SELF-DRIVING CAR SIMULATION

USING SIMPLE NEURAL NETWORK..

A presentation is a formal talk, often delivered in front of an audience, aimed at conveying information, persuading others, or sharing insights on a particular topic. Presentations can take various forms, such as verbal speeches, slideshows, demonstrations, or multimedia displays.

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INTRODUCTION TO THE PROJECT

This project simulates a self-driving car that navigates a virtual road using artificial intelligence (AI) and neural networks. The car's behavior is governed by an AI that learns to drive by interacting with its environment. The main components include a car object, a road object, a neural network brain for decision-making, and a sensory system to detect obstacles and road boundaries.

Key Objectives:

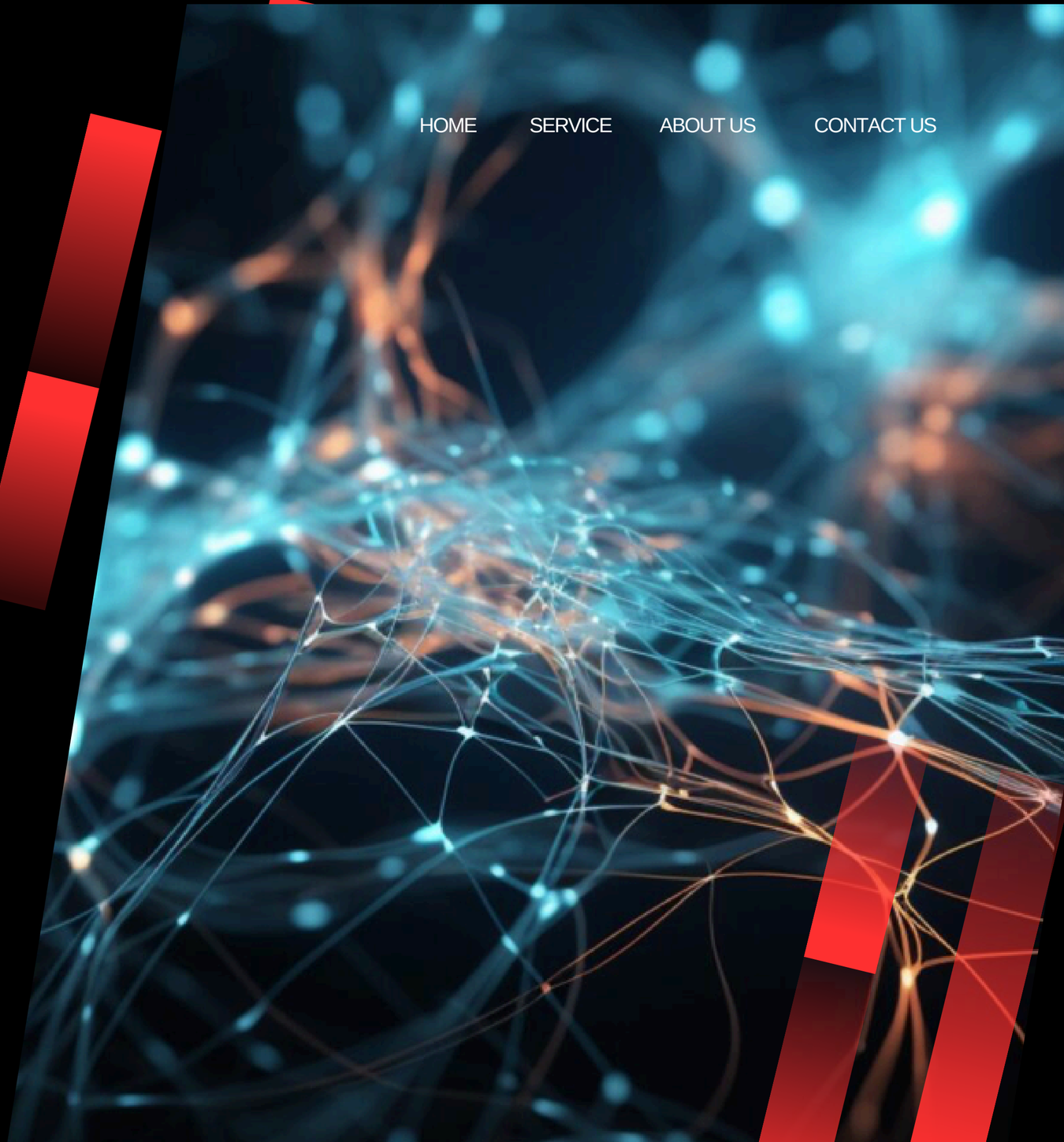
1. AI Car Navigation: Create an AI-driven car that learns to drive autonomously.

2. Road Environment: Simulate a road with lanes, borders, and other traffic to challenge the car's AI.

CORE COMPONENTS

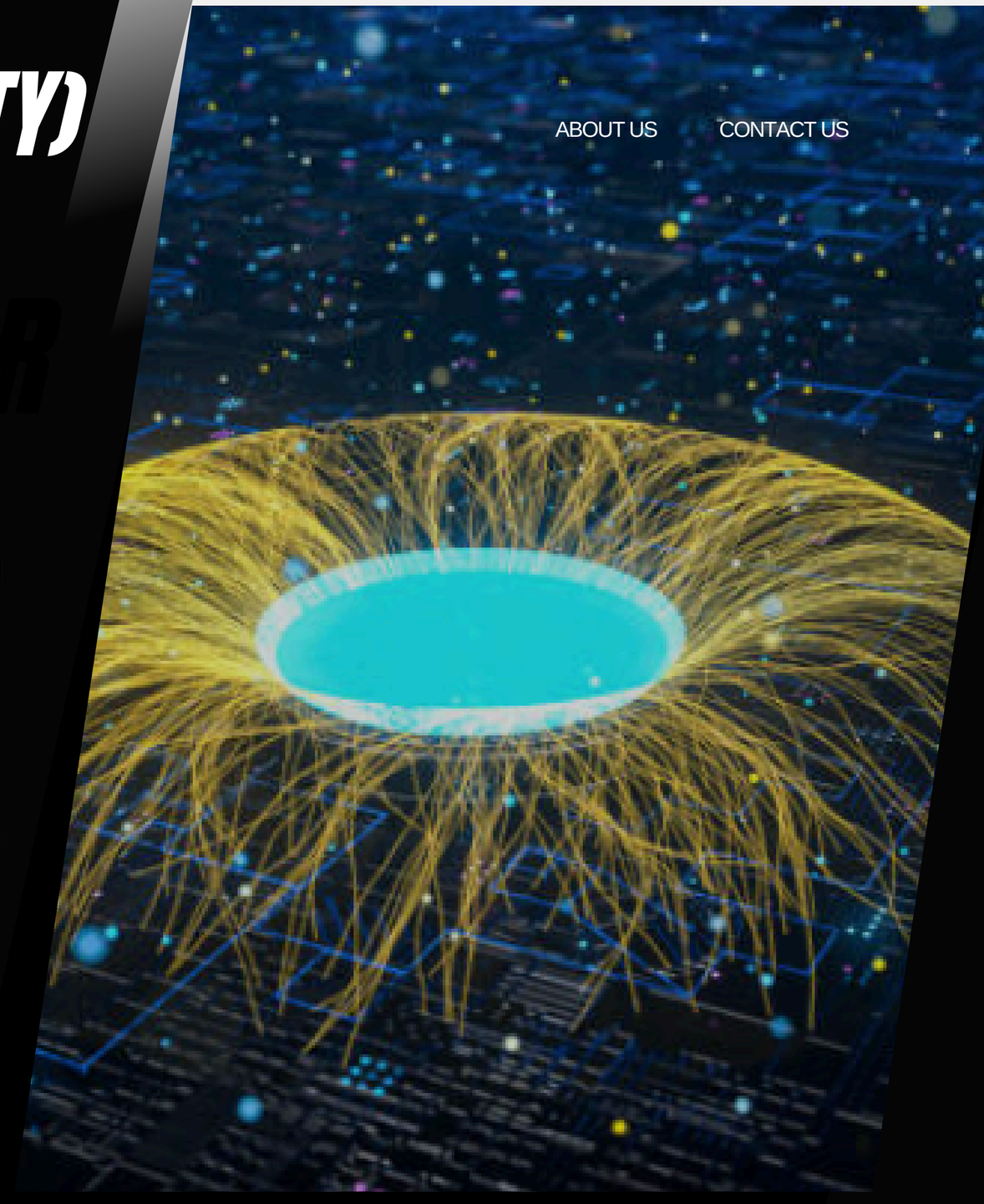
COMPONENTS

- Car Class: Defines the car’s attributes like position, speed, and controls.
- Neural Network: Controls the car’s movement based on sensor inputs.
- Sensor Class: Casts rays to detect obstacles (road borders and traffic).
- Controls Class: Handles input types (keyboard or AI).
- Road Class: Creates and visualizes the road layout with lanes.



CAR CLASS (MAIN FUNCTIONALITY)

- ATTRIBUTES:
- POSITION (X, Y), SIZE (WIDTH, HEIGHT), SPEED, ANGLE, AND ACCELERATION.
- USES SENSORS TO DETECT OBSTACLES.
- CAN BE CONTROLLED EITHER BY THE USER OR AN AI BRAIN (NEURAL NETWORK).
- FUNCTIONS:
- UPDATE: UPDATES THE CAR'S POSITION AND SENSORS, CHECKS FOR DAMAGE (COLLISION).
- MOVE: ADJUSTS SPEED, FRICTION, AND STEERING.



NEURAL NETWORK (AI BRAIN)

WHAT IT DOES:

THE NEURAL NETWORK (AI BRAIN) IS THE HEART OF THE AUTONOMOUS DRIVING SYSTEM. IT PROCESSES INPUTS FROM THE ENVIRONMENT, MAKES DECISIONS BASED ON THAT DATA, AND OUTPUTS CONTROL COMMANDS TO THE CAR FOR STEERING, ACCELERATION, AND BRAKING. THE AI BRAIN IS RESPONSIBLE FOR MAKING REAL-TIME DECISIONS THAT ALLOW THE CAR TO DRIVE AUTONOMOUSLY, NAVIGATE ROADS, AVOID OBSTACLES, AND REACT TO DYNAMIC TRAFFIC CONDITIONS. IT IS THE INTERFACE BETWEEN THE ENVIRONMENT (SENSORS, OBSTACLES, ROAD LAYOUT) AND THE CAR'S ACTIONS (STEERING, ACCELERATION, BRAKING).

OVERVIEW OF THE NEURAL NETWORK'S ROLE IN AUTONOMOUS DRIVING

- Steering: Determining how much the car needs to turn in a given situation.
- Acceleration/Braking: Deciding when to speed up or slow down based on factors like road conditions, obstacles, and traffic.

NEURAL NETWORK ARCHITECTURE FOR THE AI BRAIN

- Camera Feed (Visual Input): Images or video frames representing the car's surroundings.
- LIDAR/ Radar Sensors: Distance readings to nearby objects, vehicles, and obstacles.
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TRAINING THE NEURAL NETWORK

In supervised learning, the neural network is trained on labeled data, where the input data (sensor readings, images, etc.) is paired with the correct output (steering angle, acceleration, braking).

NEURAL NETWORK TRAINING WITH SIMULATION

- Road Networks: Various types of roads and intersections with realistic traffic rules.
- Obstacles and Hazards: Moving or static obstacles such as other cars, pedestrians, road signs, or potholes.
- Sensors: Simulated camera, radar, and LIDAR sensors feed data to the neural network.

SENSOR CLASS

The Sensor Class is a software representation of the vehicle's physical sensors. These sensors typically include cameras, LiDAR, radar, ultrasonic sensors, GPS, IMU (Inertial Measurement Unit), and other components.

The class processes input from these sensors and converts them into actionable data that can be used by the neural network for navigation, obstacle avoidance, and decision-making.

The sensors are often categorized into three broad types:

- Vision Sensors: Cameras that provide visual input (e.g., RGB images, depth images).
- Proximity Sensors: Radar, LiDAR, and ultrasonic sensors that measure the distance to objects and obstacles around the vehicle.

While individual sensors can provide critical information, sensor fusion plays an important role in making decisions that are more accurate and robust

ROAD CLASS

The Road Class is a critical component in an autonomous vehicle's navigation system, responsible for representing the road infrastructure on which the vehicle operates. It encapsulates the characteristics of the road environment, such as lanes, traffic signs, road signs, speed limits, intersections, and other key features. By modeling the road as an object, the Road Class provides important contextual information to the Car Class and helps the neural network make decisions related to route planning, lane keeping, and obstacle avoidance.

ROAD FEATURES AND CONDITIONS

THE ROAD CLASS KEEPS TRACK OF THE SURFACE CONDITIONS OF THE ROAD, SUCH AS WHETHER IT'S DRY, WET, OR ICY, WHICH INFLUENCES THE CAR'S BEHAVIOR. IF THE SENSOR CLASS DETECTS A HAZARD OR OBSTACLE (LIKE A POTHOLE OR FALLEN TREE), THE CAR CLASS CAN USE THIS INFORMATION TO TAKE ACTION, SUCH AS SLOWING DOWN OR CHANGING LANES TO AVOID THE OBSTRUCTION.

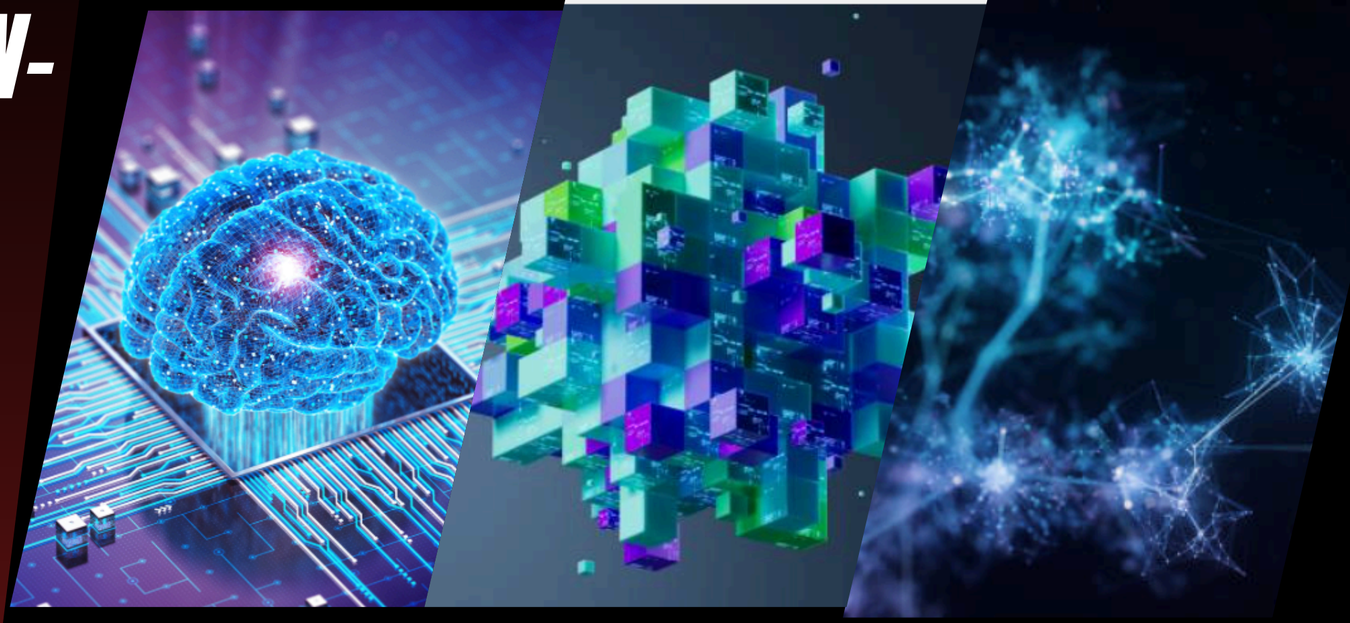
SENSOR CLASS INTEGRATION

- Sensor Detection: The Sensor Class detects immediate obstacles (pedestrians, other vehicles, road debris), while the Road Class provides broader environmental context (road markings, traffic signs).
- Object Identification: The Sensor Class can detect objects like vehicles or pedestrians, but the Road Class determines whether these objects are on the road, in the lane, or at an intersection, guiding the car’s response.

TRAFFIC AND NAVIGATION DECISION-MAKING

THE ROAD CLASS HELPS THE CAR CLASS MAKE DECISIONS ABOUT TRAFFIC, ROAD SIGNS, AND INTERSECTIONS:

- TRAFFIC SIGNALS AND SIGNS: WHEN APPROACHING A RED LIGHT OR STOP SIGN, THE ROAD CLASS SIGNALS TO THE CAR CLASS THAT IT NEEDS TO STOP OR SLOW DOWN.
- PEDESTRIAN CROSSINGS: THE ROAD CLASS PROVIDES DATA ON PEDESTRIAN CROSSINGS, ADVISING THE CAR TO BE ALERT FOR PEDESTRIANS OR CYCLISTS.
- NAVIGATION AND ROUTING: THE ROAD CLASS HELPS THE CAR FOLLOW A MAPPED ROUTE, CHECKING FOR ANY OBSTACLES OR DETOURS ON THE ROAD.



HERE ARE 5 CONCISE POINTS ON TRAFFIC GENERATION AND COLLISION DETECTION FOR DUMMY CARS:

1. DUMMY CARS BEHAVIOR: DUMMY CARS MOVE RANDOMLY OR REMAIN STATIONARY, SIMULATING REAL-WORLD TRAFFIC CONDITIONS WITHOUT AI, AND HELP TEST THE VEHICLE'S ABILITY TO NAVIGATE AND AVOID OBSTACLES.

1. TRAFFIC DENSITY VARIABILITY: DUMMY CARS CAN BE PLACED AT VARYING DENSITIES TO MIMIC LIGHT OR HEAVY TRAFFIC SCENARIOS, HELPING THE SYSTEM ADAPT TO DIFFERENT LEVELS OF CONGESTION.

HOW THE AI LEARNS

- *TRAINING THE NEURAL NETWORK:*
  - *THE CAR USES SENSOR DATA TO MAKE DECISIONS.*
  - *THE NETWORK IS TRAINED USING A GENETIC ALGORITHM, WHERE THE BEST-PERFORMING CAR'S BRAIN (NEURAL NETWORK) IS SAVED AND EVOLVED TO CREATE BETTER CAR BEHAVIORS.*
  - *MUTATION: THE NETWORK CAN MUTATE SLIGHTLY TO IMPROVE PERFORMANCE OVER GENERATIONS.*

SAVING AND DISCARDING AI BRAIN

- *SAVE AI BRAIN:*
  - *THE BEST-PERFORMING AI BRAIN (NEURAL NETWORK) CAN BE SAVED TO LOCALSTORAGE TO CONTINUE TRAINING OR USE IT LATER.*

- *DISCARD AI BRAIN:*
  - *YOU CAN REMOVE THE SAVED BRAIN, AND THE CAR WILL REVERT TO A RANDOM NEURAL NETWORK.*

VISUALIZING THE NEURAL NETWORK

- NETWORK CANVAS:
  - THE NEURAL NETWORK IS VISUALIZED USING A CANVAS SHOWING THE LAYERS, NODES, AND CONNECTIONS.
  - WEIGHT AND BIAS VISUALIZATION: THE CONNECTIONS BETWEEN NODES ARE DRAWN, WITH COLOR GRADIENTS SHOWING THE STRENGTH OF WEIGHTS.

CODE STRUCTURE OVERVIEW

FILES IN THE PROJECT:

CAR.JS: DEFINES THE CAR'S ATTRIBUTES, MOVEMENT, AND COLLISION DETECTION.

NETWORK.JS: DEFINES THE NEURAL NETWORK ARCHITECTURE AND FUNCTIONS FOR TRAINING AND MUTATION.

CONTROLS.JS: HANDLES USER INPUT (KEYBOARD OR AI CONTROL).

SENSOR.JS: MANAGES THE CAR'S SENSORS FOR DETECTING OBSTACLES.

ROAD.JS: DEFINES THE ROAD LAYOUT AND DRAWING.

INDEX.HTML: THE MAIN HTML STRUCTURE FOR RENDERING THE SIMULATION.

CHALLENGES FACED

- COLLISIONS AND ROAD NAVIGATION:
- ENSURING ACCURATE COLLISION DETECTION BETWEEN THE CAR AND ROAD BOUNDARIES OR OTHER CARS.
- TRAINING THE NEURAL NETWORK:
- FINE-TUNING THE NEURAL NETWORK TO NAVIGATE THE ROAD EFFICIENTLY.
- DEALING WITH THE RANDOMNESS OF THE ENVIRONMENT (E.G., DIFFERENT TRAFFIC PATTERNS)

THANK YOU

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