Technical Report: Time Series Forecasting of Transport Modes Using Prophet

GitHub Repository: akshayaasd/kovai.co

Key Insights from the Dataset

1. **Clear Weekly and Seasonal Trends**
   All five transport categories — *Local Route, Light Rail, Peak Service, Rapid Route,* and *School* — show strong weekly seasonality. School and Peak Services, in particular, peak during weekdays and drop on weekends, suggesting commuter-centric usage. This pattern can help optimize resource allocation by reducing fleet sizes or frequency on weekends.
2. **Differential Demand Across Transport Modes**
   - **Rapid Routes** show consistent usage, indicating a stable base of riders relying on high-speed transit options.
   - **School routes** have sharp, periodic peaks aligned with school calendars, suggesting demand forecasting should incorporate academic schedules.
   - **Light Rail** usage is more stable but shows slight dips during holidays, implying mixed-use between daily commuters and occasional travelers.
3. **Anomalies Indicate External Events or Disruptions**
   Visualizations reveal spikes or drops on specific dates across modes — possibly due to public holidays, weather conditions, strikes, or local events. Integrating external datasets (e.g., event calendars, weather data) could improve predictive accuracy.
4. **Underutilized Capacity in Local Routes**
   Local Routes show considerable volatility with lower averages and high variance. This may indicate either underutilized capacity or inconsistent service reliability. A targeted survey or real-time tracking could clarify whether route restructuring or marketing is needed.
5. **Opportunity for Dynamic Scheduling and Demand-Aware Planning**
   Given the predictable nature of usage patterns, the city transport authority can implement dynamic scheduling. For example:
   - Increase **Peak Service** frequency during morning and evening rush hours.
   - Reduce **School Services** during exam seasons or holidays based on predicted drops.
   - Use **Light Rail** consistently, but optimize train lengths during low-demand windows.

Forecast Summary

1. Data Loading & Cleaning

- Loaded a dataset containing daily passenger counts for different transport services.
- Converted the date column into a datetime format to support time-based analysis.
- Removed the 'Other' column due to missing values and irrelevance.
- Ensured that the remaining service columns had no missing data and were ready for forecasting.

2. Data Visualization

- Plotted time series graphs to show how passenger usage changed over time for each service.
- Created a correlation heatmap to observe how different transport services are statistically related.

3. Forecasting Each Service

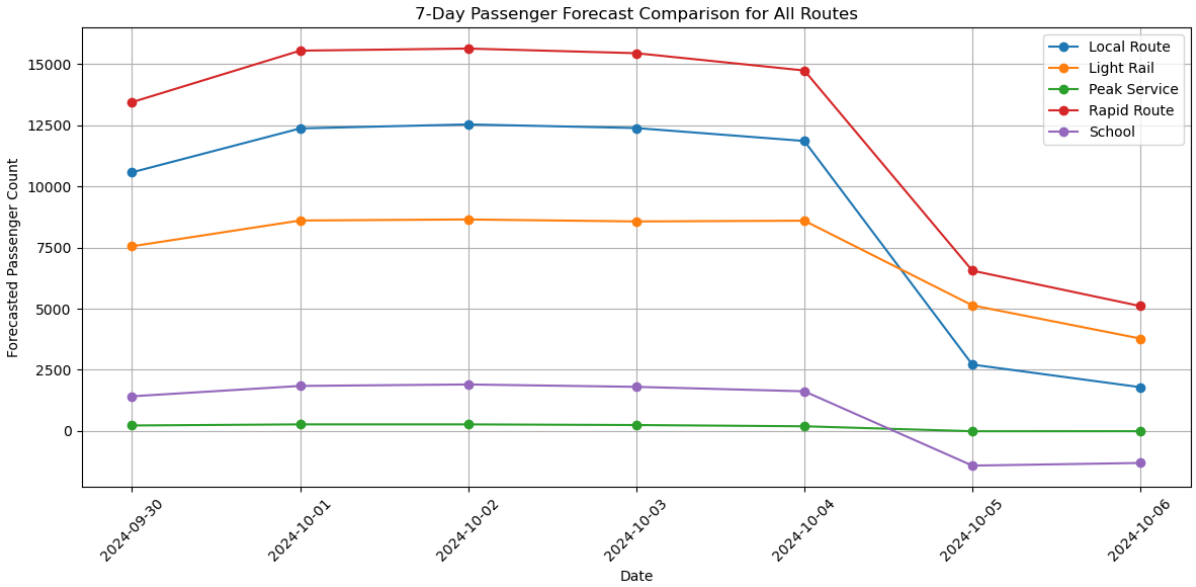
- Built a reusable function that:
    - Fits a time series model (Prophet) for each transport service.
    - Displays both the forecasted trends and their seasonal components (weekly, yearly, trend).
    - Saves the forecasted results as CSV files for later analysis.

4. Detailed Forecast for One Service

- Ran a focused 7-day forecast for "Local Route" separately.
- Visualized predicted values along with confidence intervals.
- Displayed exact forecast numbers to show future demand.

5. Combined Forecast Comparison

- Ran 7-day forecasts for all five key services.
- Merged all forecasts into one view to compare predictions across services.
- Plotted a combined line chart to visualize how each service is expected to perform in the coming week.


7-Day Passenger Forecast Comparison for All Routes
Local Route
Light Rail
Peak Service
Rapid Route
School
Forecasted Passenger Count
15000
12500
10000
7500
5000
2500
0
2024-09-30
2024-10-01
2024-10-02
2024-10-03
2024-10-04
2024-10-05
2024-10-06
Date