F1TENTH Autonomous Racing **(Due Date:)**

Final Project

Instructor: INSTRUCTOR *Name:* STUDENT NAME, *StudentID:* ID

Course Policy: Read all the instructions below carefully before you start working on the assignment, and before you make a submission. All sources of material must be cited. The University Academic Code of Conduct will be strictly enforced.

1 Overview

The objective of your final project submission is to win in two car head-to-head racing. There are multiple weekly milestones to guide you through this process. We have also provided an evaluation environment to test your solutions.

2 Project Milestones

2.1 Week 1

Tasks:

1. Install multi-vehicle racing simulator and run tests.
2. Work on project proposal and decide approach to solving upcoming tasks.

Evaluation:

1. Completion
2. Proposal feedback

Guidelines: Your project proposal should contain these points:

1. Hypothesis: we think that doing ___ will improve the performance of our vehicle in head-to-head racing because ___.
2. Planning approach
3. Perception/prediction approach
4. Control approach

5. For tasks: single vehicle, static obstacles, and two-vehicle racing
6. Measurement: how you will evaluate your results and how you will show that what you did was useful.
7. Timeline for task completions.

2.2 Week 2

Tasks:

1. Single car run with no obstacles.

Evaluation:

1. Leaderboard will be maintained, scored like other timed races

2.3 Week 3

Tasks:

1. Demonstrate single-car run with static obstacles
2. Demonstrate two-car run with instructor provided agents as the opponent

Evaluation:

1. Collision frequency
2. Present project proposal to instructors

2.4 Week 4

Tasks:

1. Two-car racing benchmark with instructor provided agents

Evaluation:

1. Collision frequency
2. Win rate
3. Agent ELO

3 The Final Race

Two vehicles will race in the multi-agent simulator on the Skirkanich Track. There will be two round of evaluations. **Evaluation I:** Performance of your agent will be evaluated against a collection of 10 agents of increasing quality supplied by instructors. You will be given access to a similar (but different) set of such solutions to practice on. **Evaluation II:** Round-robin tournament of all teams seeded by results of Evaluation I.

4 Environment Installation

All instructions can also be found in the README here.

4.1 Installing Docker

Before cloning the environment repository, you'll need to install Docker. You'll also need ROS on your host system. You can follow the instructions here to install Docker, and you can find a short tutorial here if you're not familiar with Docker.

4.2 Cloning the Repository and building the Docker image

After you've installed Docker, you'll need to clone the repository here into the **src directory of your catkin workspace**. You can then build the docker image by:

```
$ cd f1tenth_gym_ros
$ sudo ./build_docker.sh
```

Sudo may or may not be needed depending on how you've set up your Docker installation. This will take around 5 minutes to build depending on your system.

4.3 Run the containerized environment

After the Docker image is built, you can run the containerized environment by running:

```
$ sudo ./docker.sh
```

Again, sudo may or may not be needed here depending on how you set up your Docker installation. You can check everything is working by running this in a new terminal in the host system:

```
$ rostopic list
```

You should see a few topics like the usual `/rosout`, and topics provided by the environment like `/scan` etc.

4.4 Developing and running the environment

To run an example agent, run `catkin_make` in your workspace that contains the environment and source the corresponding `setup.bash` file. And then run:

```
$ roslaunch f1tenth_gym_ros agent_template.launch
```

To see an example launch file, you can checkout `launch/agent_template.launch`. This launch file will bring up the bridge node, and a pre-configured RViz window. By launching this, you should see the blue car (ego) staying at the starting point, and the orange car (opponent) going around the track.

If you want to create your own launch file, please include the following lines in your custom launch file to bring up the bridge node and the pre-configured RViz window: `<include file="$(find f1tenth_gym_ros)/launch/gym_bridge_host.launch"/>`

4.5 Available Topics

1. `/scan`: The ego agent's laser scan
2. `/odom`: The ego agent's odometry
3. `/opp_odom`: The opponent agent's odometry
4. `/map`: The map of the environment
5. `/race_info`: The information of the environment including both agents' elapsed runtimes, both agents' lap count, and both agents' collision info.

5 Project Evaluation Criteria

5.1 Topics

Empirical Milestones: Milestones 1-4 and final race performance, evaluated on weighted sum of quantitative score.
Written Report: Project proposal and written report, evaluated on instructor rubrics, formatting, and quality of writing.
Documentation and code: Maintain and document a GitHub repository, evaluated on validity of documentation, existence of unit tests etc.
Presentation: Proposal presentation and final presentation, evaluated on completion, instructor rubric, and submission of deliverable and assets.
Novelty (Bonus Points): Holistic assessment of the project submission, evaluated on claims of solution and exploration of related work.

5.2 Rubrics

Topics	**Points**
Empirical Milestones	30
Written Report	30
Documentation/Code	20
Presentation	20
Novelty (Bonus)	5
Total	100(+5)