■ TRAYA: AI-Driven Train Traffic Control System

SIH 2025 Project — Team Orion Pax

■ Project Overview

Indian Railways faces challenges with train congestion, conflicts in shared sections, and inefficient scheduling. Our system TRAYA provides a solution by detecting conflict zones dynamically, generating real-time control commands to avoid collisions, maximizing system throughput & efficiency, and providing performance analytics.

■■ System Design

1. Simulation Model

The core model (`train_scheduler.slx`) contains Train Dynamics, Sensors, Scheduler (AI Controller), and Outputs.

2. Visualization Dashboard

Simulation results are presented in a dashboard view with Train Trajectories, Conflict Zone Detection, AI Commands, KPIs, System Efficiency, and Safety Status.

■ Performance Metrics

Metric	Value
Throughput (crossings)	Train A: X, Train B: Y, Total: X+Y
Safety	Conflicts: 0, Safety Margin: 100%, Status: SAFE
Efficiency	Average stop time: ~16.7%, Efficiency: 83.3% Active
Delays	7 incidents

■ Advanced Features

1. Monte Carlo Analysis for robustness testing.

2. Impact Projection with estimated annual benefits of ■5.3M.

3. Exported Results saved in `traya_simulation_results.mat`.

■ Repository Structure

. ■■■ train_scheduler.slx # Core Simulink model ■■■ traya_analysis.m # MATLAB analysis & visualization script ■■■ docs/ # Documentation images ■■■ results/ # Simulation results ■■■ README.md # Project documentation

■ How to Run

1. Open MATLAB R2022b (or later).

2. Load the Simulink model: `open_system('train_scheduler.slx');`

3. Run the script: `traya_analysis`

■ Key Contributions

- AI-based real-time train scheduling.

- Simulink model for dual-train conflict resolution.

- Dashboard with KPIs for safety, throughput, efficiency.

- Monte Carlo robustness testing.

- Projection of real-world financial impact.

■ Team Orion Pax

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