SPATIO-TEMPORAL ROAD FAILURE RISK PREDICTION AND VISUAL EVIDENCE SYSTEM FOR DENVER

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THE PROBLEM

- Safety Hazards
- Emergency Costs
- Limited Resources
- Need of Proactive Prioritization

DATASET

Denver 311 Dataset

Citizen-reported infrastructure issues timestamps and geographic coordinates

Key attributes:

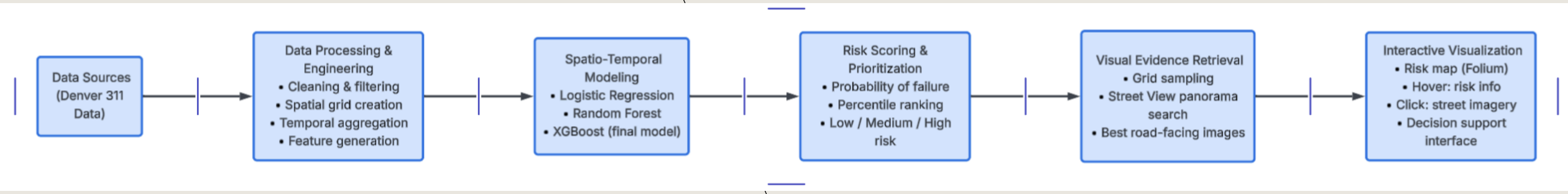
- Complaint type
- Timestamp
- Latitude & longitude
- Neighbourhood information

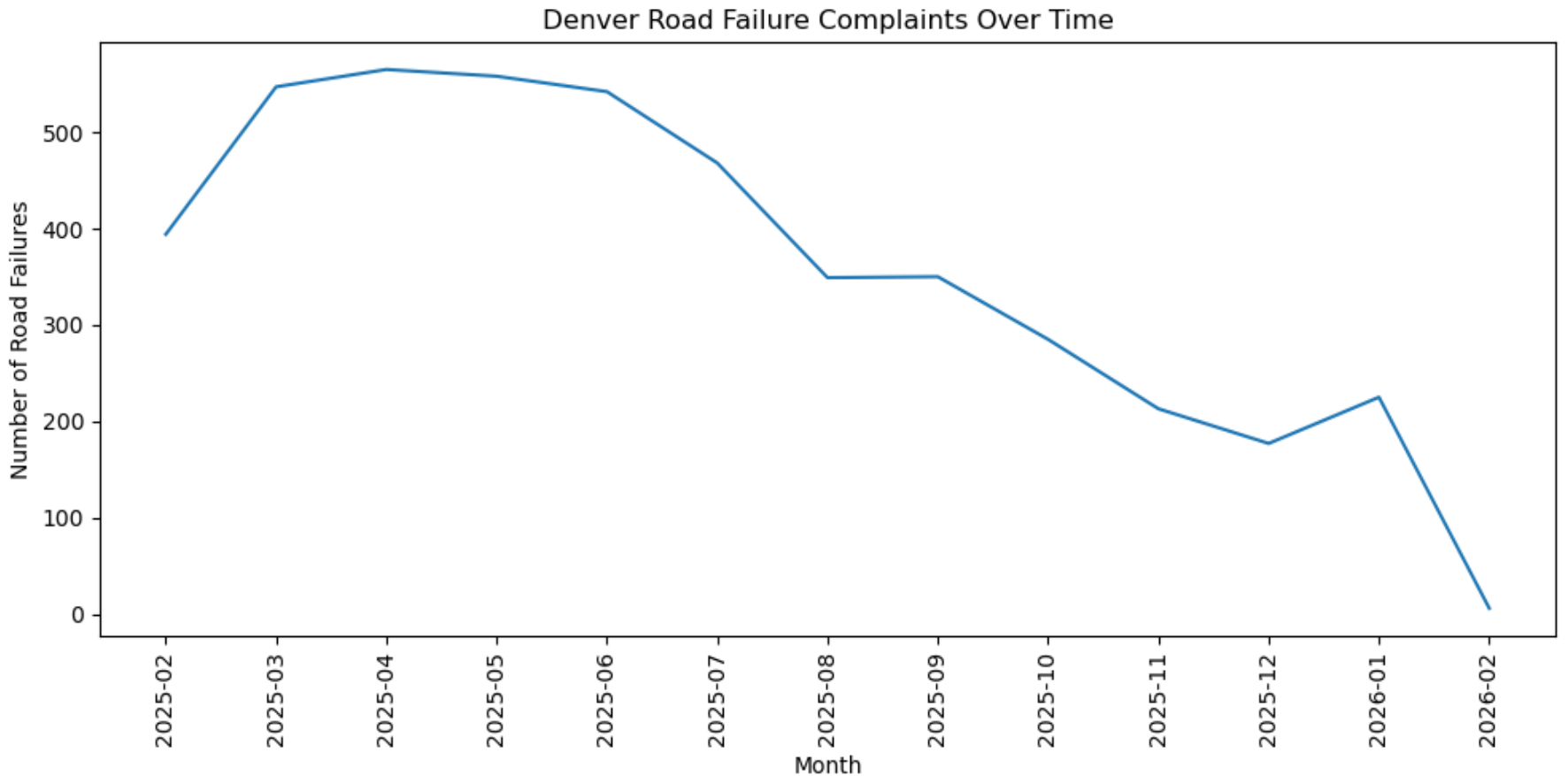
Data Cleaning:

- Filtered for road related failures.
- Drop missing values
- Coordinate filtering

Total usable records: ~4600

ML ARCHITECTURE PIPELINE DIAGRAM

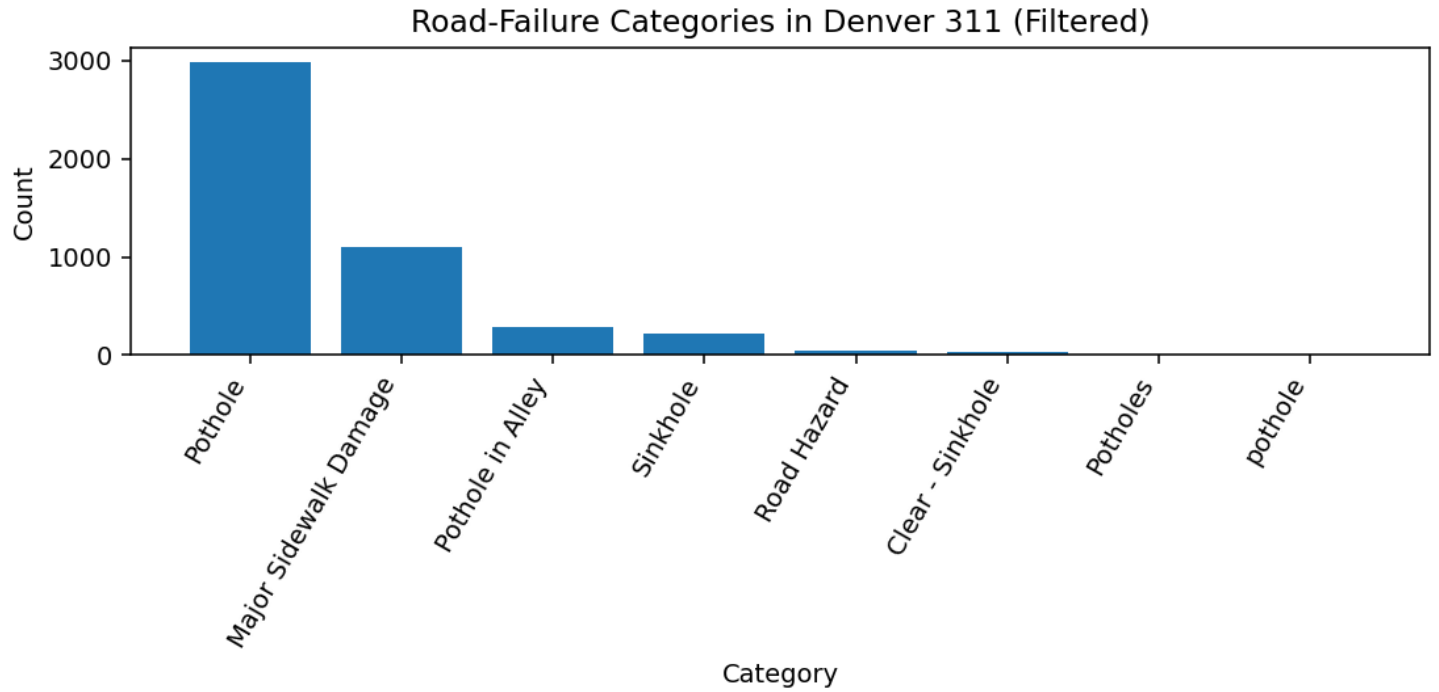



Denver Road Failure Complaints Over Time
Number of Road Failures
0
100
200
300
400
500
2025-02
2025-03
2025-04
2025-05
2025-06
2025-07
2025-08
2025-09
2025-10
2025-11
2025-12
2026-01
2026-02
Month

CATEGORY DISTRIBUTION:

MOST COMMON COMPLAINTS:

- POTHOLES
- MAJOR SIDEWALK DAMAGE
- ALLEY POTHOLES
- SINKHOLES



Feature imp diagram

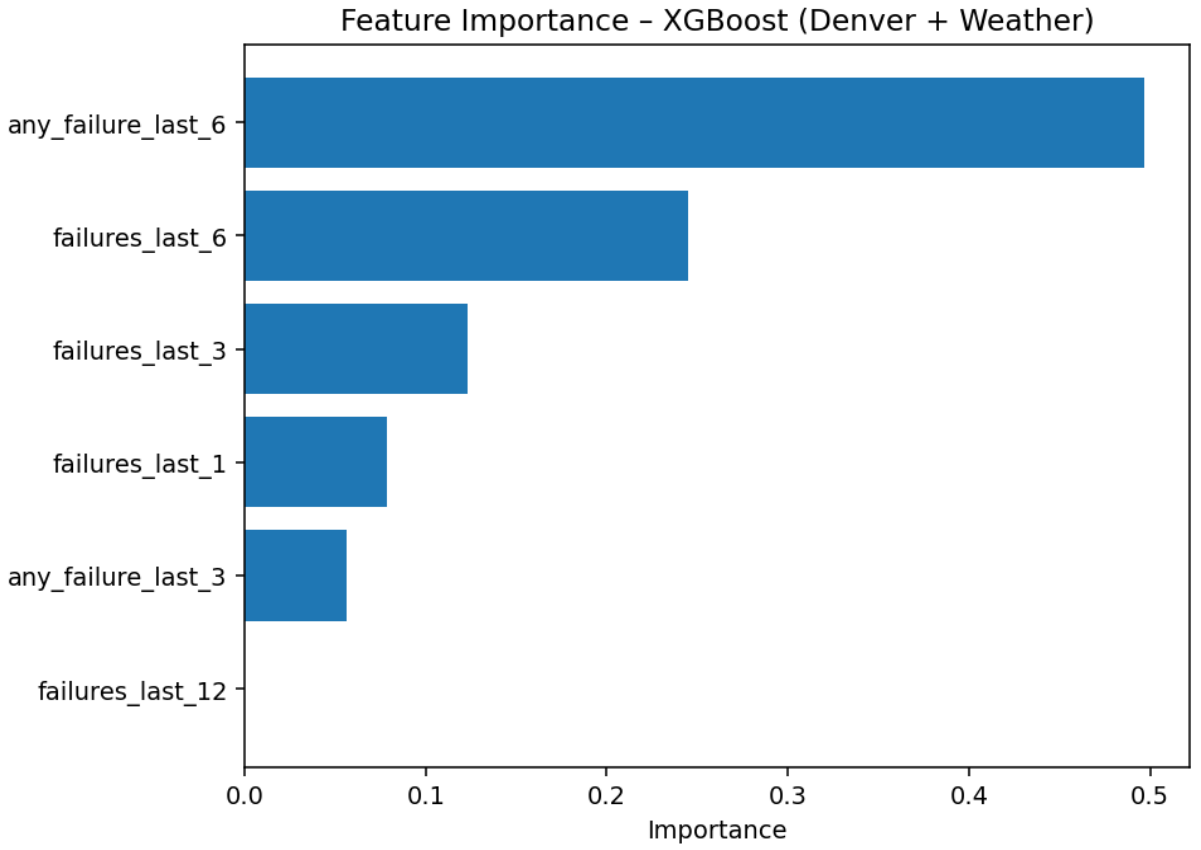
Data Processing Pipeline

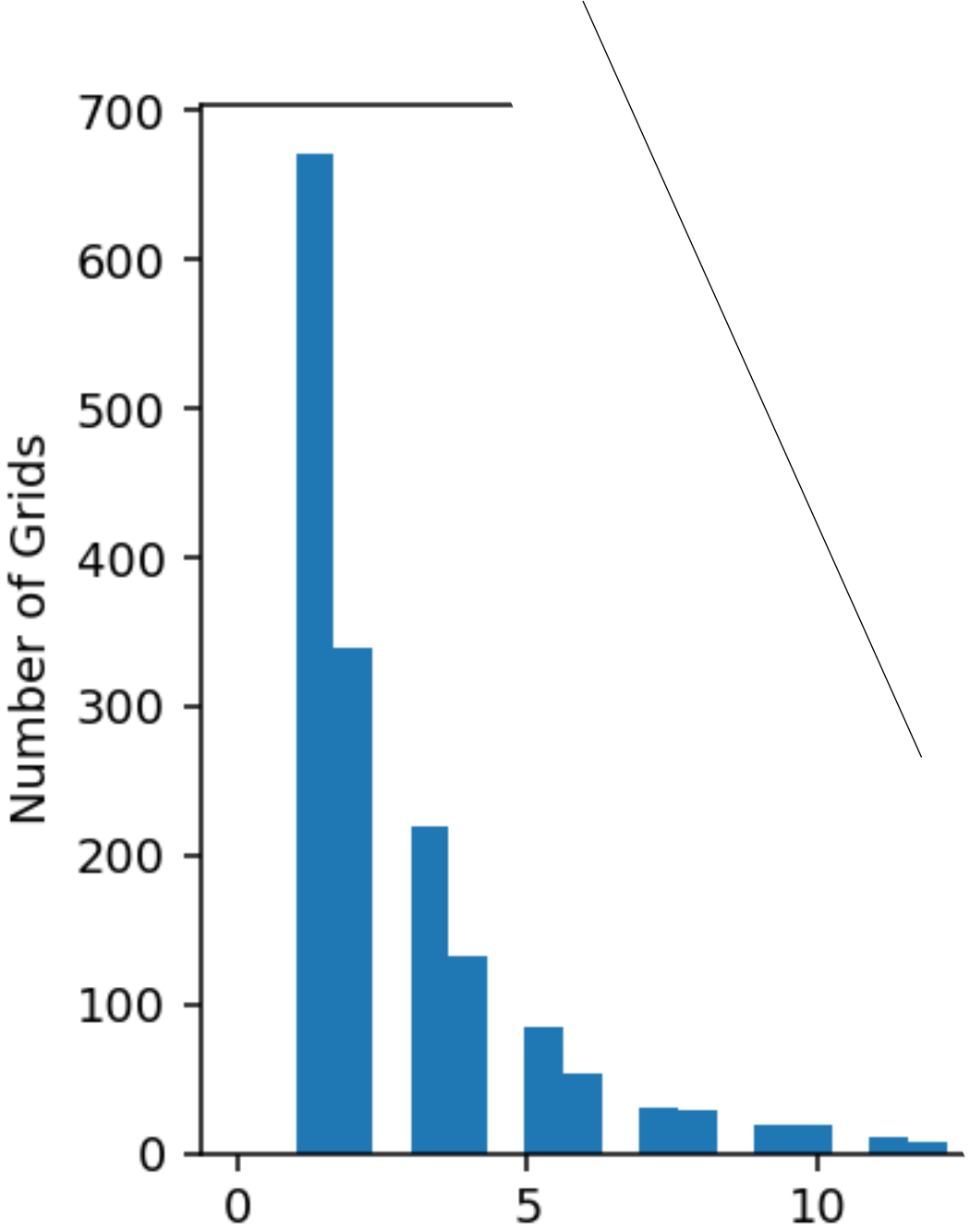
Temporal Features:

1. Failures last 1
2. Failures last 3
3. Failures last 6
4. Failures last 12
5. Any failures last 3
6. Any failures last 6

Target variable:

1. Failure next month



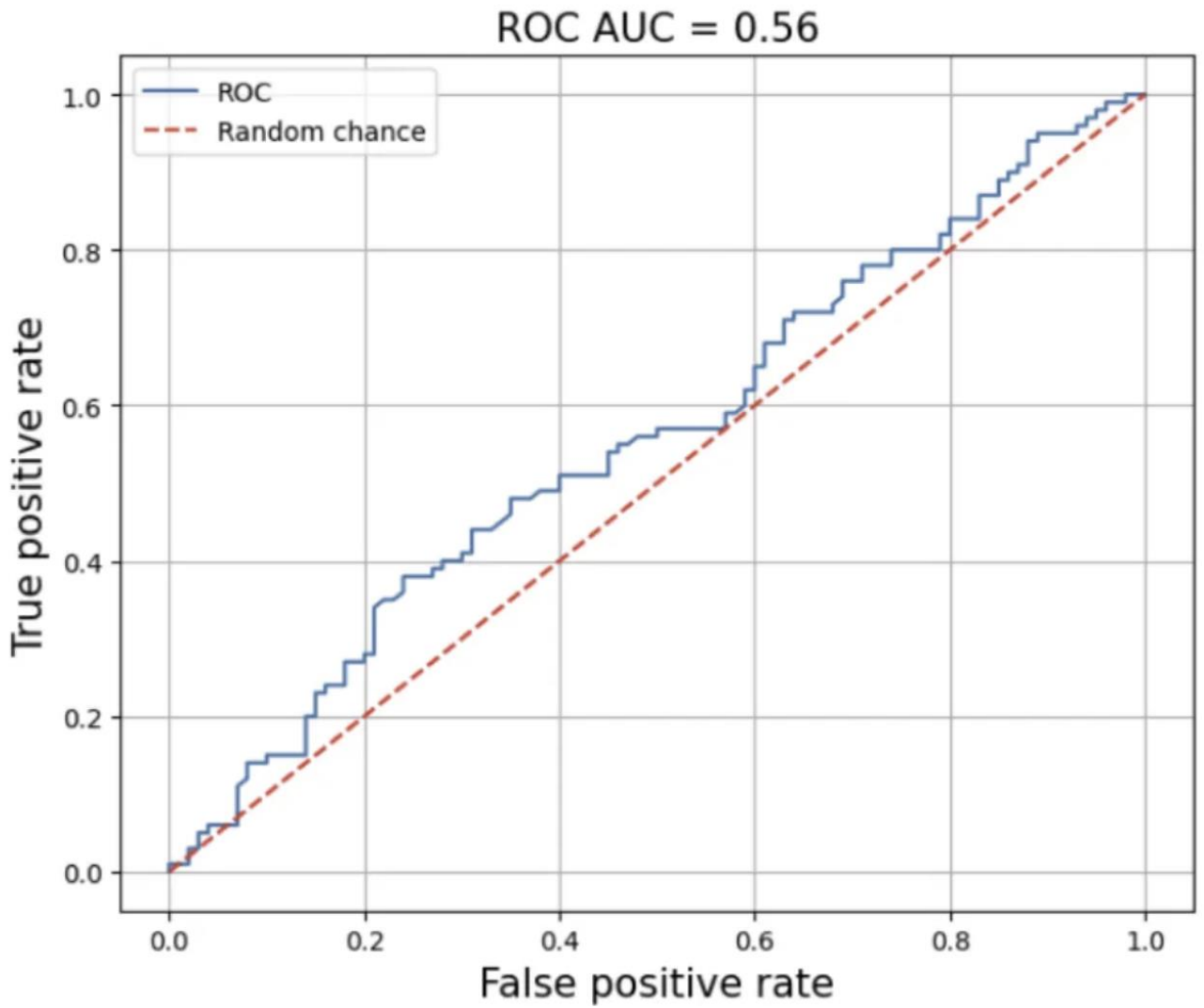


SPATIAL FAILURE CONCENTRATION

Infrastructure failures are spatially clustered.

- Most grids experience very few failures
- A small number of grids experience repeated failures

Model Performance



RISK MAPPING & SPATIAL MODELING & ANALYSIS

Probability Scores

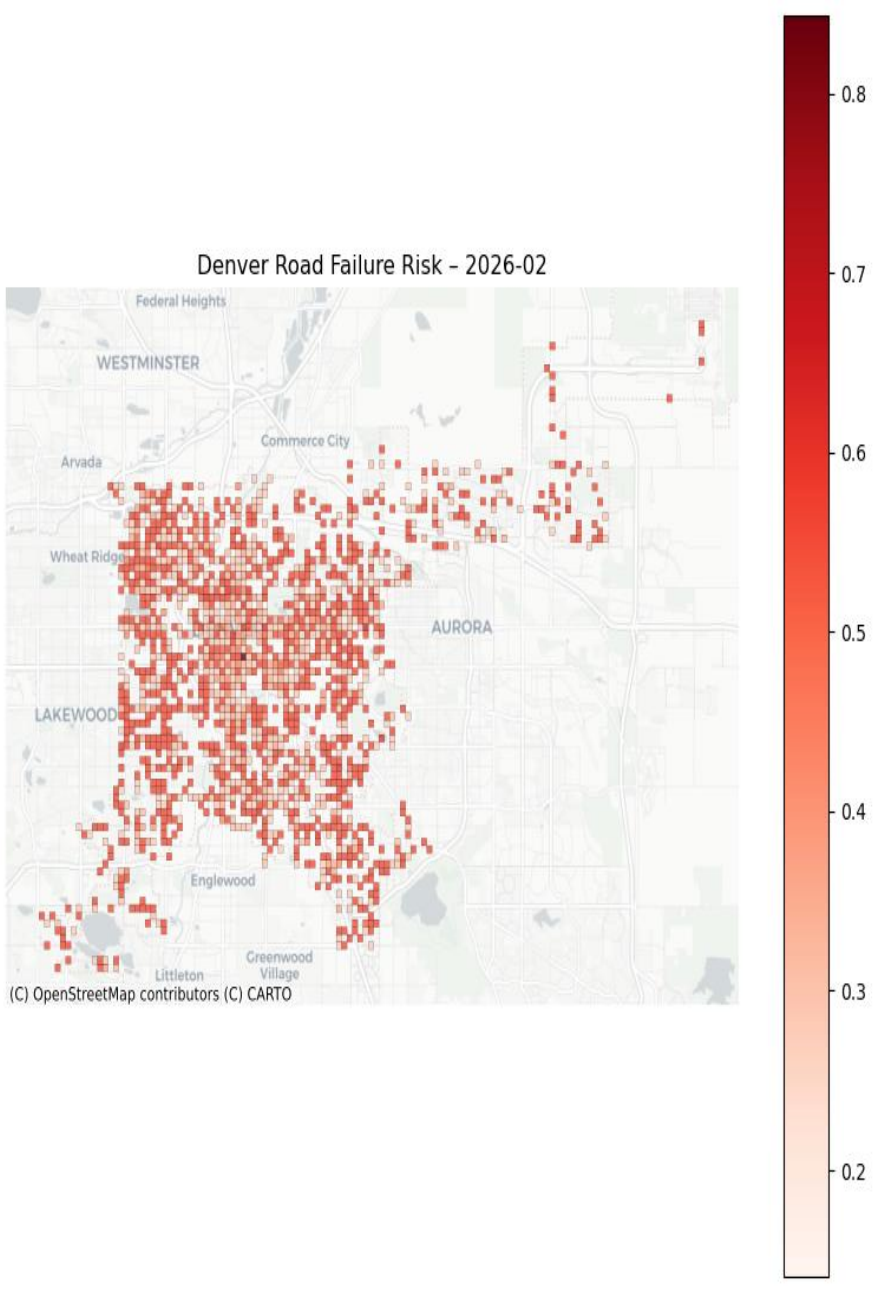
Each grid cell receives a risk probability score based on model predictions

Categorical Ranking

Scores grouped into Low, Medium, and High risk categories for clear communication

Spatial Hotspots

Clear geographic patterns emerge, revealing priority areas for inspection and maintenance



VISUAL EVIDENCE INTEGRATION

Street-Level Context

Predictions alone don't always convince engineers and decision-makers. Visual confirmation is often required before deploying inspection crews.

Google Street View API

Integrated imagery retrieval system automatically fetches nearby street-level images for each high-risk grid cell.

INTERACTIVE DECISION-SUPPORT TOOL

Map Interface

Visual representation of the entire city with grid overlays

Hover Action

Mouse hover reveals risk scores, categories, and statistics

Click Action

Click displays corresponding street-level imagery

SYSTEM CONTRIBUTION

- Spatio-temporal infrastructure modeling
- Machine learning for predictive maintenance
- Risk-based infrastructure inspection
- Integration with street-level imagery