**Project Title: Fair and Efficient Ambulance Allocation in Urban Environments**

**1. Goal of the Project**

This project aims to design a fair and efficient ambulance allocation strategy in a metropolitan area over multiple time periods. The key objective is to minimize the disparity in service accessibility across residential areas while ensuring overall efficiency in response times and coverage.

We explore the trade-off between:

* **Efficiency**: ensuring that the most densely populated or high-risk areas receive coverage.
* **Fairness**: ensuring that no neighborhood is persistently underserved.

**2. Dataset to Be Used**

We will use the publicly available dataset from the GitHub repository [PhilippeOlivier/ambulances](https://github.com/PhilippeOlivier/ambulances), which contains:

* .gpickle graph files representing city networks with nodes (areas) and edges (adjacencies).
* .bases files listing initial ambulance stationing bases.

This data allows us to model the urban space as a graph, where each node corresponds to a residential area and ambulances can serve both their own and neighboring nodes.

**3. Methodology**

We will develop a multi-period allocation model based on the framework from the paper *"Fairness over Time in Dynamic Resource Allocation with an Application in Healthcare"* (Lodi et al., 2024). The steps include:

* Formulating the allocation problem as an integer program, integrating fairness constraints (e.g., max-min fairness or Jain's index).
* Implementing a **greedy baseline** and comparing it with a **time-aware fairness algorithm**.
* Simulating ambulance deployments across multiple time periods to assess cumulative fairness and coverage.

We will evaluate the outcomes using:

* **Efficiency metrics**: total benefit, response time coverage.
* **Fairness metrics**: per-node benefit variance, worst-off area benefit, fairness-over-time criteria.