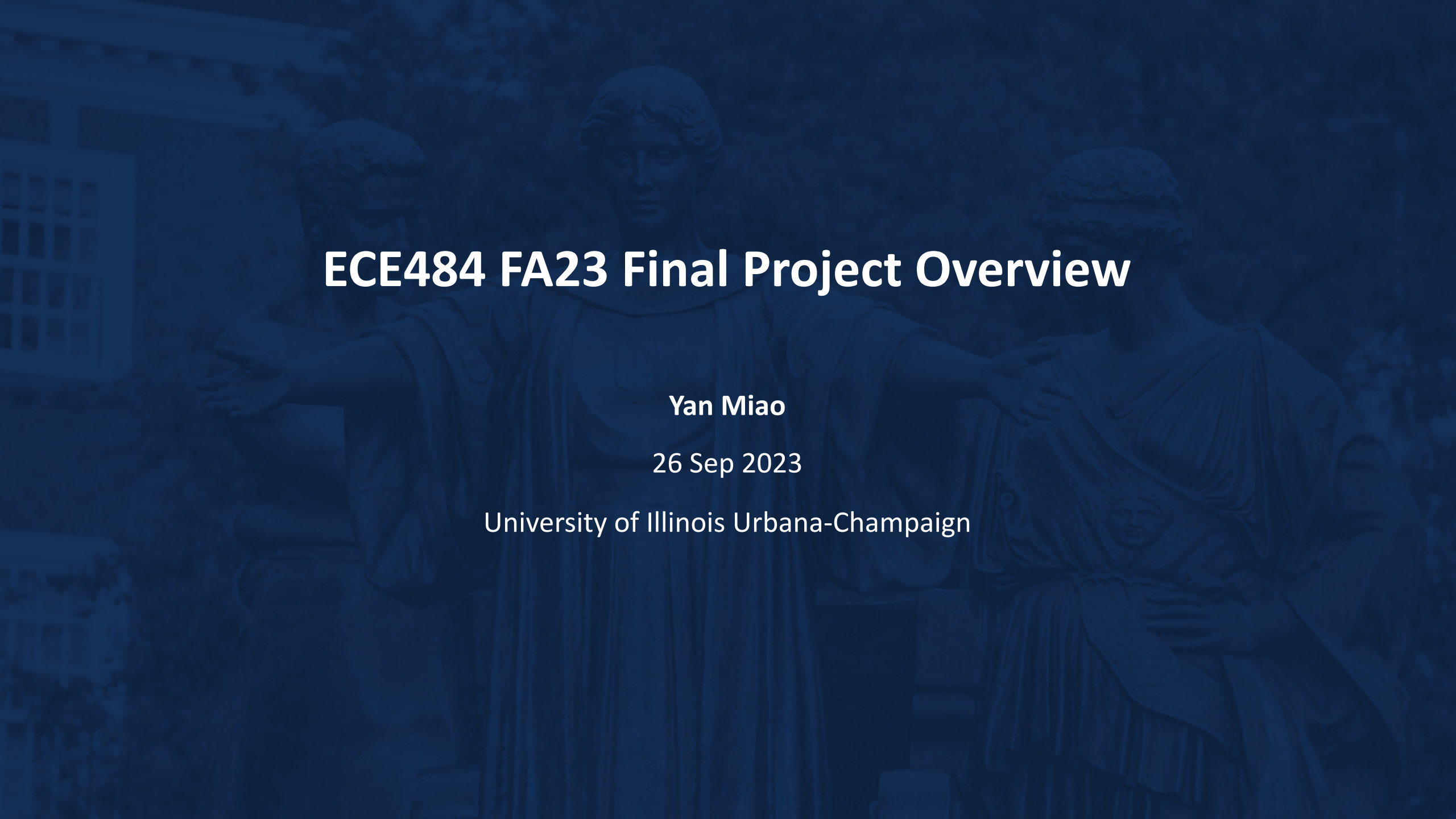


ECE484 FA23 Final Project Overview

Yan Miao

26 Sep 2023

University of Illinois Urbana-Champaign

Overview

- **Important Announcement**
- **Project Timeline**
- **Project Goal**
  - F1-tenth
  - GEM e2
  - **GRAIC**
- **Staff Team**
- **Q&A**

Important Announcement

Important Notes

- **Read the documentation carefully**
  - For example:
    - “lab computer does not have ROS installed so I cannot finish this”, we have “source /opt/ros/noetic/setup.bash”
    - Missing 4th rosbag in MP1 Demo
    - Check Campuswire regularly
- **Office Hour Usage**
  - Start your work early, office hour are largely empty for first couple weeks of MPs
  - Open OH this Friday(9/29) for exam questions during discussions
- **ECEB 5072 / GEM / F1-Tenth**
  - Do not globally install libraries (E.g. nvidia-driver mismatch)
  - Report non-working lab computer immediately
- **Read online Linux / Python Tutorial**

Logistics

- **HW0-1, MP0-1**
  - Grades out by end of today (9/26)
  - Regrades due by 10/3 through private post on Campuswire
  - Regrades feedback by 10/10
- **Exam1**
  - 10/3 during lecture time
  - Details refer to Campuswire post
- **HW2, MP2**
  - Due 10/6
- **HW3, MP3**
  - Release on 10/13
  - Due on 10/27
- **Projects**

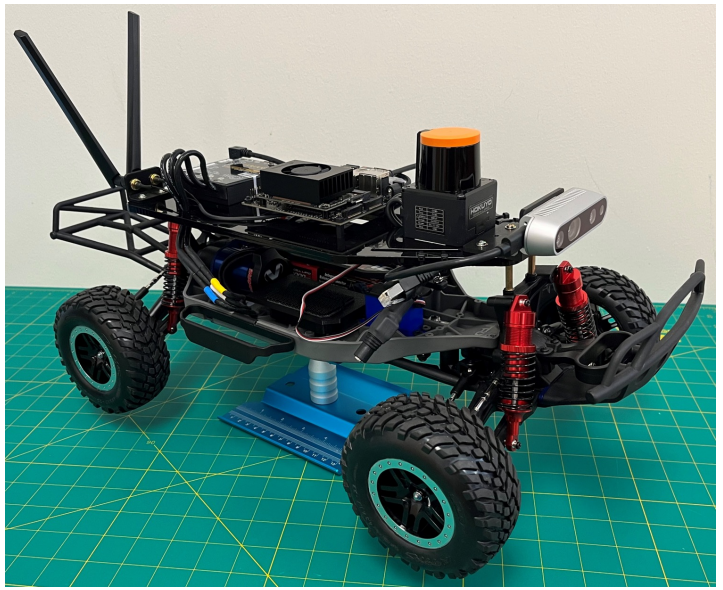
Project Timeline

Project Timeline

- **10/3**: Google Form for team sign-up (2-4 people, can be different from MP)
- **10/10** Finalize Team Assignment & Start Safety Training
- **10/24-26**: Pitch Presentation (10%)
- **11/10**: Mid Check-in (10%)
- **11/30, 12/5**: Final Presentation (30%)
- **12/12**: Final Report(40%), Videos (10%)

Project Goal

F1-tenth



- **Sensor: Camera**, 2D LiDAR, Vicon 3
- **Control: Ackermann (Steering + Speed)**

- **Goal: Lane Detection and Lane Following**
  - F1-tenth should rely ONLY on Camera to complete 3 laps with state estimation

- **Extra Credit: Obstacle Detection and avoidance (5% project grades)**
  - For example:
    - F1-tenth should stop safely in time when obstacle appears on any part of lane
    - Speed Control over different part of tracks

- **Note the extra time and constraints the hardware project have**
  - E.g. Safety Procedure; IRL Reservation; Equipment; Lighting; Calibration

GEM

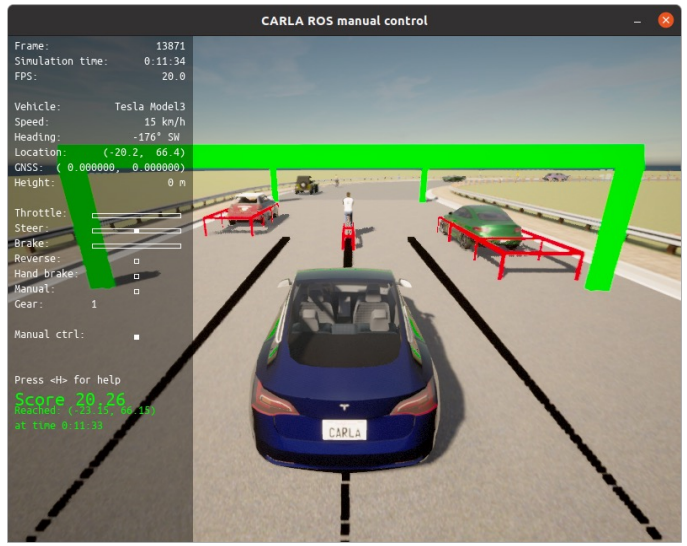
- **Sensor: Camera,** 3D LiDAR, GPS, Radar
- **Control: (Throttle, Brake, Steering)**

- **Goal: Lane Detection and Lane Following**
  - GEM should rely ONLY on Camera to follow curve lanes with state estimation at Highbay

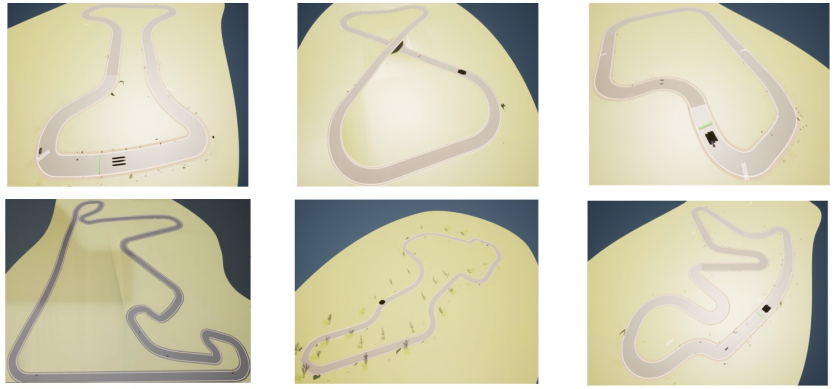
- **Extra Credit: Obstacle Detection and avoidance (5% project grades)**
  - GEM should stop safely in time when obstacle appears on any part of lane
  - Speed Control over Curve

- **Note the extra time and constraints the hardware project have**
  - E.g. Safety Procedure; Highbay Reservation; Weather; Sim-to-Real Gap

GRAIC



- **Sensor: Ground Truth Track Info**
- **Control: (Throttle, Brake, Steering)**
- **Goal: Track Following**
  - Your Controller should finish 4 tracks with 2 scenarios in specified time



- **Extra Credit: Using Vision (5% project grades)**
  - Instead of using ground truth track info, you use camera sensor as inputs.

GRAIC

GRAIC Autonomous Racing Competition

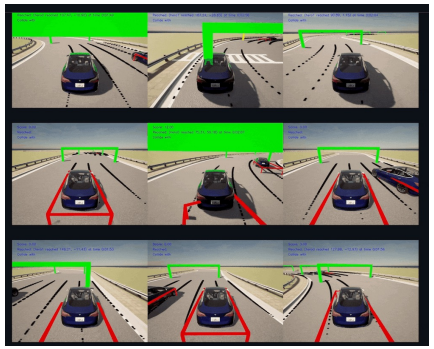
Bring together researchers in AI, robotics & control; platform for comparing algorithms in dynamic and uncertain environments

GRAIC'22 part of CPS-IoT Week, 16 submissions, 5 teams, 3 universities, one company

Outreach: Engineering Open House and the Summer Camp

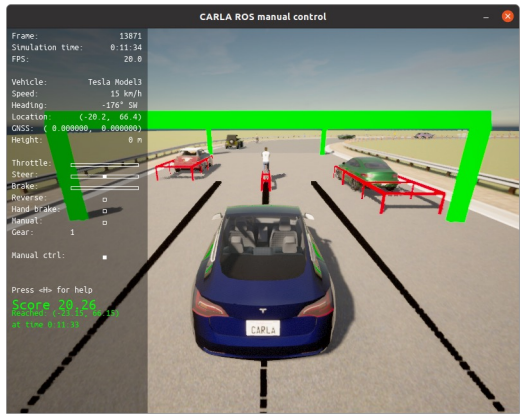
Submitted controllers become ***benchmarks*** for testing and verification research

- Race score a function of timing, collisions, violation of complex race rules (right of way)
- Scoring a controller is a software testing problem

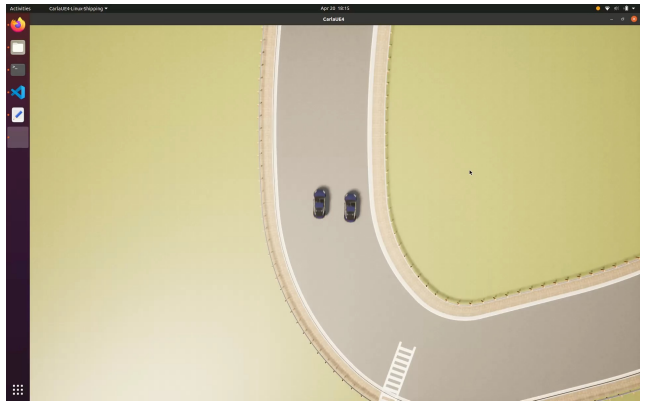


Continuous integration and testing for autonomous racing software. Jiang, Miller, Sun, Ozay, and Mitra. *ICRA 2021 Workshop on Opportunities and Challenges in Autonomous Racing.*

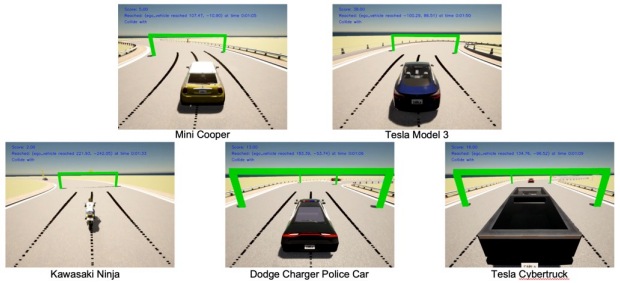
GRAIC Infrastructure



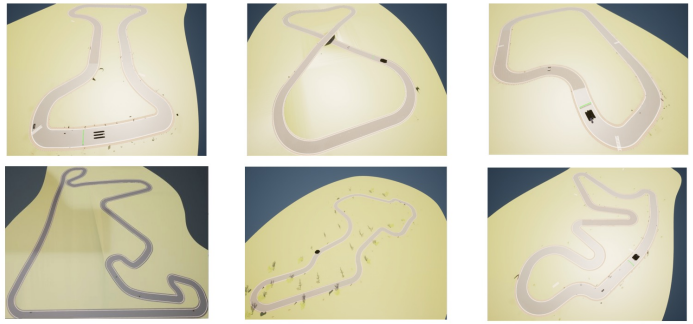
Scenario in GRAIC



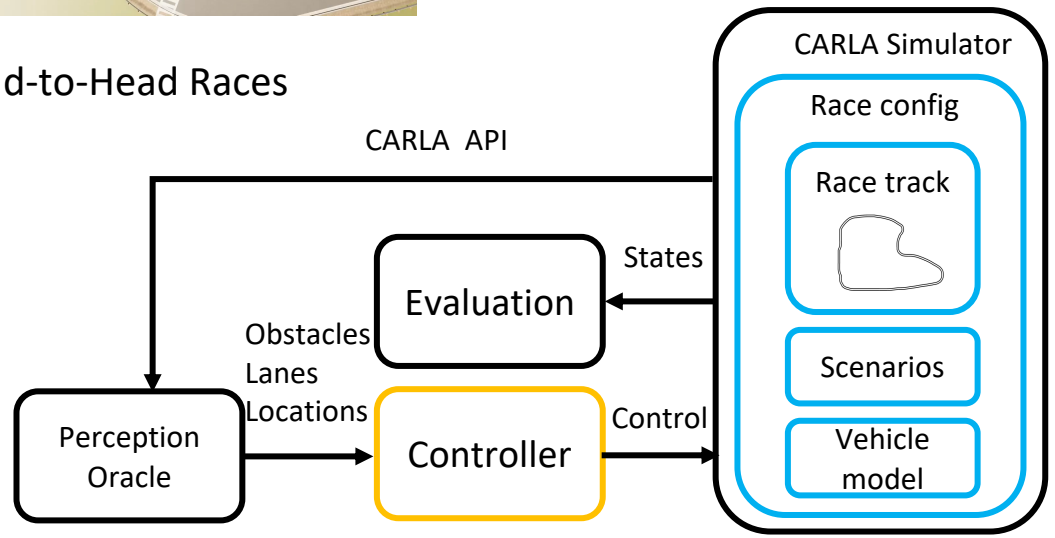
Head-to-Head Races



Vehicle Models



Tracks



Controller and testing environment

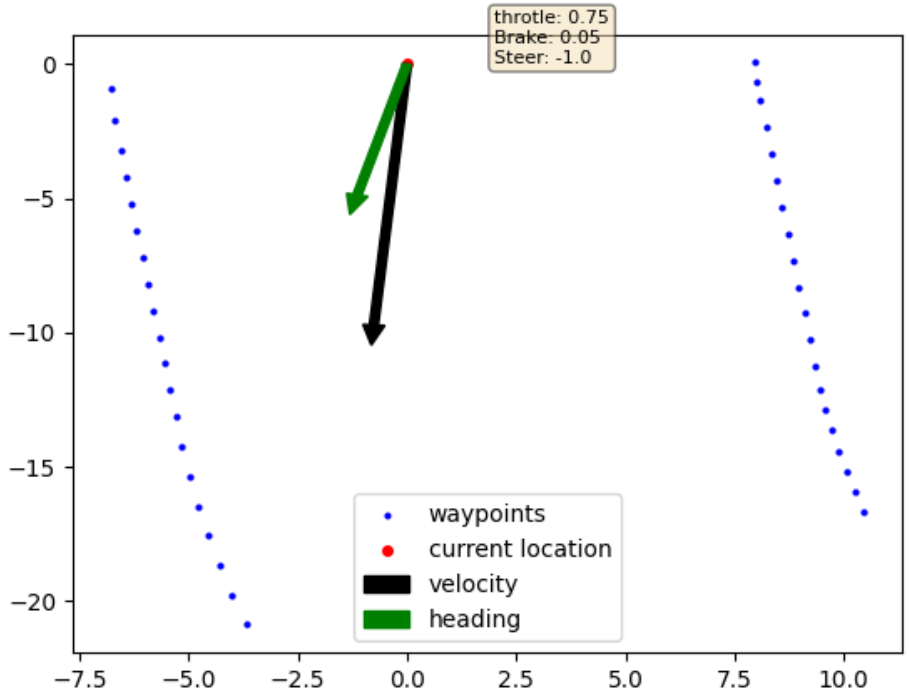
GRAIC interfaces

- Input / Output Interfaces

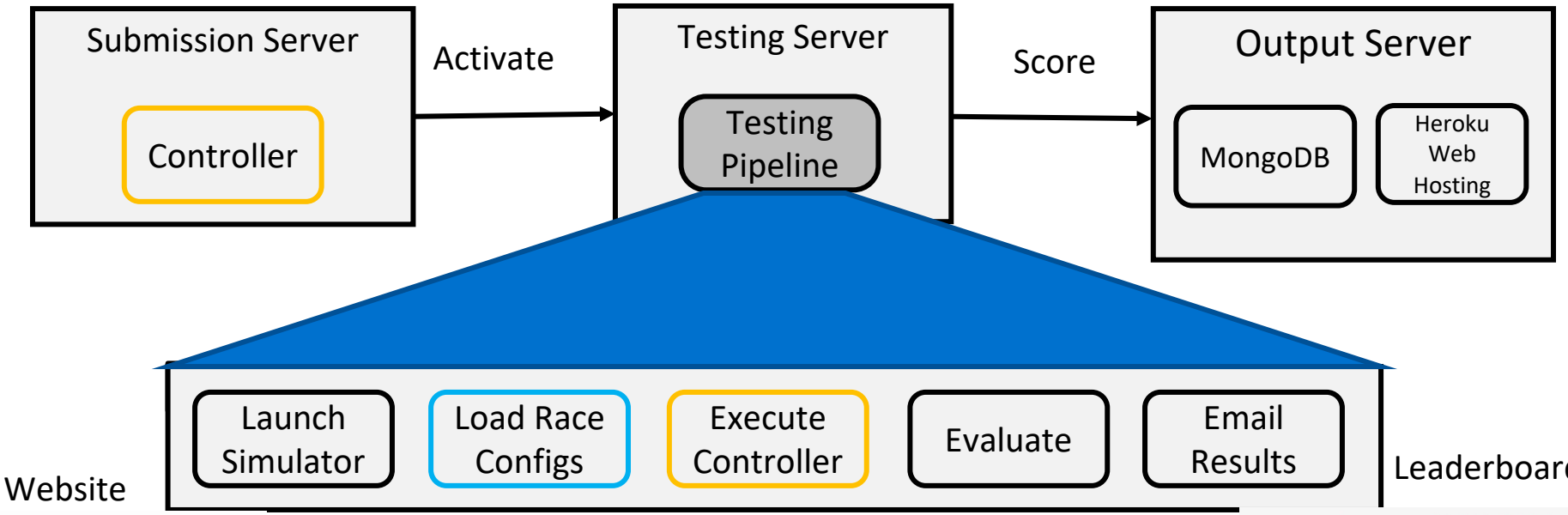
```
def run_step(self, filtered_obstacles, waypoints, vel, transform, boundary):
    """
    Execute one step of navigation.

    Args:
    obstacles
        - Type:        List[carla.Actor(), ...]
        - Description: All actors except for EGO within sensoring distance
    waypoints
        - Type:         List[[x,y,z], ...]
        - Description:  List All future waypoints to reach in (x,y,z) format
    vel
        - Type:         carla.Vector3D
        - Description:  Ego's current velocity in (x, y, z) in m/s
    transform
        - Type:         carla.Transform
        - Description:  Ego's current transform
    boundary
        - Type:         List[List[left_boundary], List[right_boundary]]
        - Description:  left/right boundary each consists of 20 waypoints,
                        they defines the track boundary of the next 20 meters.

    Return: carla.VehicleControl() <Steering + Throttle + Brake>
    """
```

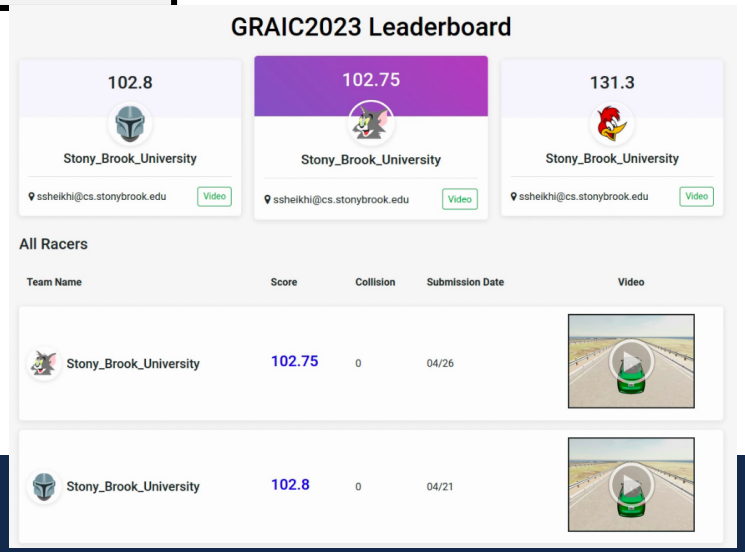


GRAIC Testing Pipeline

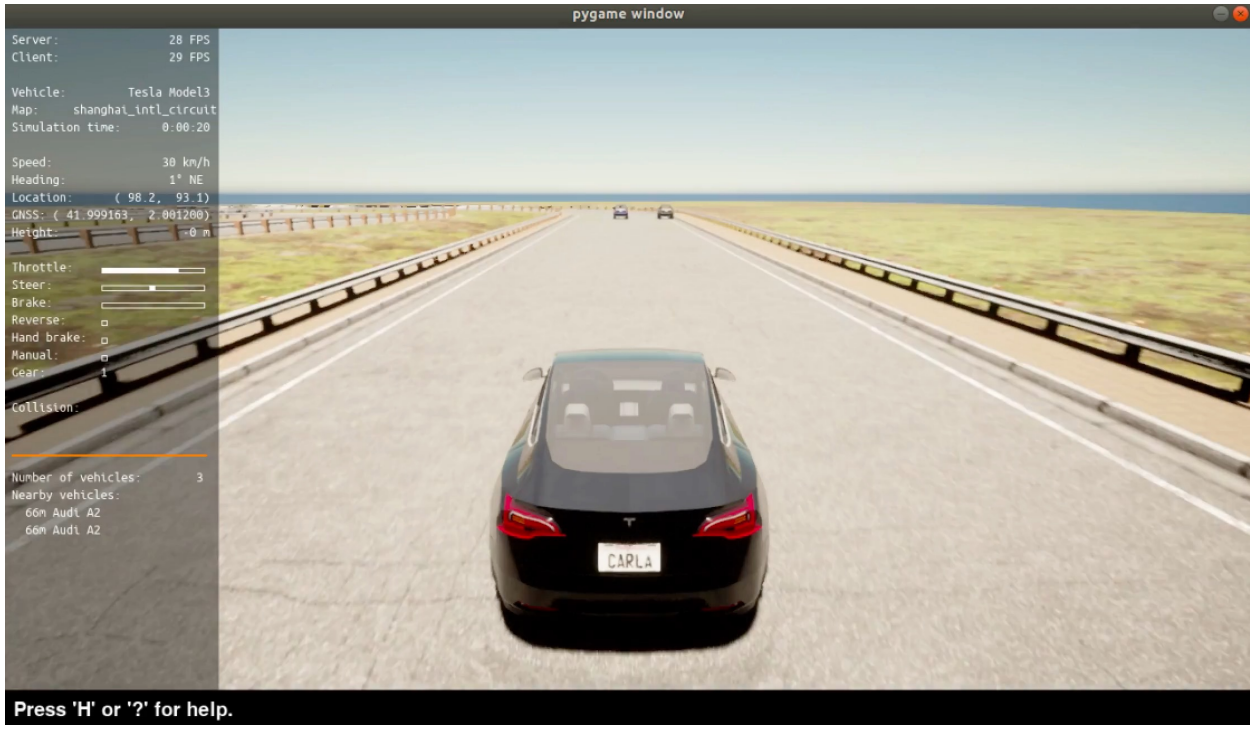


Submission Website

Leaderboard Website



Example of Expected Controller Behavior



Staff Team

Staff Team

- **GEM:** Hongyi, John, Hang
- **F1-Tenth:** Ye-ji, Sumedh, Hang
- **GRAIC:** Yan

Polls & Q&A