PROJECT PROPOSAL - TEAM NAME: BP

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AIM: *Optimal Speed Determination for Minimizing Total Travel Cost Using Optimization Methods*

1. Problem Statement & Motivation

A person's driving speed has a big impact on fuel consumption and travel time when they commute every day between their home and work. Driving too slowly increases travel time, while driving too fast increases fuel consumption due to aerodynamic drag. Finding the ideal driving speed (v) that minimizes overall fuel-related expenses while maintaining a reasonable travel time is the goal.

This model incorporates key real-life parameters such as **traffic density**, **number of passengers**, **travel distance**, **engine size**, **fuel price**, etc. Our problem statement when defined mathematically is continuous, differentiable, and convex in the decision variable. This helps use to apply and compare classical optimization algorithms which we have learnt in this course into real world problems.

2. Methodology

The focus of this project is on **applying optimization techniques** to achieve efficient driving speeds which in-turn can be used to minimize fuel cost and time costs. We will experimentally compare the performance of the following algorithms on the formulated objective:

- **Steepest Descent (Gradient Descent)**
  - With fixed step size and with line search (Armijo backtracking).
- **Newton's Method**
  - Using analytical first and second derivatives.
  - With step damping and projection to handle feasibility.
- **Quasi-Newton Method (BFGS)**
  - If computing hessian becomes expensive, we will use Quasi-Newton Method
- **Trust-Region Method**
  - We will use a quadratic model with radius updates which is robust.

For each algorithm, we will record:

- Number of iterations
- Convergence speed
- Function evaluations
- Stability across different initial points.

Once we have worked with all the methods, we will use the **top 2-3** methods to give insights about optimum speeds and fuel costs.

All algorithms will be implemented in **Python** without using high-level minimization libraries to ensure full understanding of the optimization process.