Autonomous Driving : Predicting Driver Behavior and Vehicle Maintenance Using Simple Data

R25 – 034

SLIIT
FACULTY OF COMPUTING

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Introduction

- Our research focuses on using simple on-board data and the CARLA Simulator to predict driver behavior and vehicle maintenance needs.

- We identified four key components:
  1. analyzing driving styles
  2. predicting vehicle maintenance
  3. studying how weather impacts driving
  4. improving fuel efficiency

- The CARLA Simulator allows us to test and refine these models in realistic environments.

- This work aims to create affordable, scalable solutions to enhance driving safety and efficiency.

Research Questions

- How can simple data predict driver behavior in autonomous driving?
- How can vehicle maintenance needs be anticipated using basic data?
- How can these predictions improve safety and efficiency in autonomous systems?

Research Problem

- Autonomous systems lack efficient models for using simple data to predict driver behavior and maintenance needs.

- This leads to safety risks, unexpected breakdowns, and reduced trust in autonomous driving.

Research Objectives

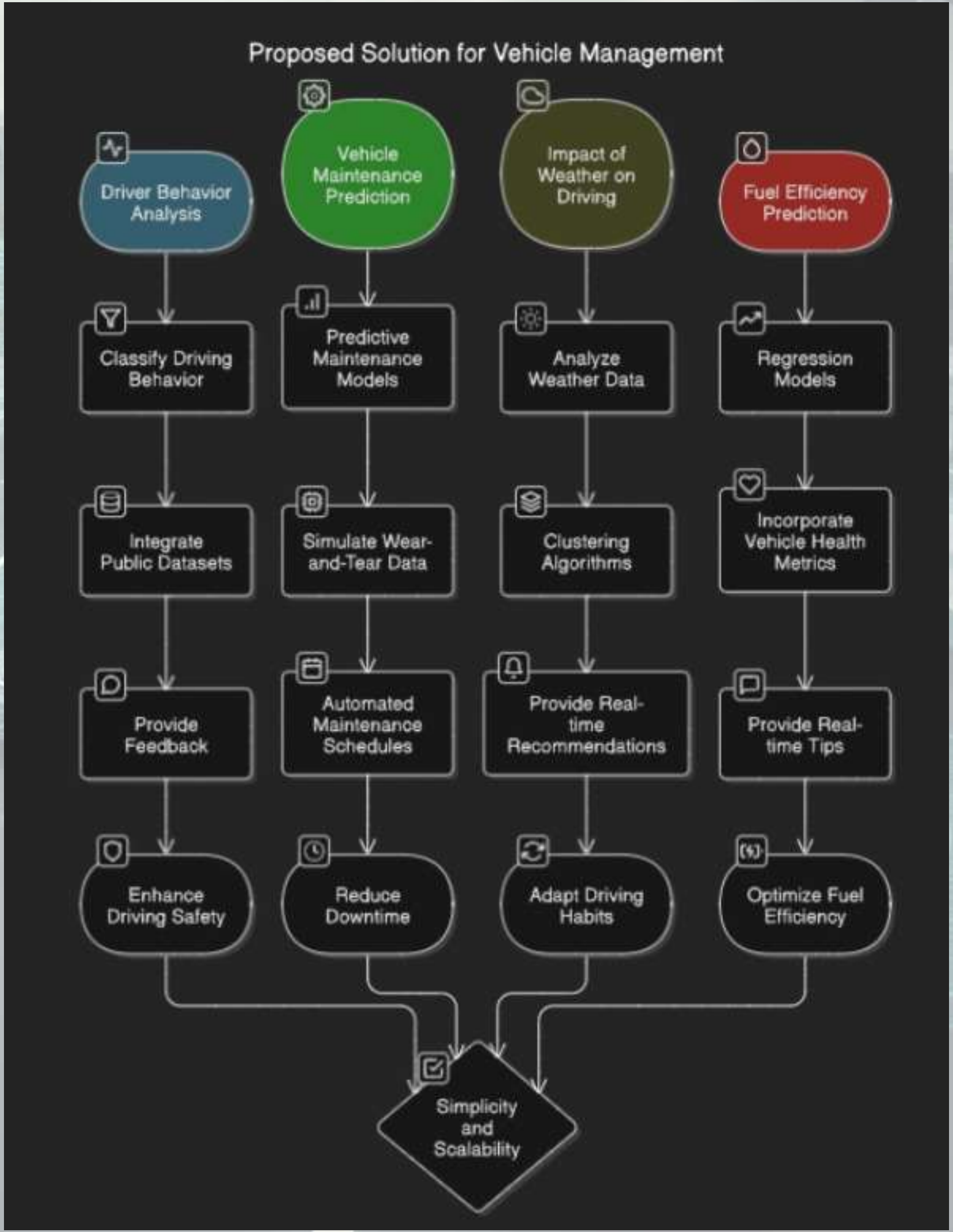
Main Objective

To develop a machine learning framework that predicts driver behavior, vehicle maintenance needs, and fuel efficiency using easily accessible data for real-world applications.

Sub Objective

- Driver Behavior: Classify driving behavior using mobile phone sensors.
- Vehicle Maintenance: Predict maintenance needs based on driving patterns and vehicle logs.
- Weather Impact: Analyze how weather affects driving behavior and provide recommendations.
- Fuel Efficiency: Predict fuel consumption based on driving habits, weather, and vehicle health.

Overall System Diagram



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Driver Behavior Analysis

- Driver behavior analysis helps classify driving styles (aggressive, moderate, cautious).
- Focuses on non-invasive, affordable technology like mobile sensors (GPS, accelerometer).
- Reduces reliance on expensive hardware and is suitable for non-connected vehicles.
- Combines public driving datasets and simulated environments for training ML models.

Research Gap

Features	Research 1 (2020)	Research 2 (2013)	Research 3 (2022)	Proposed
Utilizes Mobile Phone Sensors	✔	✔	✔	✔
Employs CARLA Simulator for Data Generation	✘	✘	✔	✔
Integrates Real and Simulated Data	✘	✘	✘	✔
Classifies Driving Behavior Using Machine Learning	✔	✔	✔	✔
Focuses on Non-Invasive, Low-Cost Implementation	✔	✔	✔	✔

Research Questions

1. How can mobile sensors be used to classify driver behavior?

2. What features are most effective in distinguishing driving styles?

3. How accurate can models be with non-invasive, low-cost data sources?

Specific Objectives

- Develop a machine learning model to classify driving behavior into categories.
- Use non-invasive, easily accessible data like mobile sensor readings.
- Ensure affordability and scalability across various vehicle types.

Methodology

Functional Requirements

- Classify driving behavior (aggressive, moderate, cautious).
- Use supervised learning algorithms like decision trees or SVM.

Non- Functional Requirements

- Ensure scalability for various vehicle models.
- Minimize computational and sensor costs.
- Security and Privacy.

Methodology

Tools
CARLA Simulator
Jupyter Notebook.

Web Server (Backend)
Python
SQL

Database
SQLite

ML Libraries
Scikit-learn
Pandas
Matplotlib

CARLA

Work Break Down Structure

- **CARLA Simulation Project**
  - **Project Management**
    - Timeline Planning
    - Resource Allocation
    - Progress Monitoring
  - **Documentation**
    - Proposal Draft
    - Technical Documentation
    - Final Report
  - **Simulation Development**
    - Environment Setup
    - ML Integration
    - Behavior Analysis
  - **Testing and Validation**
    - Scenario Testing
    - Performance Review
    - System Validation

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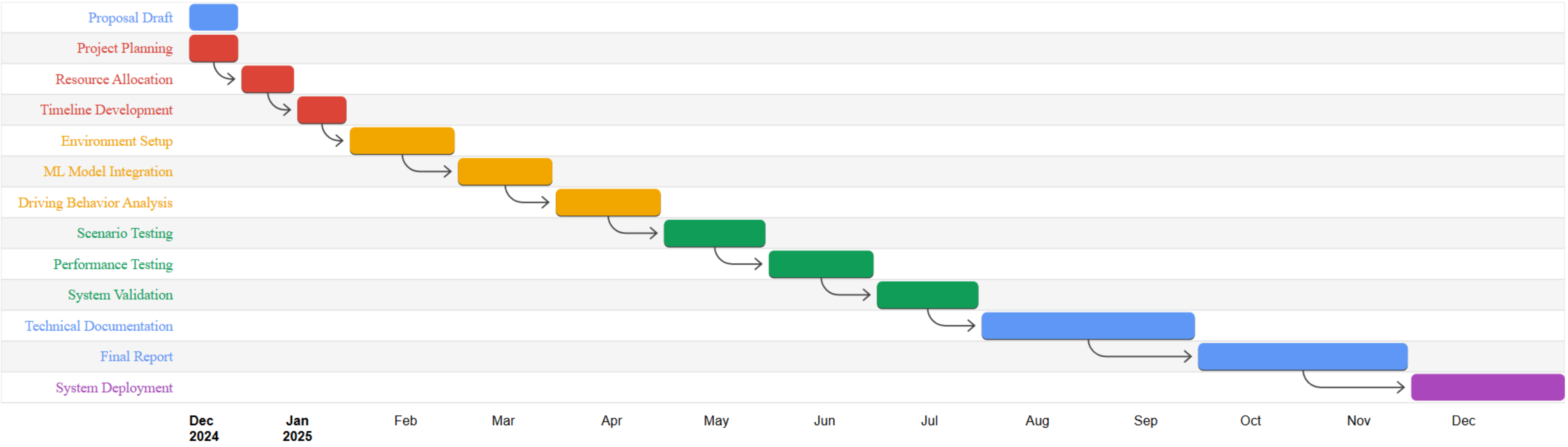
Gantt Chart



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Vehicle Maintenance Prediction: Develop predictive Maintenance models accessible to non-connected vehicles

- Analyze driving data patterns to identify behaviors that impact vehicle performance and safety.

- Assess historical maintenance records to predict part failures and recommend proactive solutions.

- Develop predictive models to enable efficient scheduling and reduce unexpected downtimes.

Research Gap

Features	Research 1 (2024)	Research 2 (2009)	Research 3 (2014)	Proposed
Leverage IOT data	✗	✗	✗	✓
Create Dynamic	✗	✓	✗	✓
Advanced Models	✓	✗	✓	✓
Incorporate Personalized Driving Pattern	✗	✗	✓	✓
Test and Refine Predictive Accuracy	✗	✗	✗	✓

Research Questions

1. How can historical maintenance data improve the accuracy of component failure predictions?

2. What role do driving patterns and vehicle usage play in predicting maintenance needs?

3. How can predictive models optimize maintenance schedules for cost and efficiency?

Specific Objectives

- Enhance travel recommendations by deeply analyzing the travelers' needs and preferences using ML.
- Apply Natural Language Processing (NLP) to analyze and interpret individual tourist preferences from textual data,.
- Use past ratings and reviews of travelers to travel partner recommendations to individual preferences.

Methodology

Functional Requirements

- • Collect historical data, such as part replacement records and maintenance logs.
- Use machine learning models to predict the lifespan of critical vehicle components.
- Identify potential component failures based on patterns in the data.
- Provide maintenance alerts to users before issues occur, reducing downtime and costs.

Non- Functional Requirements

•Ensure quick processing of data for timely maintenance predictions.

•Protect sensitive vehicle and user data with strong privacy measures.

•Maintain high system availability with 99.9% uptime for reliability.

•Design a user-friendly interface that is simple and intuitive for vehicle operators.

Methodology

Tools
CARLA Simulator
Jupyter Notebook.

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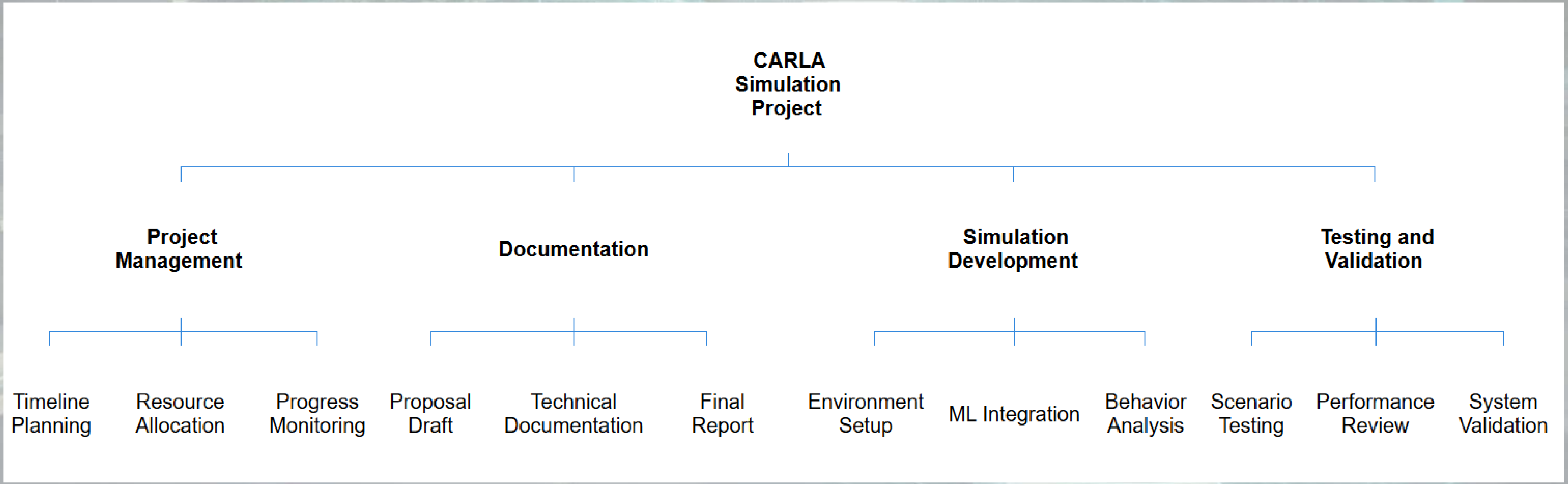
Work Break Down Structure



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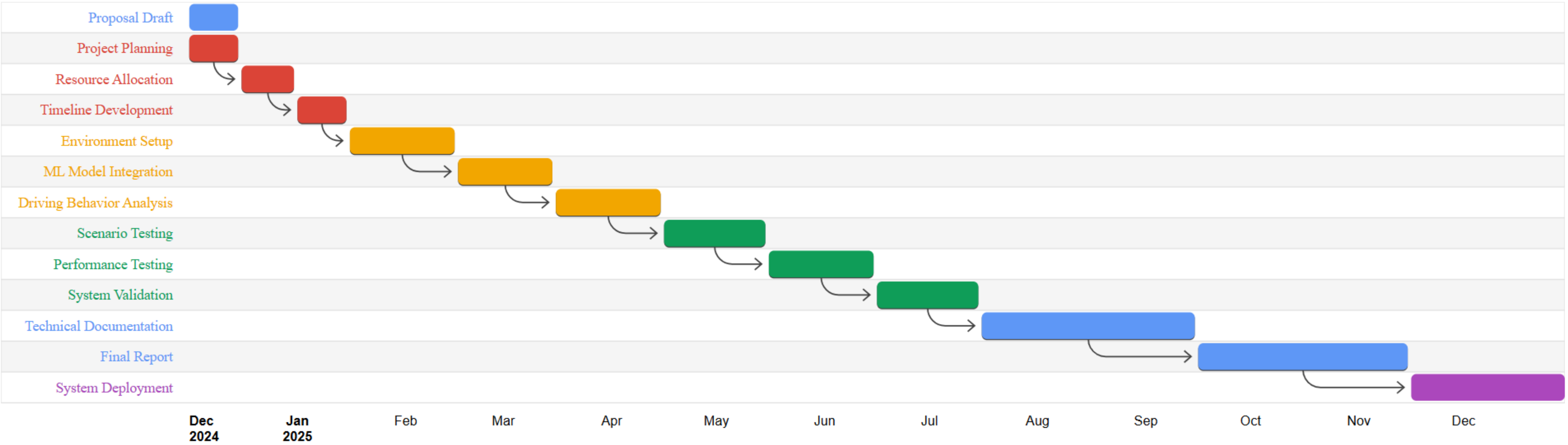
Gantt Chart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Impact of Weather and Environmental Conditions on Driving Patterns: Integrate weather data for personalized driving safety recommendations.

- Analyze real-time weather data to identify its influence on driving behavior and road safety.
- Assess environmental factors like road traction, gradients, and surfaces to predict risks
- Provide adaptive driving recommendations based on evolving weather conditions.

Research Gap

Features	Research 1 (2024)	Research 2 (2009)	Research 3 (2014)	Proposed
Leverage IOT data	✗	✗	✗	✓
Create Dynamic	✗	✗	✗	✓
Advanced Models	✓	✗	✓	✓
Incorporate Personalized Driving Pattern	✓	✗	✗	✓
Test and Refine Predictive Accuracy	✗	✗	✗	✓

Research Questions

1. How does real-time weather analysis improve the accuracy of driving behavior predictions?

2. What role do environmental factors like road conditions and gradients play in assessing driving risks?

3. How can adaptive machine learning models enhance driving recommendations under dynamic weather conditions?

Specific Objectives

- Analyze real-time weather data to identify its effects on driving behavior using machine learning models.

- Integrate road and environmental factors, such as gradients and surfaces, to enhance risk assessment and predictions

- Develop adaptive models that provide personalized, real-time driving recommendations based on changing weather and environmental conditions.

Methodology

Functional Requirements

- Collect real-time data from IoT sensors, GPS, and weather APIs for accurate analysis.
- Use machine learning models to analyze driving patterns and identify risks dynamically.
- Provide personalized, real-time recommendations to improve driving safety and efficiency.
- Test and deploy the system to ensure reliability and scalability in real-world scenarios.

Non- Functional Requirements

- Process data quickly and handle more users as demand grows.
- Protect user data with strong security and privacy measures.
- Ensure 99.9% uptime for reliable service
- Make the interface simple and easy to use

Methodology

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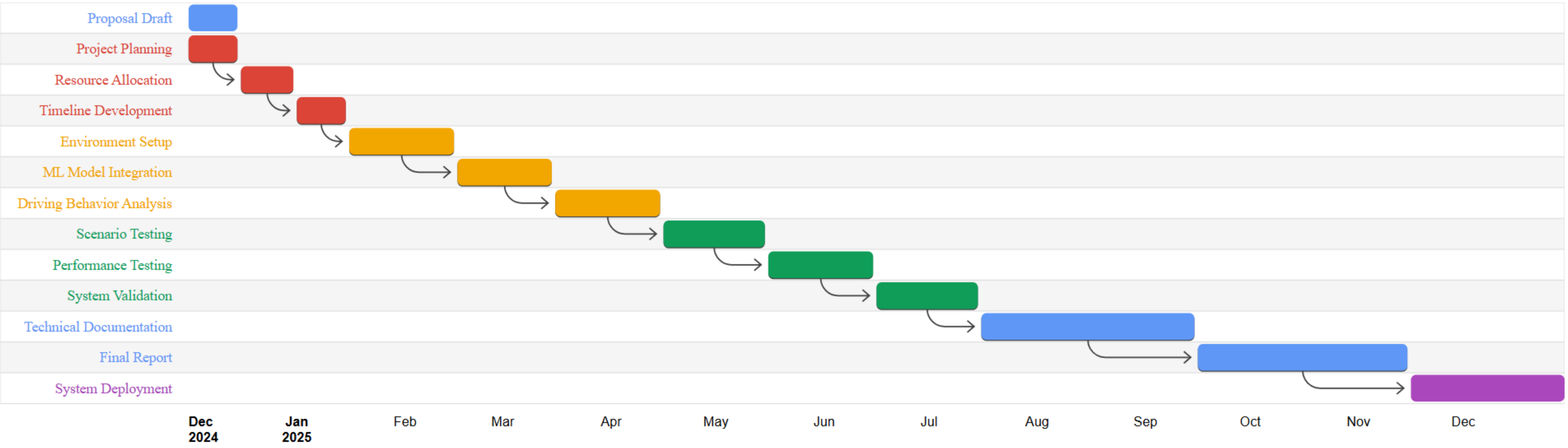
Gantt Chart



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Fuel efficiency prediction: Create actionable fuel efficiency insights using regression models

- Use regression models to analyze driving behavior, vehicle health, and environmental factors for real-time fuel efficiency optimization.

- Leverage simple, accessible data to provide scalable insights without expensive tools.

- Deliver actionable recommendations to reduce fuel costs and promote eco-friendly driving.

Research Gap

Features	Research 1 (2024)	Research 2 (2009)	Research 3 (2014)	Proposed
Leverage IOT data	✗	✗	✗	✓
Create Dynamic	✗	✗	✗	✓
Advanced Models	✓	✓	✓	✓
Incorporate Personalized Driving Pattern	✗	✗	✗	✓

Research Questions

1. How do driving behavior and environmental conditions influence fuel efficiency?

2. What is the role of regression models in predicting fuel efficiency?

1. How can simple data sources be used to create actionable fuel-saving insights?

Specific Objectives

- Develop regression models to analyze the impact of driving behavior, vehicle health, and environmental conditions on fuel efficiency.
- Utilize simple data sources, such as OBD-II data and weather APIs, to create personalized fuel efficiency insights.
- Provide actionable recommendations to drivers for optimizing fuel consumption based on real-time and historical data analysis.

Methodology

Functional Requirements

- Predict fuel efficiency using regression models and real-time data..
- Provide a simple interface for user input and insights.
- Collect data from OBD-II devices and weather APIs.
- Offer actionable fuel-saving tips.

Non- Functional Requirements

- Efficient data handling.
- Protect user data.
- Ensure 24/7 availability.
- Simple and user-friendly design.
- Easy to update and support

Methodology

Tools
CARLA Simulator
Jupyter Notebook.

Web Server (Backend)
Python
SQL

Database
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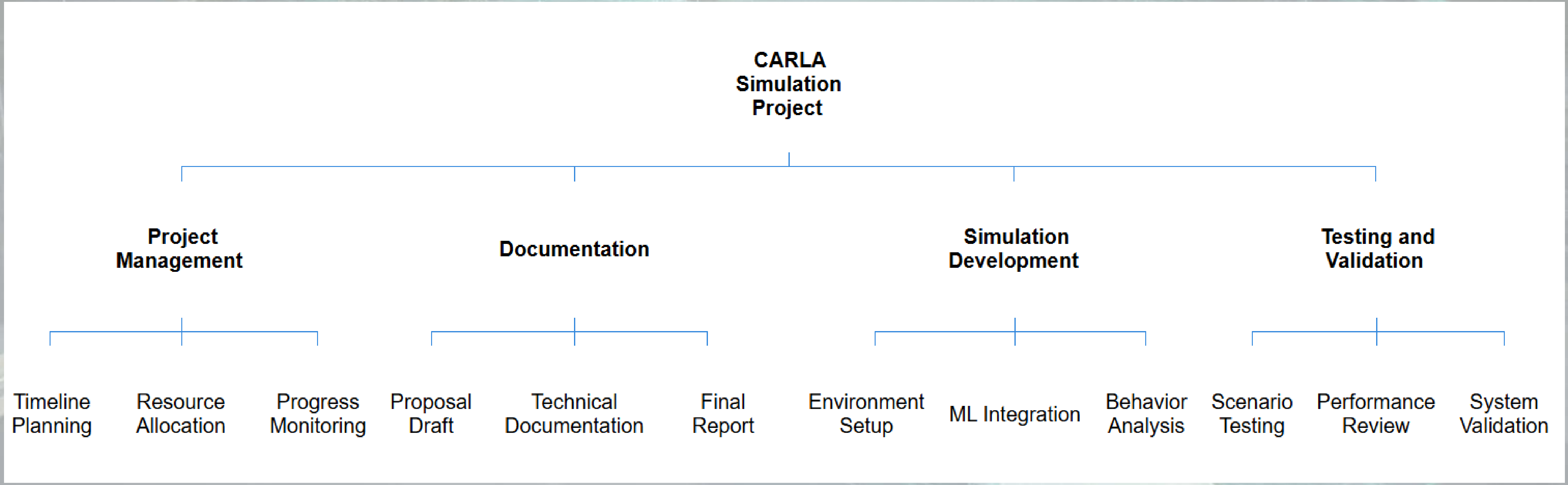
ML Libraries
Scikit-learn
Pandas
Matplotlib

Work Break Down Structure



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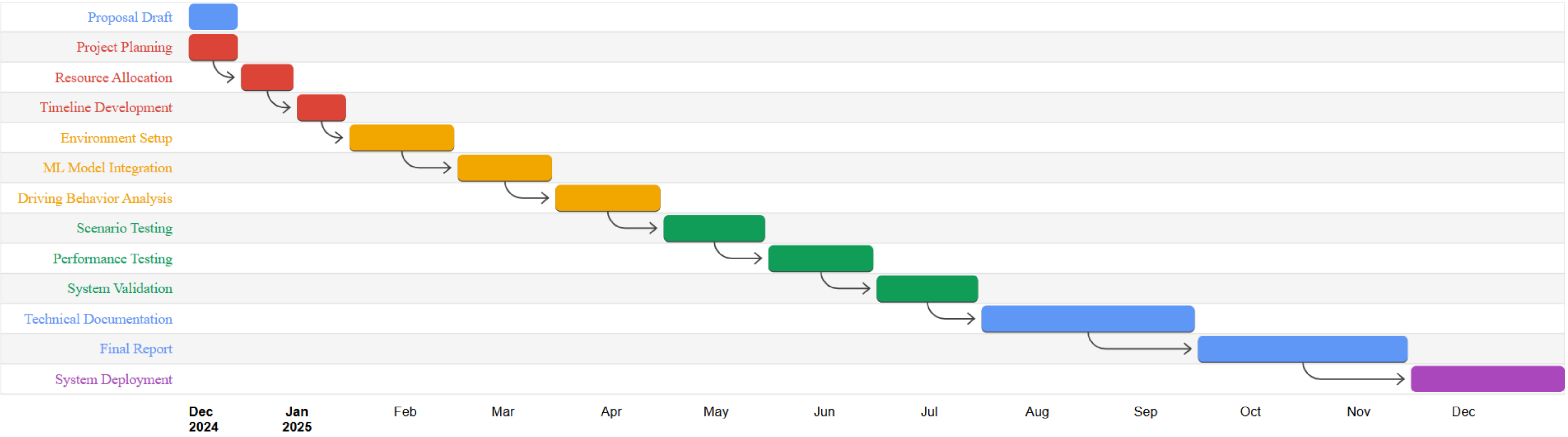
Gantt Chart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THANK YOU!