

Title: Fuzzy Logic-Based Traffic Signal Control System

Problem Statement:

You are designing an **intelligent traffic signal control system** at a four-way intersection. The system must decide how long the **green light** should stay ON based on the following inputs:

1. **Traffic Density (TD):** The number of vehicles present in the lane
 - o **Low (0-30 vehicles)**
 - o **Medium (30-70 vehicles)**
 - o **High (70-100 vehicles)**
2. **Waiting Time (WT):** The time vehicles have been waiting in the queue
 - o **Short (0-30 sec)**
 - o **Moderate (30-60 sec)**
 - o **Long (60-120 sec)**

The **output** is the **Green Light Duration (GLD)** in seconds:

- **Short (10-30 sec)**
- **Medium (30-60 sec)**
- **Long (60-120 sec)**

Using Python's **skfuzzy** library,

1. **Define fuzzy sets and membership functions** for **Traffic Density**, **Waiting Time**, and **Green Light Duration**.
2. **Develop fuzzy rules** (e.g., If TD is **High** and WT is **Long**, then GLD should be **Long**).
3. **Implement and simulate the system** to test different traffic scenarios.

Sample Fuzzy Rule Base:

| Traffic Density | Waiting Time | Green Light Duration |
|------------------------|---------------------|-----------------------------|
| Low | Short | Short (15 sec) |
| Low | Moderate | Medium (35 sec) |
| Low | Long | Medium (45 sec) |
| Medium | Short | Medium (30 sec) |
| Medium | Moderate | Medium (50 sec) |
| Medium | Long | Long (75 sec) |
| High | Short | Medium (40 sec) |
| High | Moderate | Long (70 sec) |
| High | Long | Long (90 sec) |

Practical Tasks for Students:

1. **Define Fuzzy Variables & Membership Functions:** Use triangular or Gaussian membership functions for **Traffic Density, Waiting Time, and Green Light Duration**.
2. **Create a Fuzzy Inference System (FIS):** Use **Mamdani-based inference** to implement the system.
3. **Develop the Rule Base:** Implement at least **9 fuzzy rules**.
4. **Run Simulations:** Test different input values to observe system behavior.
5. **Interpret Results:** Analyze how fuzzy logic makes **adaptive decisions** for green light duration.