participation have to be confirmed by the Audi jury and they have to be registered at least one week in advance. They have the option to register for the test event, including qualifiers. They must bring their own model vehicles with them, which, however, must be technically identical to the model vehicles issued by Audi. No changes are allowed. These vehicles must be submitted to the jury, who will decide on eligibility for the qualifiers. If the team then qualifies as one of the best eight teams, it is officially invited to the final in the same way as all qualified teams.

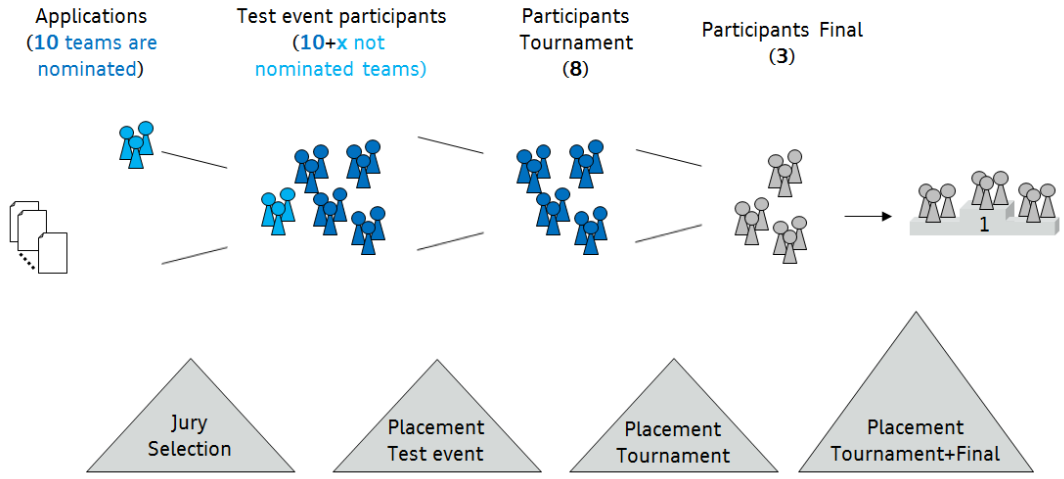


Illustration 1: Selection process procedure

2.3. Target group

2.3.1. Teams

2.3.1.1. The 2018 competition is aimed at student teams, under the auspices of a professor or academic employee of an European higher education institution.

2.3.1.2. A team consists of a maximum of five participants.

2.3.1.3. Participants must be students and not academic staff or professors of the institute of higher education. PhD students are excluded explicitly from this, these may – as team members – take part.

2.3.1.4. Each team nominates a team spokesperson.

2.3.1.5. Organisers, affiliated companies, and their employees and families are excluded from competition participation.

2.4. Language

2.4.1.1. The official 2018 competition language is English.

2.4.1.2. All competition communications (application, website, forum, tournament, and final, etc.) shall be in English.

2.4.1.3. Each team's spokesperson must therefore speak and understand English.

2.4.1.4. Technical documentation must be in English.

2.4.1.5. Comments in program code must be in English.

2.5. Deadlines

2.5.1. Application phase

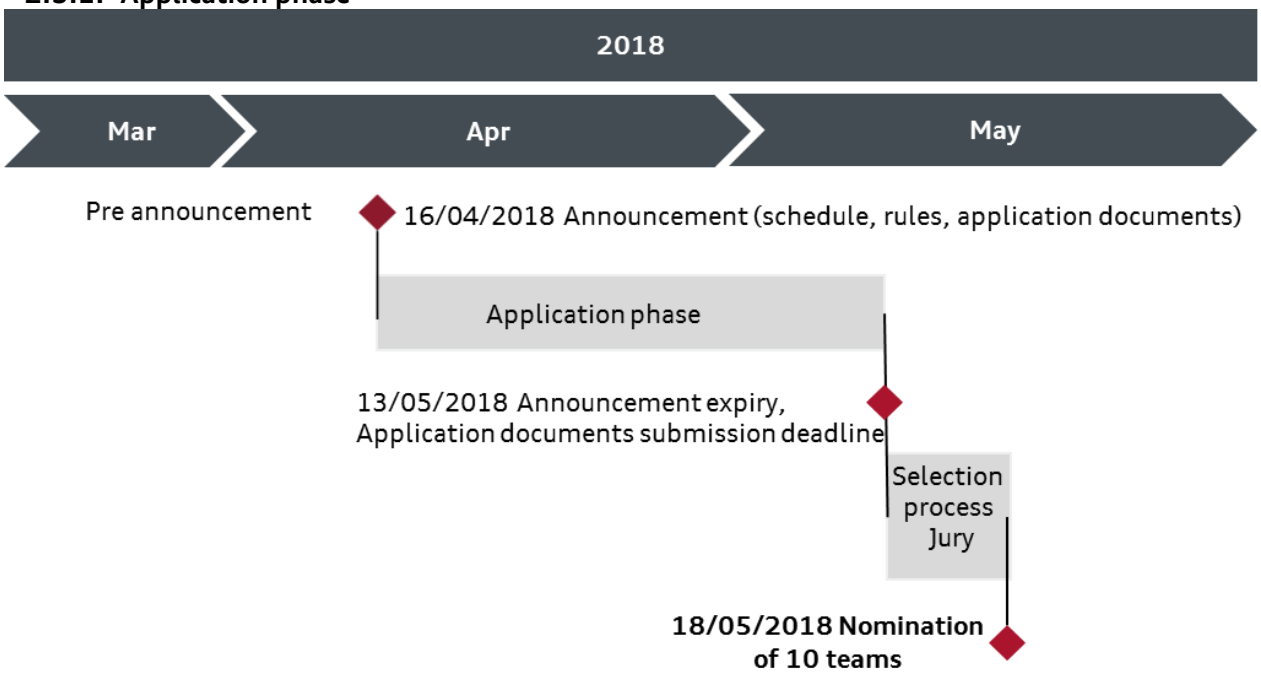


Illustration 2: Application phase procedure

2.5.1.1. Announcement

- The competition will be announced on **16/04/2018**
- The application deadline is **13/05/2018**

2.5.1.2. Team selection

Publication of the team selection for the competition will take place on **18/05/2018** on the competition website.

2.5.2. Implementation phase

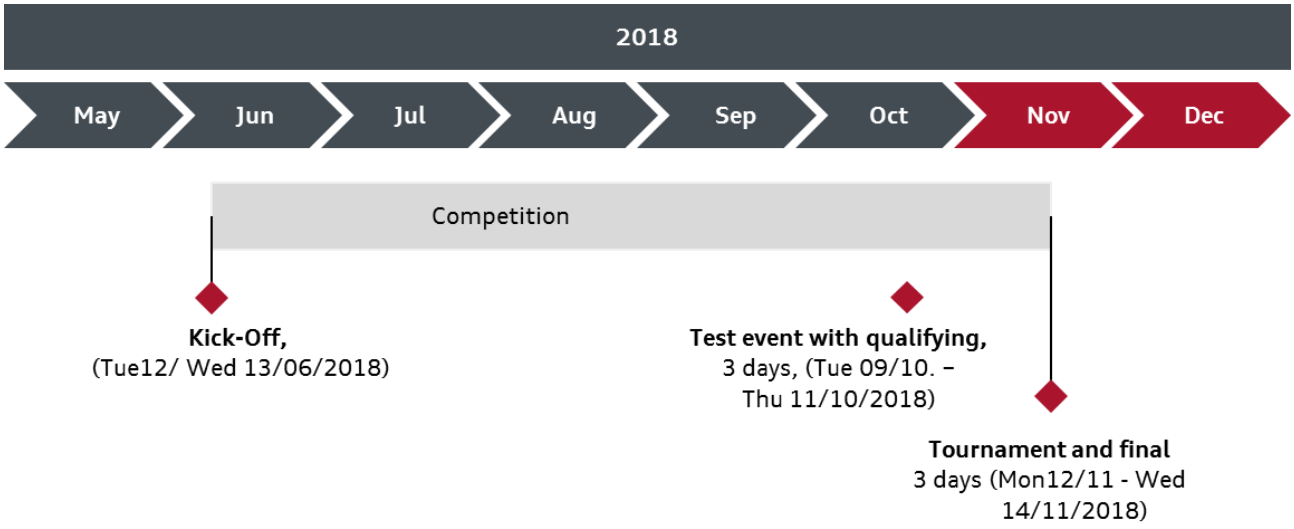


Illustration 3: Implementation phase procedure

2.5.2.1. Kick-off

- The kick-off event will take place on Tuesday 12/06/2018 and Wednesday, **13/06/2018**, in Ingolstadt.

2.5.2.2. Test event and qualifying

- The test event will take place from **09** to **11/10/2018** in Ingolstadt.

2.5.3. Tournament and final

- The tournament and final will take place from **12** to **14/11/2018** in Ingolstadt.

2.6. The Competition Committee

2.6.1. Composition

2.6.1.1. The Competition Committee consists of five Audi AG employees

- Dr.-Ing. Lars Mesow
- Dr. tech. Harald Altinger
- Simon Seitle
- N.N. AI
- N.N. Backend

3. Competition procedure

3.1. Application phase and team selection

3.1.1. Fundamentals

3.1.1.1. The competition will be announced by sending of invitations to selected higher education institutions, or upon publication of the invitation (for example on the www.audi-autonomous-driving-cup.com website and in other media). The application phase for teams starts on this date.

3.1.1.2. The application phase generally ends three to six weeks after the announcement. This date is the deadline for submission of team applications. Applications received following announcement expiry will not be taken into account for team selection.

3.1.1.3. Following receipt of invitations, the Competition Committee takes approximately two weeks for review and evaluation, and then selects the participating teams on the basis of this.

3.1.1.4. Teams will receive written confirmation from the Competition Committee, informing them of whether their competition application was successful or not.

3.1.1.5. Teams selected for the competition will be published on the website.

3.1.1.6. Following successful application, any change to the team composition for organisational reasons shall be limited to a maximum of one person per team. The team spokesperson also has the option to remove individual team members from the team.

3.1.2. Application documents

3.1.2.1. In order for a competition application to be valid, the following documents are required:

3.1.2.1.1. Team description

The team description must contain the following as a minimum:

- Team name
- Team photo
- Brief institution presentation
- Team self-introduction
- Team motto
- Team members with name, nationality, photo, Email address, motto (a maximum of five team members)
- Team spokesperson (one of the maximum five team members)

The team description will be published on the website. Offensive, racist, or advertising content is therefore not permitted and will result in rejection of the application.

3.1.2.1.2. Project description or academic abstract

The project description should include the ideas for vehicle programming, and the planned scientific approach (e.g., learning technique to be used). Ideally, preliminary statements with regard to project extensibility and portability to other autonomous driving challenges should be covered here.
If participation is included in university teaching, for example through accompanying teaching events or practical training, this should also be mentioned here.
Usually this document is in the range of three to ten pages.
Note: Will not be published!

3.1.2.1.3. Team members' self-description

A brief description of team members' prior career with thematic focal points.
Note: Will not be published!

3.1.2.1.4. From each individual team member, a signed copy of the Audi Autonomous Driving Cup 2018 terms and conditions, and a declaration of consent to recording of film, sound, and photography from Audi Autonomous Driving Cup 2018 participants.

Both documents can be found in the website downloads area. Teams who do not include these fully completed and signed documents in their application documentation will not be taken into account for team selection.

3.1.3. Team selection

3.1.3.1. The Competition Committee selects the teams based on the application documents submitted.

3.1.3.2. The Competition Committee's decision is final.

3.1.3.3. Only those teams who fulfil all requirements specified in Sections 2.3, 2.4 and 3.1.2 will be included in the selection.

3.1.3.4. A maximum of ten teams is allowed and will be nominated by the Competition Committee.

3.1.3.5. Participation of a maximum possible number of higher education institutes will take precedence over participation by multiple teams from one higher education institute during selection.

3.2. Implementation phase

3.2.1. Fundamentals

3.2.1.1. The implementation phase is made up of the kick-off, team preparation (training, programming, local testing, etc.) and a test event.

3.2.2. Kick-off

3.2.2.1. Fundamentals

3.2.2.1.1. The kick-off is an information briefing during which the sequence of competitive events, as well as the vehicle and development environment with system software will be presented in detail.

3.2.2.1.2. Participation by all team members is strongly recommended.

3.2.2.1.3. Participation by the team spokesperson of the participating teams is, however, mandatory.

3.2.2.1.4. If necessary, the respective professor or academic assistant of the professor may attend the event following prior notification.

3.2.2.2. Content

3.2.2.2.1. Overview and organisation of the entire competition
- Scheduling
- Test event travel/accommodation
- Tournament and final travel/accommodation
- Schedule of test event, tournament, and final

3.2.2.2.2. Vehicle presentation
- Sensors
- Actuators

3.2.2.2.3. Framework presentation
- ADTF middleware
- Hardware interface

3.2.2.2.4. Control presentation
- Tasks
- Course
- Rules
- Evaluation Criteria

3.2.2.2.5. Questions and answers

3.2.2.2.6. Issue of vehicles

3.2.3. Preparation

3.2.3.1. During the preparation, each team must independently construct facilities for local testing (see 4.3.1).

3.2.3.2. The corresponding master copies for the base elements of a tournament track (course maps, traffic signs, markers, etc.) can be found in the website download area.

3.2.4. Test event

3.2.4.1. The test event takes place over three days.

3.2.4.2. During the test event, all teams come together for the first time and have the opportunity to spend two days on a large tournament course, intensively testing, further developing, and comparing their current progress with the other teams.

3.2.4.3. On the third day of the test event, the teams tackle the first tasks under competition conditions, and the Competition Committee draws up a team ranking. This is the qualifying for the final tournament.

3.2.4.4. Only the first eight teams in this ranking may take part in the tournament and final.

3.3. Tournament and final

3.3.1. Fundamentals

3.3.1.1. The tournament and final are the highlight of the competition, when the eight best teams from the test event come together and compete against one another under the same conditions.

3.3.1.2. In order to participate in the tournament and final, the team must publish the entire program code in accordance with the requirements in 4.2.5.

3.3.1.3. The overall tournament winner is determined in three stages:
- A mandatory programme of driving tasks
- Academic lecture
- A free demonstration, in which participating teams can demonstrate a task of their choice
- A final with unknown driving tasks, in which the winner is determined from the three first-place winners from the first two stages

3.3.1.4. The tournament takes place over three days.

3.3.2. Day 1 (free training)

3.3.2.1. Course visit

3.3.2.2. Meeting of team spokespersons
- Organisational
- Final rules briefing

3.3.2.3. Free training
Final tests and adjustments on the competition course

3.3.3. Day 2 (mandatory programme)

3.3.3.1. Meeting of team spokespersons
- Handover of mandatory programme manoeuvres list
- Drawing of lots to determine mandatory programme sequence

3.3.3.2. Delivery of configured vehicles to the parc fermé and inspection by the Competition Committee

3.3.3.3. Driving tasks
- Teams start in reverse test event placing order (8th to 1st place)
- The time available for the driving tasks is 20 minutes, plus a 5 minute setup time/buffer

3.3.3.4. Presentation of scientific approaches
- The presentation duration is 30 minutes each
- (20-minute lecture + 5-minute discussion)

3.3.3.5. Competition Committee evaluation of mandatory programme

3.3.3.6. Conference dinner/party

3.3.4. Day 3 (free demonstration & final)

3.3.4.1. Meeting of team spokespersons
- Ranking notification following mandatory programme

3.3.4.2. Free demonstration: Open demonstration, 2018 motto: artificial intelligence
- The teams start in reverse mandatory programme order
- Presentation duration is 20 minutes each, inclusive of setup time/buffer
- The team spokesperson of the respective team delivers the presentation
- Presentation of a maximum of one slide containing the key lecture points is permitted

3.3.4.3. Open demonstration evaluation by Competition Committee

3.3.4.4. Joint lunch

3.3.4.5. Meeting of team spokespersons
- Announcement of the final ranking for places four to eight, and the three finalists

3.3.4.6. Final: Unknown driving tasks
- Final of the three finalists in reverse order, thus third placed first, then second placed, and finally first placed

3.3.4.7. Competition Committee evaluation of unknown driving tasks

3.3.4.8. Award ceremony

4. Competition rules

In addition to the rules defined in Section 3, during the tournament and final in particular, the following rules apply.

4.1. Fundamentals

4.1.1. Rulebook

4.1.1.1. The Competition Committee specifies the rules applicable to the respective competition.

4.1.1.2. The rules are changed between competitions and further developed.

4.1.1.3. By kick-off of an in-progress competition at the latest, the Competition Committee discloses the competition rules, or publishes them on the website.

4.1.1.4. Rules violation will result in disqualification from the current competition.

4.1.1.5. In addition to the rules defined in this document, the Federal Republic of Germany road traffic regulations (StVO) are to be observed for the test event, tournament, and final, driving tasks. This concerns in particular – but not exclusively – the following regulations:

- Compliance with right of way rules (StVO, Part I, §8)
- When anyone wishes to turn or park, this must be clearly indicated in a timely manner; direction indicator lamps are to be used for this. (StVO, Part I, §9, para. 1)

4.1.2. Changes to the Rulebook

4.1.2.1. The Competition Committee reserves the right to change the rules.

4.1.2.2. Proposed changes can be submitted at any time via the corresponding forum board on the website.

4.1.2.3. Rule changes once a competition is in progress (after kick-off) are not envisaged.

4.1.2.4. In justified exceptional cases (Rulebook error, ambiguities, etc.), however, the Competition Committee expressly reserves the right to change the rules also once a competition is underway.

4.1.2.5. Where the Competition Committee makes changes to the Rulebook, the most recently dated Rulebook that can be retrieved from the website is always binding. It is the responsibility of participants to make themselves aware of the most up-to-date Rulebook version via the website during the ongoing competition.

4.2. Vehicle and software environment

4.2.1. Vehicles for nominated teams

4.2.1.1. At the kick-off, AUDI AG provides teams eligible for the competition with two 1:8 scale model vehicles, free of charge, for the duration of their participation.

4.2.1.2. The team must use these vehicles to implement its algorithms, and to compete in the tournament and final.

4.2.1.3. The vehicles are to be treated with appropriate care.

4.2.1.4. If, however, a defect should occur in a vehicle, the respective team is responsible for restoring its vehicle to driveable condition. Any required drawings and parts lists can be found in the website download area.

4.2.1.5. It is expressly forbidden to make changes or optimisations to the hardware provided by Audi, and use of the hardware for other vehicles is also not allowed. Changes made to the hardware will result in exclusion from the competition. An exception to this is the replacement of faulty hardware with an identical module according to the parts list.

4.2.1.6. The Competition Committee expressly reserves the right to inspect the vehicle for changes.

4.2.1.7. The Competition Committee will equip the vehicle bodies with the competition logo and start numbers. Attachment of university and/or team logos is expressly permitted, but must remain limited to the surfaces authorised by the Competition Committee. Attachment of additional sponsor logos is strictly prohibited.

4.2.1.8. A detailed description of the vehicles can be found in the website download area.

4.2.1.9. On departure from the competition, i.e. on the last day of the test event or after the final, the vehicle is to be returned to AUDI AG immediately. All non-public documents are to be deleted from the vehicle prior to its return. Changed settings (e.g., proxy server, special usernames, passwords, etc.) are to be reset to the original condition.

4.2.2. Vehicles from registered, but not nominated, teams

4.2.2.1. Should teams apply for competition participation that are not nominated by the specialist Audi Competition Committee, they may register to participate in the kick-off, test event, and qualifiers. The Competition Committee has to confirm the registration to approve the participation. They must, however, then bring their own model vehicle with them, which must have an identical structure to that of the competition vehicles. This will be determined by specialist Audi Competition Committee inspection, carried out by the start of the test event at the latest.

4.2.2.2. Up to two model vehicles can be registered to take part in the competition. This maximum of two model vehicles is then approved for participation in the competition following inspection by the Competition Committee. Participation is permitted only with a fully authorised model vehicle and approval by the Competition Committee.

4.2.2.3. Only vehicles approved by the Competition Committee are permitted to take part in the subsequent competition and tournament, including the final.

4.2.2.4. Approved vehicles may not subsequently be changed. Defective components may be replaced with structurally identical modules only.

4.2.2.5. The Competition Committee expressly reserves the right to inspect the vehicle for changes.

4.2.3. Base software

4.2.3.1. Basic software for operating the vehicles is specified by the organiser and made available under the BSD licence. The actual base software version, together with a detailed description, is available in the website download area.

4.2.3.2. This base software for the 2018 competition provides all resources required to control the vehicle, i.e., its sensors and actuators, and contains of a number of ADTF filters.

4.2.3.3. The base software must be used, may not be changed, and will be substituted with the latest version prior to tournament start. Change requests are to be submitted via the website forum.

4.2.3.4. The Competition Committee reserves the right to optimise the base software at any time in terms of performance and stability, and to publish the latest version on the website. The interfaces to the base software will remain unchanged in all cases.

4.2.3.5. Only the latest software version made available on the website is valid for the tournament.

4.2.4. Demo software

4.2.4.1. In addition to the base software, demo software modules are also supplied with the vehicle, which contain sample implementations of individual functionalities, but which are not necessarily optimised in terms of speed of execution or accuracy.

4.2.4.2. The use of this demo software is not mandatory but is allowed.

4.2.4.3. In addition to the demo software supplied, the program code written by the finalists of the previous competition will be made available at a minimum.

4.2.5. Program code

4.2.5.1. The given base software forms the basis for the program code of participating teams and must be used.

4.2.5.2. There are no restrictions on participating teams in terms of program code creation. This is the actual part of the competition. In order to ensure equal competition conditions, the following restrictions must, however, be observed:

4.2.5.2.1. Program code creation is limited to high-level architecture and data processing. The framework (ADTF middleware, hardware interfaces) is fixed and cannot be arbitrarily changed or replaced. Changes to the high level architecture are subject to the same conditions as rule changes (see 4.1.2).

4.2.5.2.2. Third-party material may also be used, as long as this does not result in infringement of another's copyright, and the material is distributed under an open source or free software licence and does not contravene the conditions described in Section 4.2.5.3. The only exception to this is ADTF, which is licensed for the competition by the event organiser. The terms and conditions of the Audi Autonomous Driving Cup regulate this in more detail.

Note: You can find a list of free licences at http://opensource.org/licenses

4.2.5.3. A mandatory component of competition participation is publication of the entire program code under the BSD licence. For the eight teams participating in the tournament and final, publication prior to the tournament is mandatory.

4.2.5.4. By the first day of the tournament at the latest, the Competition Committee will verify program code publication.

4.2.5.5. Subsequent changes to the program code (for example for the final) are to be included in the published code accordingly.

4.2.5.6. Failure to comply with these requirements will result in disqualification from the current competition.

4.2.6. Jury module

4.2.6.1. The jury module is an ADTF filter with graphical user interface. It is used for basic tournament control by the Competition Committee and sends its commands to the vehicle via a defined interface.

4.2.6.2. This jury module is the only authorised interface for vehicle control during the tournament. Any other interaction with the vehicle during the tournament is expressly forbidden.

4.2.6.3. The teams themselves are responsible for implementing the interface to the jury module in their software, and for responding to jury module commands. More information can be found in the AADC software manual. The jury module itself is included in the demo software.

4.2.7. Vehicle positioning

4.2.7.1. The positioning algorithm is provided as an ADTF module. To do this, the vehicle odometry (speed signal, 6D acceleration sensor), and regular position synchronisation using the traffic and supplementary "Test track A9" signs from Section 4.3.2 positioned on the track, are used.

4.2.7.2. The vehicle position must be periodically transmitted to the backend for visualisation purposes on a monitor. The ADTF "Network" module is to be used here. The visualization takes place in an openDrive formatted map of the track (scale 1/8). This map material gets delivered to the competitors as well in openDrive format.

4.2.8. Communication with the backend

4.2.8.1. The vehicle is capable of communicating with a backend.

4.2.8.2. The vehicle position is to be sent cyclically (10 Hz) to the backend.

4.2.8.3. The protocol to be used can be found in the vehicle documentation.

4.3. Competition track

4.3.1. Course

4.3.1.1. The course for the tournament and final is assembled from 1m x 1m panels.

4.3.1.2. The panels are dark anthracite with white lines (like a street).

4.3.1.2.1. The width of the lines is 30 mm for roadway boundaries (outer lines), 20 mm for lane boundaries (dashed centreline) and 50 mm for stop lines.

4.3.1.2.2. The dashes of the dashed centreline have a length of 297.75 mm and a distance from one another of 200 mm.

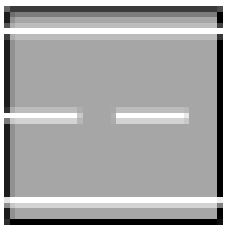
4.3.1.2.3. The inner roadway width is 440 mm.

4.3.1.2.4. All bends are formed from circular segments.

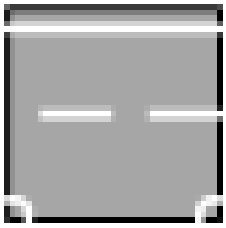
4.3.1.3. The course of the road on the track for the tournament and final is specified by the Competition Committee and announced at the tournament only.

4.3.1.4. The competition track will contain the following course elements at a minimum:

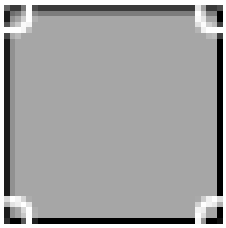
4.3.1.4.1. Straight lines



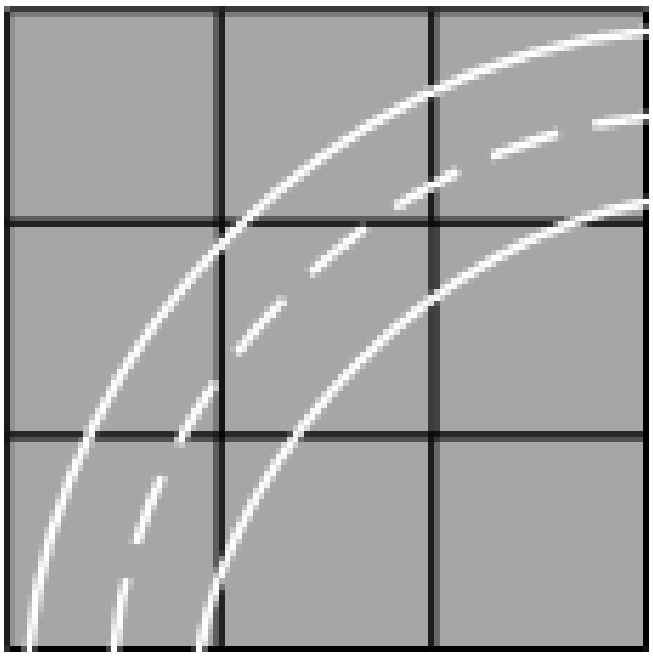
4.3.1.4.2. T junctions



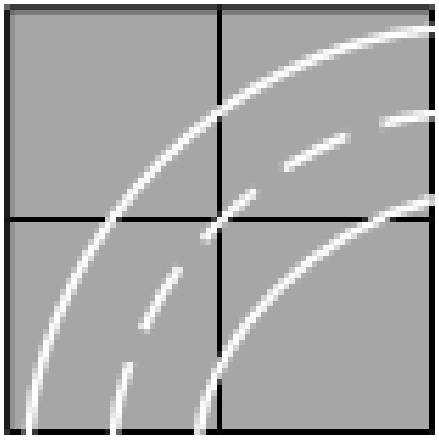
4.3.1.4.3. Crossings



4.3.1.4.4. 90° bend, large

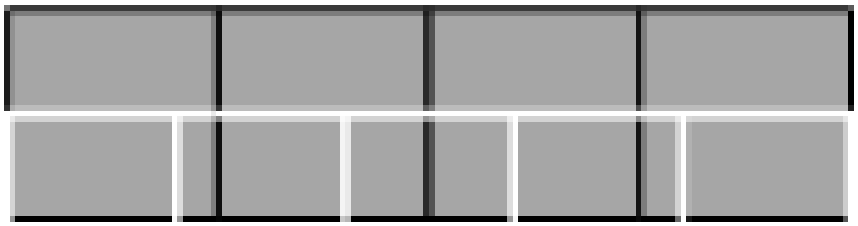


4.3.1.4.5. 90° bend, small

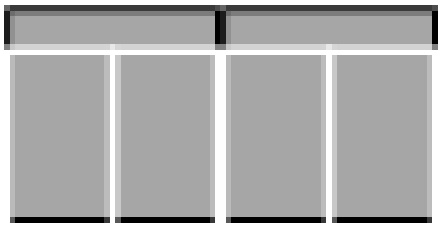


4.3.1.4.6. Parking space, parallel

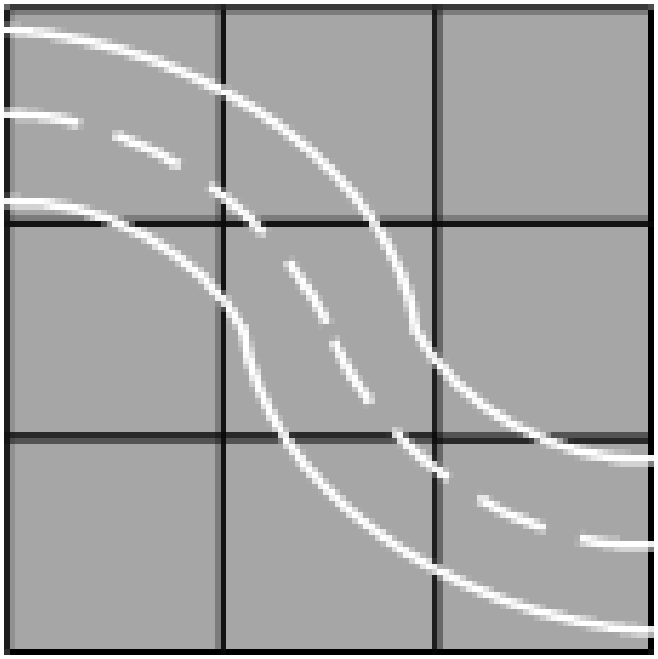
Note: (Not used in AADC 2018, placeholder)



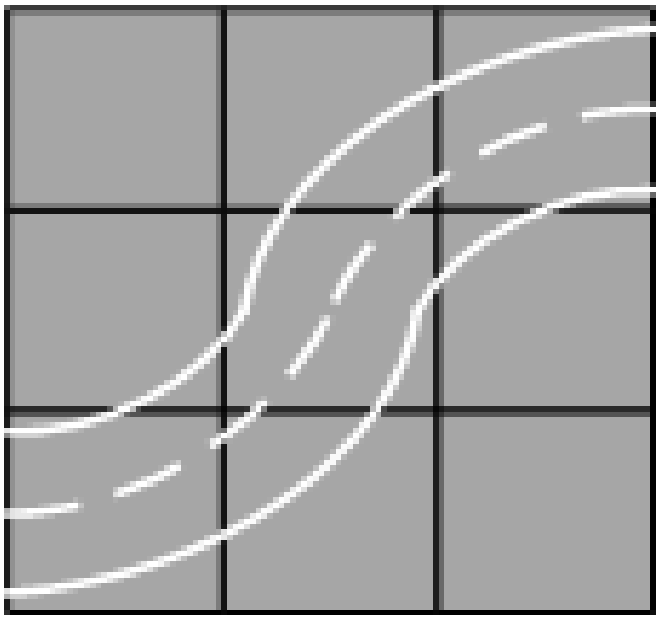
4.3.1.4.7. Parking space, cross



4.3.1.4.8. S bend

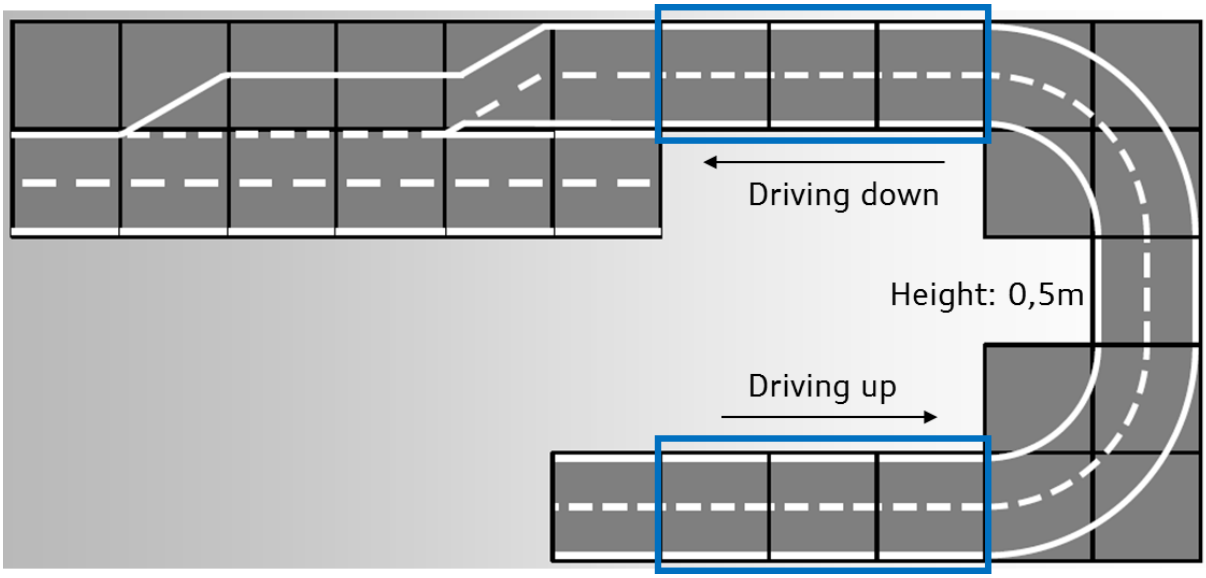


or



4.3.1.4.9. Ramp and merge szenario

The blue Elements representing the ramp to drive up and drive down. After driving down there is the merging scenario.



4.3.2. Traffic signs

4.3.2.1. The type and position of traffic signs on the competition track are specified by the Competition Committee and announced at the tournament only.

4.3.2.2. Traffic signs are also equipped with a unique marker (below the sign), to allow easier detection of the sign. It is planned to dispense with this aid for future competitions.

4.3.2.2.1. The markers are implemented as bit codes.

4.3.2.2.2. The markers have a minimum size of 10 cm x 10 cm.

4.3.2.2.3. The markers associated with traffic signs are listed as traffic sign images in 4.3.2.3.

4.3.2.3. The competition track may contain the following traffic signs:

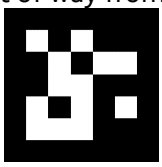
4.3.2.3.1. Give way (StVO, sign: 205)

At junctions displaying this sign, a white stop line will also be placed on the course panel.

4.3.2.3.2. Stop. Give way. (StVO, sign: 206, "stop sign")

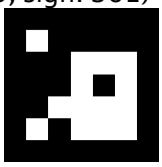
At junctions displaying this sign, a white stop line will also be placed on the course panel.

4.3.2.3.3. Crossing with right of way from the right (StVO, sign 102)

At junctions displaying this sign, a white stop line will also be placed on the course panel.

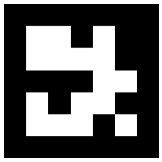
4.3.2.3.4. Right of way (StVO, sign: 301)

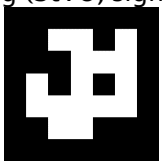
4.3.2.3.5. Mandatory direction of travel straight ahead (StVO, signs: 209-30)

(Not used in AADC 2018, placeholder)


4.3.2.3.6. Parking (StVO, sign: 314);

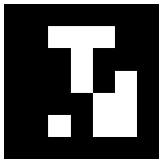



4.3.2.3.7. Pedestrian crossing (StVO, sign: 350)

4.3.2.3.8. Roundabout (StVO, sign: 215)

(Not used in AADC 2018, placeholder)

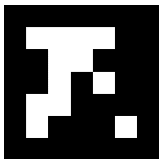
4.3.2.3.9. No overtaking by vehicles of any kind (StVO, sign: 276)

(Not used in AADC 2018, placeholder)


4.3.2.3.10."Test track A9" traffic sign

This sign is only uses for positioning purposes.


4.3.2.3.11.Roadworks (StVO, sign: 123)

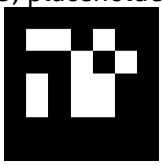



4.3.2.3.12.No entry (StVO, sign: 267)

(Not used in AADC 2018, placeholder)


4.3.2.3.13.One-way street (StVO, sign: 220)

(Not used in AADC 2018, placeholder)



4.3.3. Traffic lights

4.3.3.1. The use of traffic lights is omitted. The use of traffic lights is planned for future competitions.

4.3.4. Tunnels

4.3.4.1. It is possible that part of the course may be fully or partially covered.

4.3.5. Buildings

4.3.5.1. It is possible that buildings or building-like structures are set up adjacent to the road.

4.3.6. Plants

4.3.6.1. It is possible that trees or other plants are set up adjacent to the road.

4.3.7. Lighting conditions

4.3.7.1. In general, changing light conditions similar to those found in normal road traffic can be expected (e.g. tunnel entrance/exit, direct sunlight with shadows).

4.3.7.2. Largely homogeneous illumination will be ensured for the majority of the course. This cannot, however, be entirely guaranteed.

4.4. Driving tasks during the test event and tournament (mandatory programme)

4.4.1. Manoeuvre list

4.4.1.1. Each team will receive a manoeuvre list prior to tackling the driving tasks. The manoeuvre list will be an XML file containing an ordered list of manoeuvres that the vehicle must execute.

4.4.1.2. The manoeuvres used are listed in the following table:

Manoeuvre	Action
left	Turn left at the next crossing
right	Turn right at the next crossing
straight	Go straight ahead at the next crossing
merge_left	Merge left into left lane
merge_right	Merge right into left lane (note: not used in 2018, placeholder)
parallel_parking <ID>	Parallel-park in the next parking space on the right in the direction of travel (note: not used in 2018, placeholder)
cross_parking <ID>	Cross-park in the parking space with given <ID> on the right in the direction of travel
pull_out_left	Exit parking space to the left (from parking space, straight ahead looking in the direction of the street. In conjunction with cross parking only)
pull_out_right	Exit parking space to the right (from parking space, straight ahead looking in the direction of the street)

4.4.1.3. The manoeuvre list specifies only the sequence of individual manoeuvres, not the time of execution. The vehicle shall select the time automatically based on external influences, i.e. detected traffic signs or crossings.

4.4.1.4. The manoeuvre list is also divided into different sectors (see 0).

4.4.1.5. Within the driving route defined in this way, all driving tasks (see 4.4.3) are encountered at least once. One exception is the test event, in which only a subset of the driving tasks is executed.

4.4.2. Sectors

4.4.2.1. Sectors are specific track sections within the course. They are made up of a list of manoeuvres, which must be repeated in full in the event of an incorrectly executed manoeuvre, or an emergency stop by the Competition Committee.

4.4.2.2. A sector can be repeated up to three times at the request of the team spokesperson for the respective team. A manual restart of the corresponding sector takes place via the jury module.

4.4.2.3. A sector can be omitted at the request of the team spokesperson for the respective team. A manual start of the next sector takes place via the jury module.

4.4.2.4. The sequence of the sectors must always be respected, i.e., a cancelled or omitted sector cannot subsequently be repeated.

4.4.2.5. Times are measured on individual sectors. The time measurement will be included in the assessment.

4.4.3. Basic driving tasks

4.4.3.1. Crossing task I
- Vehicle arrives at a crossing with the "Give way" or "Stop. Give way" sign
- Oncoming slow traffic from the right on the road with right of way

4.4.3.2. Crossing task II
- Vehicle arrives at a crossing and must turn left
- Oncoming slow traffic

4.4.3.3. Parking task I
- Cross parking right
- The end of the parking procedure must be signalled by a stop of at least 3 seconds with hazard warning lights active.

4.4.3.4. Parking task II (note: omitted in 2018, placeholder)
- Parallel parking right
- The end of the parking procedure must be signalled by a stop of at least 3 seconds with hazard warning lights active.

4.4.3.5. Driving distance task
- Driving behind or overtaking another vehicle

4.4.3.6. Emergency braking scenario task
- Suddenly occurring obstacle

4.4.3.7. Merge into lane
- Merge into lane, set appropriate indicator left/right and take care about possible traffic.

4.4.3.8. Obstacle on the road
- There can be obstacles on the road. These obstacles have to be overtaken. If a lane change is necessary the indicators (left, right) must be used.

4.4.4. Backend communication

4.4.4.1. There will be communication to the backend. This year we will only transfer the cars position to visualize it on a map. The competitors have to make sure that the related ADTF filters are included in the ADTF configuration correctly.

4.4.4.2. The last years (2017) tasks like transfer obstacle position, free parking space communication or traffic sign communication is not scope of 2018 AADC.

4.4.5. Map data and Positioning

4.4.5.1. The map is provided by a given openDrive formatted file. With this information the competitors get additional options to use this map data to improve the performance of all the driving tasks. The usage is optional.

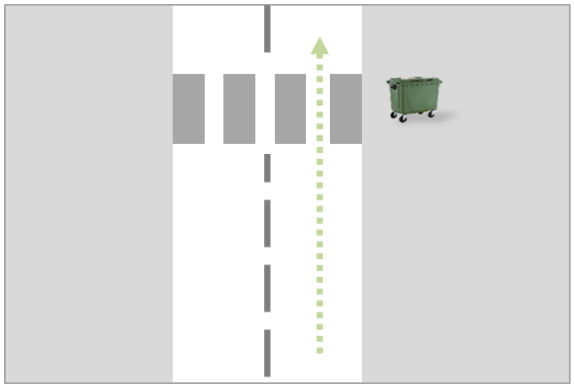
4.4.5.2. The map data (openDrive formatted file) will be transferred from the jury tool at the beginning of the drive, together with the manoeuvre list.

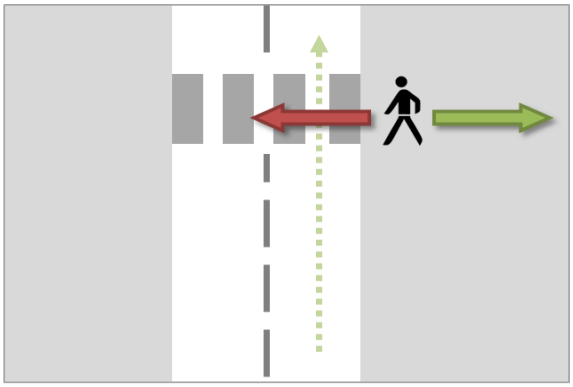
4.4.5.3. There will be an ADTF filter that provides the position information of the car. This position can be noisy. The accuracy is better than 20cm around the exact car position.

4.4.6. Artificial intelligence-related driving tasks

4.4.6.1. "Zebra crossing" task

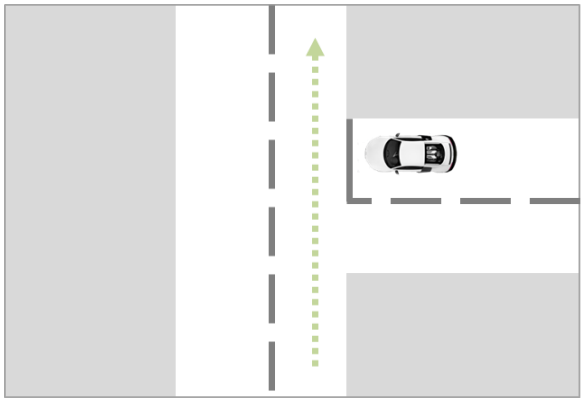
The vehicle must be able to autonomously distinguish between people and other objects. This includes giving way to people crossing the zebra crossing.

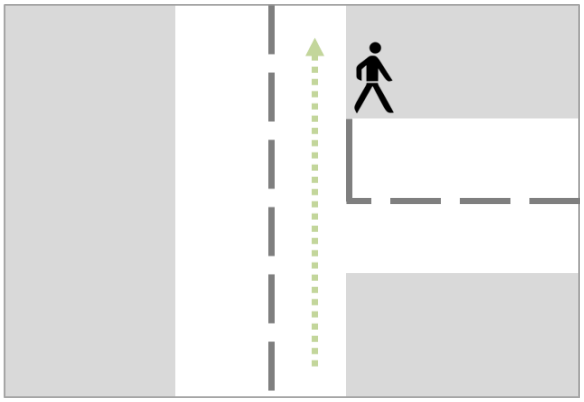




4.4.6.2. "Crossing" task

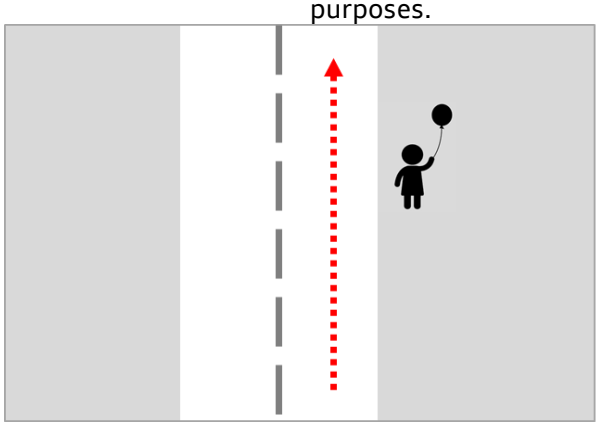
The vehicle must be able to autonomously distinguish between people and vehicles. If a vehicle is detected, right of way must be granted where applicable in accordance with the traffic regulation. If a pedestrian is detected, his/her orientation must be used to determine whether he/she is crossing the road in front of your vehicle, so the vehicle must wait.

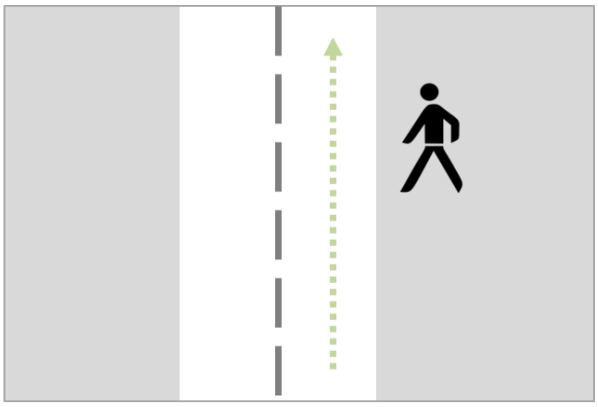




4.4.6.3. "Adult versus child" task

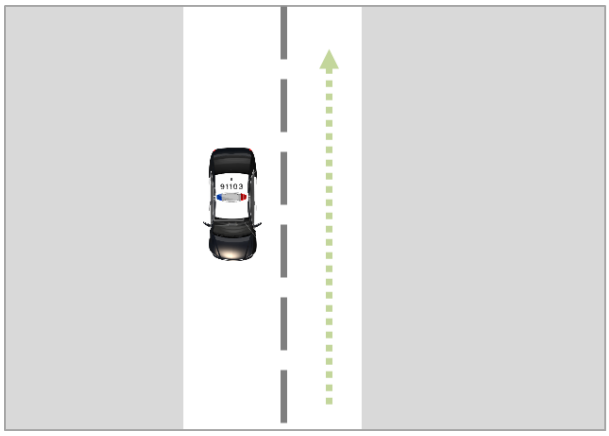
- The vehicle must be able to distinguish between adults and children. If a child is detected, the speed shall be reduced and this shall be indicated by the brake lights. For adults, the scenario can remain with no action.
- Each team will be provided with one child and one adult doll for training purposes.

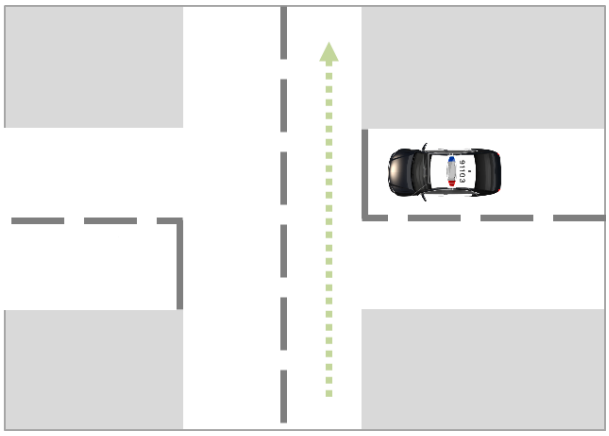




4.4.6.4. "Yielding to Emergency Vehicles" task

- The car must yield the right-of-way to any emergency vehicle using a siren and emergency lights. Drive to the right edge of the road and stop until the emergency vehicle have passed. However, never stop in an intersection.
- If you are in an intersection when you see an emergency vehicle, the emergency vehicle has right of way in every case even when is has a stop sign. You always have to stop and give the emergency vehicle right of way.





4.4.7. Schedule

4.4.7.1. The overall time specified for completing all driving tasks in the tournament (see 3.3.3.3) is selected such that the driving tasks can be executed with no time pressure.

4.4.7.2. A signal sounds at the end of the timeslot and ends the current execution. Any sector not completed at this point is not counted.

4.4.7.3. Should the time be insufficient for all tasks, the sectors that were not driven are not counted.

4.4.7.4. The Competition Committee expressly reserves the right to a hardship case rule, for example for the case where a team has a serious hardware error.

4.4.8. Sequence of events

4.4.8.1. The sequence of driving tasks in the test event and final is divided into the following steps:

- The vehicle receives a manoeuvre list to be loaded.
- The team is given time to prepare the vehicle. The vehicle is then brought to the start position by the team spokesperson.
- The Competition Committee connects to the vehicle and controls the sequence within the manoeuvre list via the jury module.
- The index of the next manoeuvre is set via the jury module, and vehicle readiness is verified.
- Following release by the jury module, the vehicle software begins to execute the manoeuvre list.
- The Competition Committee observes and evaluates the drive through the respective sectors. Should errors occur, the vehicle is stopped via the jury module and must be placed at the corresponding sector start by the team spokesperson. The sequence is then continued from item four of this list.
- Once the manoeuvre list has been processed, the vehicle stops and reports that it has completed the program run.

4.5. Academic lecture during the tournament (mandatory programme)

4.5.1. Content

4.5.1.1. Software architecture for driving tasks

- Presentation of own software architecture
- Presentation of modules and algorithms used

4.5.1.2. Driving tasks using artificial intelligence

- Presentation of the driving tasks that are using AI approaches
- Which machine learning techniques are used?

4.5.1.3. Free demonstration task

- Which task was chosen, and why?
- How was the task tackled?

4.5.2. Schedule

4.5.2.1. The lectures duration is 20 minutes.

4.5.2.2. 5 minutes are allowed at the end of each lecture for questions and discussion.

4.6. Free demonstration in the tournament (freestyle)

4.6.1. Content

4.6.1.1. The freestyle content of the 2018 competition is under the motto of "closed loop function, artificial intelligence and car2x". The demonstration itself is freely selectable.

4.6.1.2. By "closed loop function, artificial intelligence and car2x ", we mean application of the following approaches:

- Ideas of driving functions in combination with smartphones
- Use if AI-algorithms to fulfil the functional task
- Communication, data transfer to a backend

4.6.1.3.

4.6.1.4. “artificial intelligence” means:

- Reinforcement learning: learning based on experience
- Supervised/unsupervised learning
- Deep learning

Here, the following tasks can be tackled in the form of a demo:

- Solving of classification tasks
- Generalisability
- Voice control
- Driving functions
- etc.

4.6.1.5. To do this, each team chooses a task for itself and demonstrates the fulfilment of this task with its vehicle.

4.6.1.6. The course may be used, but this is not required. If tools (other tracks, other surfaces, etc.) are required, the team itself is responsible for their procurement. A complex installation is not recommended. In any case, special features must be clarified in advance with the Competition Committee.

4.6.1.7. The free demonstration should firstly comply with the motto, but also be presented in the form of a presentation with audience appeal.

4.7. Unknown driving tasks in the final

4.7.1. Participants

4.7.1.1. Only the three most highly placed teams take part in the final; i.e., the teams with the highest overall score from the tournament.

4.7.2. Content

4.7.2.1. In the final, driving tasks are executed in the same way as during the tournament, except the selection of tasks is unknown and may also include tasks not described in this Rulebook.

4.7.2.2. The final tasks, in the same way as the tournament tasks, are based on road traffic situations.

5. Evaluation

5.1. Fundamentals

5.1.1.1. Evaluation of all competition parts is the responsibility of the Competition Committee.

5.1.1.2. The overall competition winner is decided by the Competition Committee.

5.1.1.3. Decisions taken by the Competition Committee are final.

5.1.1.4. Specified times shall be strictly adhered to at all times. After the specified time has expired, the Competition Committee will interrupt the task execution by the respective team.

5.2. Test event, Qualifying

5.2.1. Driving tasks evaluation criteria (4.4.3)

The qualifying will address a selection of all possible driving tasks specified in 4. That means all scenarios described are possible. The connection to the jury tool is obligatory. The criteria of selection are the same like in the tournament.

5.2.2. Point deduction

5.2.2.1. Points will be deducted in all cases for each infringement of these rules or of the StVO.

5.2.2.2. Infringements not explicitly listed below may, however, be penalised with a point reduction by the Competition Committee. The Competition Committee will seek to maintain commensurability. However, decisions taken by the Competition Committee are final.

5.2.2.3. The following offences in particular will result in point deduction:

- Leaving own lane (per second)
  (Exception: correctly indicated and executed overtaking, driving over inner bend lines at crossings)
- Incorrectly indicated changes of direction (indication incorrect or not executed)
- Collision with obstacles or traffic signs

5.3. Driving tasks during the tournament (mandatory programme)

5.3.1. Fundamentals

5.3.1.1. Points are awarded for each successfully completed sector. The maximum score for a sector derives from the sum of a basic score for a sector and a score for the tasks occurring in the sector.

5.3.1.2. For each restart of a sector, the maximum achievable score for the sector is reduced by 25% of the original maximum score.

5.3.1.3. For sectors that are not completed successfully or are omitted, no points will be awarded or subtracted.

5.3.1.4. Special points can be awarded to the five fastest teams in sectors with time measurement.

5.3.1.5. The rules listed in 5.2.1 and 5.2.2 apply to driving task evaluation and any point deduction.

5.4. Academic lecture during the tournament (mandatory programme)

5.4.1. Criteria

Evaluation of the academic lecture is based on the following criteria:

- Originality of the idea/approach
- Level of scientific maturity
- Transferability to series vehicles (relationship to reality)
- Preparation/lecture style
- Time compliance

5.4.2. Result

5.4.2.1. Each Competition Committee member will receive a questionnaire, and can evaluate the performance of the demonstrating team according to the criteria listed in 5.4.1 by awarding points.

5.4.2.2. The total score for the respective team derives from the arithmetic average of scores from Competition Committee members.

5.5. Free demonstration in the tournament (freestyle)

5.5.1. Criteria

Evaluation of the free demonstration is based on the following criteria:

- Task originality
- Quality of the implementation in practice
- Coolness factor and aesthetics

5.5.2. Result

5.5.2.1. Each Competition Committee member will receive a questionnaire, and can evaluate the performance of the demonstrating team according to the criteria listed in 5.5.1 by awarding points.

5.5.2.2. The total score for the respective team derives from the arithmetic average of scores from the Competition Committee members.

5.6. Overall tournament ranking

5.6.1. Result

5.6.1.1. The overall tournament results derive from the three individual scores according to the following percentage weighting:

- 50% tournament driving tasks
- 15% academic lecture during the tournament
- 35% free demonstration during the tournament

5.7. Final

5.7.1. Result

5.7.1.1. Assessment of the three final participants will be made exclusively by the Competition Committee. The assessment will be based on the criteria described in 5.2.

5.7.1.2. The final placing results from the overall tournament result and the final result, according to the following percentage weighting:

- 50% tournament result
- 50% final result