

Delta X Self-Driving Competition Rules

1. INTRODUCTION

The Delta X self-driving competition is a software challenge for developing autonomous driving solutions using toy cars. The emphasis is put on software, with no changes to the hardware allowed. The cars are equipped with a camera, driving decisions are expected to be mainly based on this camera input.

The goal of the competition is to inform students about self-driving technologies and offer them hands-on experience in the field.

The track and toy cars are made available in September 2020, the solutions must be submitted by 13 January 2021. Beyond the rules stated in this document, this competition abides by the [general rules](#) of the Delta X competitions.

Credit points

In autumn semester 2020, a 6 ECTS course "Autonomous Vehicles Project" (LTAT.06.012) will be organised. Participation in the Delta X self-driving competition is one of the possible projects in that course. The course will be taught by Lecturer of Autonomous Driving Naveed Muhammad. Participation in this competition can be used as a course project in various other courses, e.g. Machine Learning (MTAT.03.227) taught by Dmytro Fishman.

Thesis and internship opportunities

The task of this competition closely relates to the work done in the University of Tartu Autonomous Driving Lab. One of the goals of the competition is to inform students and wider audiences about the competences and work done in the Autonomous Driving Lab.

This competition provides students with a good opportunity to learn more about autonomous driving technology, including image processing, path planning, controller modules, etc. Being familiarised with and having experience in these topics will help students to get noticed by the Autonomous Driving Lab team and will increase their chances of doing an internship or thesis in the lab. This competition is also sponsored by companies interested in the field of autonomous driving.

2. COMPETITION RULES

Below, we list the main rules of the competition. If you have doubts or questions not covered by these rules, contact the organisers (Ardi Tampuu ardi.tampuu@ut.ee). The rule "what is not

forbidden, is allowed” is not applied here. Conversely, unless coordinated with organisers, custom tricks might be forbidden after you have put considerable effort into them.

The main instructions and information page of the competition is:

<https://courses.cs.ut.ee/t/DeltaX2021SelfDriving/Main/HomePage>

In there you find instructions for connecting to the car and driving it manually (data collection), for controlling it via Python code and additional materials.

2.1 TASKS AND PRIZES

There are two tasks. The main prize will be given in the Autonomous driving - Fastest Lap challenge.

1. **Autonomous driving - Fastest Lap.** The created autonomous driving solutions need to complete a lap as fast as possible, driving alone on the track.
2. **Autonomous driving - Grand Prix.** Selected human drivers and fastest autonomous systems are placed on the track simultaneously. The first car to finish a lap wins.

In all the tasks, collisions are not penalised, unless they put in danger the safety of the car. In that case, the car is removed from the track and the attempt does not count. The decision of car safety is an arbitrary decision made by the organisers; however, this should be an extremely rare occasion, considering the speed and type of the car.

Jury prize for advanced approach

It's undecided, but here might be a special prize for the solution the jury finds most applicable in real-car autonomous driving.

2.2 HARDWARE

The RC cars that will be used in this project are provided by RCSnail (<https://rcsnail.ee/>). The cars measure 190x80x60mm and weigh 280 grams. See the picture of the car below.



Figure 1: Remote-controlled car equipped with a camera and Wi-Fi connection.

The only external sensor onboard the RC cars is a single frontal camera. The camera provides HD images in 1280x640 resolution with a frequency of 30 frames per second. The latency between the camera capturing the frame and the server receiving it is approximately 100-150 milliseconds.

The car also provides access to its state, which consists of the current steering, throttle, gear, and braking values. Throttle, braking and steering have real numbered values. Gear takes values -1, 0, 1 for reverse gear, neutral gear, and forward gear.

The top speed of the car depends on the surface of the track. But it is no higher than a few meters per second.

2.3 RESTRICTIONS ON THE CREATED SOFTWARE AND COMPUTATIONAL RESOURCES

To claim the prizes, competing solutions must make their driving decisions based on image inputs. Image-dependent driving-decisions must be taken with higher frequency than 1Hz. The way of using image input is not restricted - it can be hand-designed heuristic rules or advanced machine learning models, mapping-and-localization based solutions or other. Solutions may not consist in replaying a recorded set of actions.

There are no restrictions on the computational resources the teams can use. The organisers do not provide access to a computing cluster, but the participants are allowed to use hardware or web services of their choice.

For claiming the prizes, the created software must be labelled with a **free-to-use licence**, so that the next generation of students could learn from it. The code must be made available to the organisers via a GitHub repository. The repository should be private at first but made public to claim the prizes.

An example of a forbidden solution is a model that replays one or multiple predefined sequences of commands (lasting the entire lap or significant parts of a lap, respectively), because in that case

the driving is not based on image input (or images are used very rarely). Rule-based solutions inherently make use of predefined commands that follow the fulfillment of certain criteria in the input. This is allowed, if the input is compared and decisions made regularly, say every one second. Defined behaviour between two decisions should not last longer than one turn on the track.

2.4 FINAL COMPETITION, END OF JANUARY

The same track will be used for the final competition, but its location in the Delta building might be changed for better accessibility of spectators. The direction the car traverses the track in the final competition is decided before the competition by a coin-toss.

Solutions must be submitted by 13 January at the latest. If necessary, a preliminary round will be held to determine the teams whose solution is good enough to be allowed to the competition. If there are many teams with competitive results, the organisers will do their best to include as many teams as possible in the final competition (e.g. by limiting the time or number of laps per team).

Fastest lap

Each team has two laps to score the fastest time. The two laps are not driven in a row. For the second lap, the car is stopped and placed again inside the starting area. The teams have a few minutes to change car parameters (e.g. max speed) before the second attempt.

The **launching time** of AD programs **will be discounted** from the lap time, as the lap time is measured from a video recording from the moment of the car starting to move until crossing the start marker again.

Grand Prix

The best human driver and two best Autonomous Driving solutions will be given control of cars placed side by side in the starting area, with the fastest qualifiers (as per Fastest Lap challenge) choosing their starting spot first. At the start command, all programs are launched, and humans are allowed to start driving. **The launching time of AD programs is not discounted from the result.** The participants should implement instant start functionality that does not incur any loading times. The driver (human or not) to complete a lap and the first autonomous solution will be awarded prizes.

2.5 TEAM FORMATION

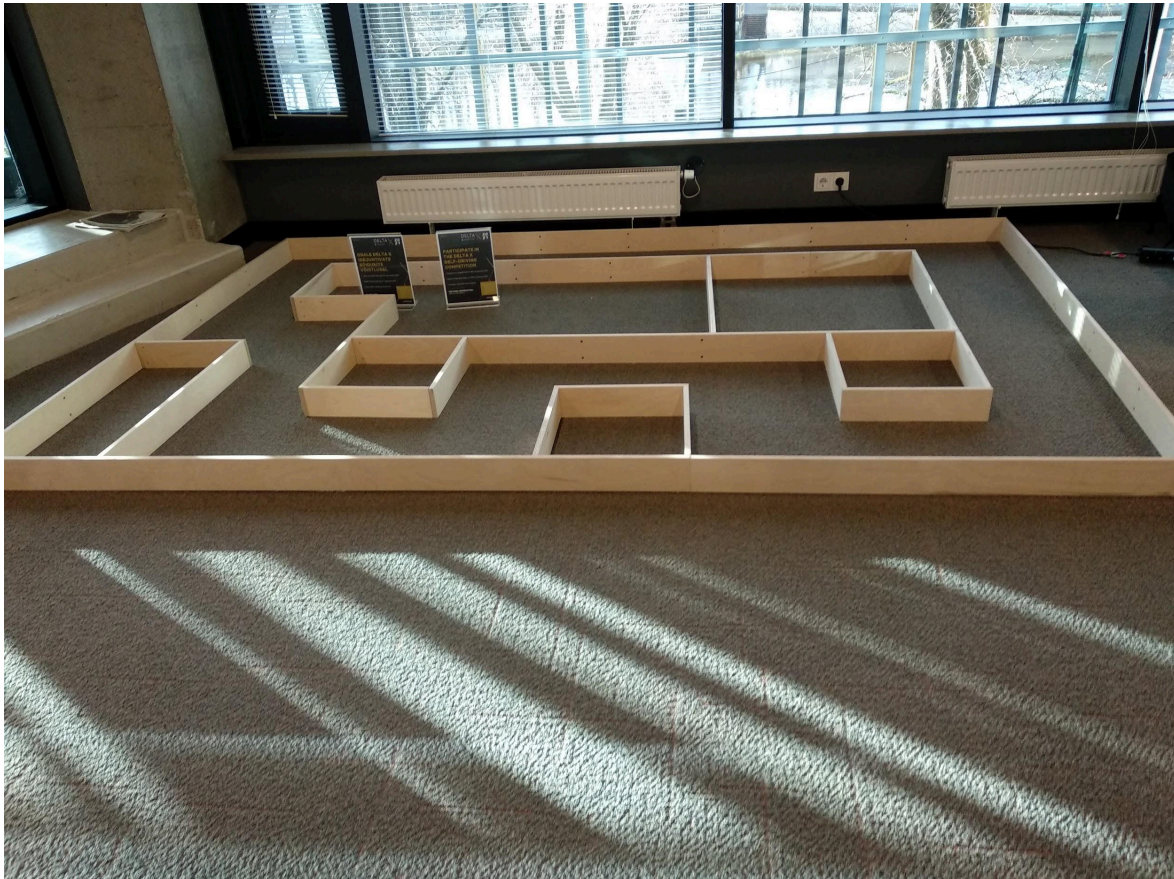
- A team may have up to five persons and a supervisor. However, teams are encouraged to collaborate in the early stages of the competition, e.g. for data collection. The team can find a supervisor who does not count as a team member.

Figure 2: The competition track. The surrounding walls and walls within the track are 10 cm high. The starting area will be positioned on the long straight.

- As per Delta X general rules, at least half of the members of each team must be students.
- The last deadline for registering teams to the self-driving competition is 30 November. To register your team, write to Ardi Tampuu (ardi.tampuu@ut.ee). **Exceptions can be made.**

2.6 TRACK DETAILS

The track is formed by placing plywood walls with the height of 10 cm into a rectangular area of 3.2 x 2 metres. The width of the drivable area (track) is approximately 40 cm.



The surface of the track is covered by the carpet covering the floors of the Delta building.

2.7 AVAILABILITY OF DATA

The organisers will provide a small curated dataset for participants because some teams might be located far from the track in the Delta Centre where data can be generated. The dataset contains recordings of human driving, with video frames and recorded driving commands.

<https://owncloud.ut.ee/owncloud/index.php/apps/files/?dir=/data&fileid=87360958>

The data consists of recording folders. Each folder contains a JSON file that contains the timestamps of all images in the frames folder and the commands the car received (also timestamped). See the readme file and instructions linked on

<https://courses.cs.ut.ee/t/DeltaX2021SelfDriving/Main/HomePage> .

The participants might nevertheless find it useful to generate their data by driving the car on the track. The video feed from the car can be observed on the screen and the car can be controlled via keyboard or video game controller.

There is no support from the organisers' side for remote data collection and testing of the car for teams not located in Tartu. Such teams will have access to driving recordings to train their models and to compare their models' outputs with. However, they must find a person to place the car on the track in Delta Centre to test the autonomous driving ability of their solution in the real world (on the track). A person is needed to be present at the track to take the car from storage (and return it), be responsible for the car, place the car into the starting grid, monitor whether the driving is safe for the car, change batteries if needed, etc.

However, if a sufficient number of teams are interested, intermediate test-competitions could be held at an agreed time. In such events, the teams not physically present can also participate.

2.8 DATA COLLECTION SCHEDULE

Teams can book times at the track by contacting the organizers via writing to ardi.tampuu@ut.ee. If agreed between themselves, multiple teams can work at the track simultaneously. There will be certain restrictions for track usage:

- Due to the cost of the vehicles, they must be received and returned to the organisers in person. This means that the possible recording times will be most probably during the working hours.
- Each team will have a limited amount of time they can book per week. If the track is available by other teams, any team can also use the track beyond their booked time.
- The organisers have the right to pre-book some time slots for their usage or for a team (e.g. from outside of Tartu) that specifically needs some timeslot.

3. CHANGES AND CANCELLATIONS IN RULES

The organisers maintain the liberty of making any changes to the rules if such need arises. However, the changes will be justified and explained to the participants.