COMP4096 Project Plan

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Course: MSc Data Science

1. Project title. Optimizing Bus Routes Using Location Data

2. Statement of the research problem. The project aims to address the problem of congestion on bus routes. Congestion on the routes increases the passenger waiting times and decreases the service reliability and passenger satisfaction. By using real-time location data from buses, this project seeks to identify congested routes, analyze the impact of the congestion on bus speed and schedule adherence, and propose alternative routes or method to relieve the congestion. This research is crucial as it can help in improving the public transportation efficiency which will eventually lead to better mobility, lower environmental impact and customer satisfaction.

3. Related work. Previous studies have explored various aspects of public transportation optimization including the use of Automatic Vehicle Location (AVL) data to monitor bus performance and identify congestion patterns. Research has shown that real-time data can significantly improve service reliability and passenger satisfaction. This project builds on prior research by focusing specifically on the identification and mitigation of congestion using the location data. The novelty of this approach lies in the integration of multiple data sources and the use of Geographic Information System (GIS) tools to propose and evaluate alternative routes.

The study by Ana Almeida. (2023) explores the use of city buses as mobility probes to measure and classify traffic congestion. They employ k-means and DBSCAN clustering methods to identify congestion patterns and assess road segments prone to congestion using four weeks of bus tracking data from Aveiro, Portugal. This work demonstrates the potential of leveraging existing bus tracking infrastructure for urban traffic analysis.

Jiaman Ma. (2019) propose a novel segment-based approach for predicting bus travel times using real-time traffic data from both buses and taxis. By separating bus routes into transit and dwelling segments, their method improves prediction accuracy, especially under irregular traffic conditions. This research highlights the importance of considering distinct patterns for transit and dwelling times in travel time prediction models.

Kai Huang. (2020) proposes a real-time customized bus (CB) route optimization framework aiming to maximize service rates and operator profits. They develop three nonlinear programming models to optimize routes based on dynamic client requests, demonstrating computational efficiency with a real-time search algorithm. Their approach improves bus service reliability and operational sustainability in urban settings, as validated on the Sioux Falls network.

Quingshuai Shi. (2020) developed a comprehensive evaluation model for bus route optimization based on multi-source data, including smart card transactions and bus location data. They propose an indicator system and apply the Analytic Hierarchy

Process (AHP) to assess optimization schemes at various levels, from individual bus routes to system-wide combinations. Their approach aims to scientifically classify and quantify the impact of optimization efforts, providing valuable insights for decision-making and improving urban public transport efficiency.

4. Methodology. The following methodology will be employed to address the research problem.

- **Data Collection:** Get AVL, timetable and disruptions data from the Bus Open Data Service.
- **Data Preprocessing:** Clean and synchronize the data, and calculate key variables such as average speed and delays.
- **Congestion Analysis:** Identify congested routes by analyzing average bus speeds and delays. Use time-of-day and route segment analysis to determine congestion patterns.
- **Propose Alternatives:** Use Geographic Information System (GIS) to identify alternative routes and evaluate their potential impact on congestion.
- **Evaluation:** Assess the effectiveness of the proposed alternatives by comparing predicted vs actual speed and schedule adherence.

This methodology is well-suited to solving the problem as it leverages real-time data and advanced analytical tools to derive actionable insights.

5. Programme of work.

Work Package 1 (WP1) – Data Preparation:

- Activity: Gather AVL, timetable and disruptions data from Bus Open Data Service (BODS). Clean and preprocess it for analysis.
- Milestone 1 (M1): Preprocessed dataset ready for analysis

Work Package 2 (WP1) – Literature Review:

- Activity: Conduct secondary research on bus route optimization and congestion analysis.
- Milestone 2 (M2): Literature review for the dissertation completed

Work Package 3 (WP3) – Congestion Analysis:

- Activity: Perform speed and delay analysis to identify congested routes. Analyze congestion patterns using time and route segment data.
- Milestone 3 (M3): Congested routes and congestion patterns identified.

Work Package 4 (WP4) – Proposing Alternatives:

- Activity: Use GIS tools to identify and map alternative routes. Evaluate potential improvements in congestion.
- Milestone 4 (M4): Proposed alternative routes and evaluation results documented.

Work Package 5 (WP5) – Evaluation:

- Activity: Assess the effectiveness of proposed alternatives based on improvements in speed and schedule adherence.
- Milestone 5 (M5): Evaluation results documented and analyzed.

Work Package 6 (WP6) – Dissertation Writing and Presentation:

- Activity: Compile findings, write the final dissertation and prepare the presentation.
- Milestone 6 (M6): Final dissertation submitted and presentation prepared.

6. Time plan.

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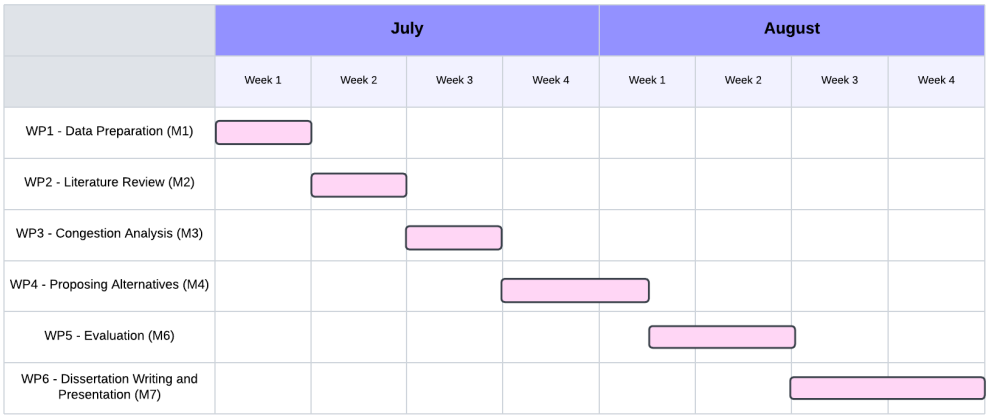

7. References.

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