

# **Final Research Problem & Research Questions**

## **Data Fusion for Predicting Highway Maintenance and Deterioration Trends**

### **Team Members:**

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## Why this problem?

**Novel Elements:** Integrates HPMS and FAF datasets—an innovative fusion approach not widely explored.

**Scope of the Problem:** Addresses critical challenges in highway maintenance. Aiding in preventive maintenance rather than reactive maintenance.

**Quality of Data:** Utilizes high-quality, publicly available data from the Federal Highway Administration and the Bureau of Transportation Statistics.

- Highway Performance Monitoring System (HPMS)
- Freight Analysis Framework (FAF version 4&5)

### **Cost and Resource Efficiency:**

- Leveraged existing data, minimizing additional costs and labor associated with new data collection.
- Extensive time was invested in data preprocessing due to the need to integrate HPMS and FAF datasets.
- Ensured that data granularity matched between the two sources for consistency.
- Addressed challenges in aligning data points to maintain uniformity across the 2013–2022.

### **Potential Influence:**

- The research outcomes are poised to inform proactive maintenance strategies and influence related research areas.
- Potential impact in infrastructure management practices.

### **Career Impact:**

- Enhances innovative thinking in data integration and analysis methods.
- Enhances expertise in data preprocessing, machine learning, and predictive analytics.
- Enhances transportation infrastructure domain knowledge which increases potential career opportunities.

## Final Research Questions

- **Research Question 1:** How does the fusion of HPMS and FAF datasets (2013–2022) enhance the predictive performance of highway deterioration models in estimating IRI, compared to traditional statistical and machine learning approaches using single-source data?
- **Research Question 2:** What are the most influential predictive features—such as traffic volume, freight load, and pavement condition indices—derived from the integrated datasets, and how do their contributions vary across different machine learning models?
- **Research Question 3:** How effectively can the proposed predictive model, leveraging data fusion and advanced machine learning techniques, minimize forecasting errors and improve the optimization of maintenance scheduling to reduce unplanned highway repairs?
- **Research Question 4:** How effectively can the proposed predictive model, leveraging data fusion and advanced machine learning techniques, minimize forecasting errors and improve the optimization of maintenance scheduling to reduce unplanned highway repairs?
- **Research Question 5:** What is the optimal approach to forecasting IRI at different levels of granularity—both for entire highway routes (RouteID level) and for specific highway sections (0.1-mile segments)—to support more precise maintenance planning?

## Summary & Next Steps

- Our research will bridge the gap between reactive and proactive maintenance by utilizing data fusion and advanced analytics.
- The proposed study promises to deliver actionable insights that can transform infrastructure management practices.
- Next steps include, preparing for the detailed analysis phase.

**THANK YOU**