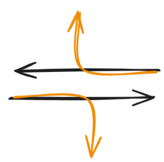
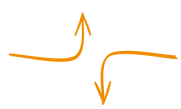
System Overview

The reinforcement learning (RL) task at hand involves optimizing traffic signal control (TSC) at a signalized intersection with four access roads. The goal is to manage traffic flow efficiently by dynamically adjusting traffic signal phases to minimize congestion, delays, and conflicts. The environment consists of a four-legged intersection with six lanes in each direction (north, west, south, and east). Vehicles follow standard movement rules: turning left from the leftmost lane, proceeding straight from the middle or rightmost lane, and turning right from the rightmost lane.

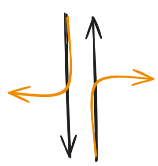
WEG (West-East Green)



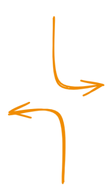
WELG
(West-East Left Green)



NSG
(North South Green)



NSLG
(North-South Left Green)



The action space consists of four predefined traffic signal phases:

1. **WEG (West-East Green)** – Green light for straight and right-turning vehicles in the W-E direction.
2. **WELG (West-East Left Green)** – Green light for left-turning vehicles in the W-E direction.
3. **NSG (North-South Green)** – Green light for straight and right-turning vehicles in the N-S direction.
4. **NSLG (North-South Left Green)** – Green light for left-turning vehicles in the N-S direction.

Each phase lasts a minimum of 10 seconds, with a mandatory 4-second yellow light during transitions.

The simulation is based on real-world data collected from an intersection in Changsha City, China and operates within the SUMO traffic simulation environment using the TRACI module to interact with real-time traffic states. The system will be deployed in the same intersection as the simulation data was collected from.

Your Task

You will contribute to designing the system with a focus on **[OBJECTIVE]**. To do this, you will complete the following steps:

Steps to Complete:

1. Read through the **Task Overview** and **System Assumptions** (available here: [Assumptions]).
2. Define System Requirements for [OBJECTIVE]:

    a. Identify key system requirements necessary to achieve **[OBJECTIVE]** within the system.
    b. Use the following EARS format for your response:
        ■ When <optional trigger>, the <system name> shall <system response>
    c. For each requirement, detail a **potential design solution** in bullet points.

Example:

- **Requirement:** *When a sudden obstacle is detected, the autonomous vehicle shall apply emergency braking to avoid a collision.*
- **Potential Design Solutions:**
    - Implement LiDAR and camera-based object detection to identify obstacles in real time.
    - Develop an emergency braking algorithm that calculates safe stopping distances.
    - Integrate a redundant braking system to ensure functionality in case of sensor failure.
    - Conduct extensive simulations and real-world testing to validate emergency braking effectiveness.

3. Answer RL-Related Questions:
    a. After completing the requirements, you will receive an Excel sheet containing a set of questions assessing the RL & system design.
    b. Provide **detailed responses**, following the provided example answer as a guide for the expected level of specificity:
        ■ Collision avoidance accuracy measures the percentage of successfully detected and avoided obstacles, with an acceptable range of ≥98% based on autonomous flight performance benchmarks. Evasion precision is assessed using the Mean Absolute Error (MAE) of deviation from the optimal avoidance path, with an acceptable deviation of ≤0.5 meters to ensure precise maneuvering. These thresholds are determined through industry standards and empirical performance evaluations.
    c. Some high-level questions (marked with an asterisk *) are broken down into sub-questions which may be fully addressed by responding to all sub-questions. If so, you may skip the high-level question as long as your responses to the sub-questions fully address it.
    d. Some of your responses may overlap—this is okay! If responses overlap, you may **reference previous answers** (include the relevant ASK ID #) but you should still explain how the design choice applies to the current question.
    e. If a question does not apply, respond with **N/A** and briefly explain why.
4. Review and Provide Feedback on Requirements:
    a. Based on your responses, a refined set of system requirements will be developed.
    b. You will review these new requirements and provide feedback in a **brief interview**.

c. During this session, you may be asked to **elaborate on some of your responses**.

Additional Notes

- You may use any available tools to assist with your task.
- However, you must be able to **explain and justify** your answers in a short meeting.
- Do not submit any responses you **cannot clearly explain**.
- You will **not** be implementing the system, but your responses should be **realistic and implementable** given sufficient time.