NHTSA FARS · DATA SCIENCE RESEARCH · 2025

Airbag Failure Analysis

Predicting when airbags should deploy — and identifying crashes where they unexpectedly didn't. Based on 36,470 crash records from the NHTSA Fatality Analysis Reporting System.

8.3%
OVERALL FAILURE RATE
AMONG EXPECTED DEPLOYMENTS

36,470
TOTAL CRASHES ANALYZED
NHTSA FARS 2023 dataset

18.8%
OVERALL DEPLOYMENT RATE
Across all crash types

61%
FATAL CRASH DEPLOY RATE
Highest severity crashes

XGBoost
BEST PERFORMING MODEL
Selected via F1 + precision-recall

VEHICLE ANALYSIS

Failure Rate by Vehicle Make

% of crashes where airbags failed to deploy — passenger vehicles with 200+ records

Key finding: Audi and Jeep show the highest failure rates among mainstream passenger brands at 84%+, while Infiniti and Acura have the lowest at ~74%.

MODEL PREDICTIONS

Deployment Outcome Distribution

How XGBoost predictions compared against actual deployment outcomes

8.3%
EXPECTED BUT FAILED

13.1%
EXPECTED & DEPLOYED

66.5%
EXPECTED NO DEPLOYMENT

9.1%
UNCERTAIN

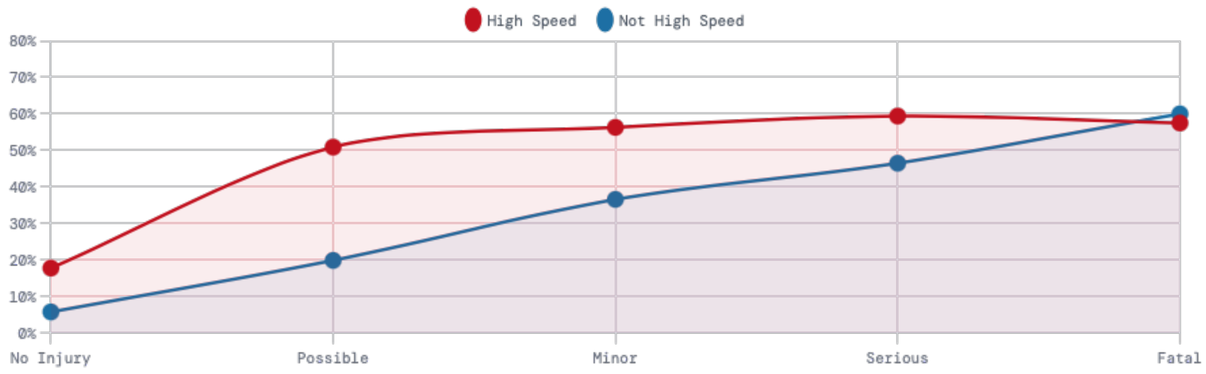
3.0%
UNEXPECTED DEPLOYMENT

The model flagged **8.3% of high-confidence predictions** as failures — crashes where airbags should have deployed but didn't, warranting further investigation.

SEVERITY ANALYSIS

Deployment Rate by Injury Severity

How crash severity and speed jointly predict airbag deployment likelihood

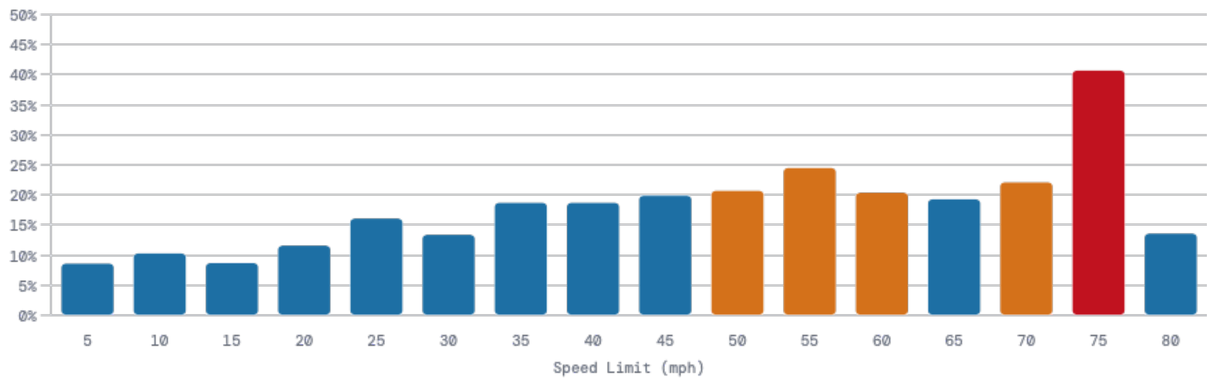


High-speed crashes show **2-3× higher deployment rates** at every severity level — especially at "Possible Injury" where the gap is largest (51% vs 20%).

SPEED ANALYSIS

Deployment Rate by Speed Limit Zone

Airbag activation rates across posted speed limit zones

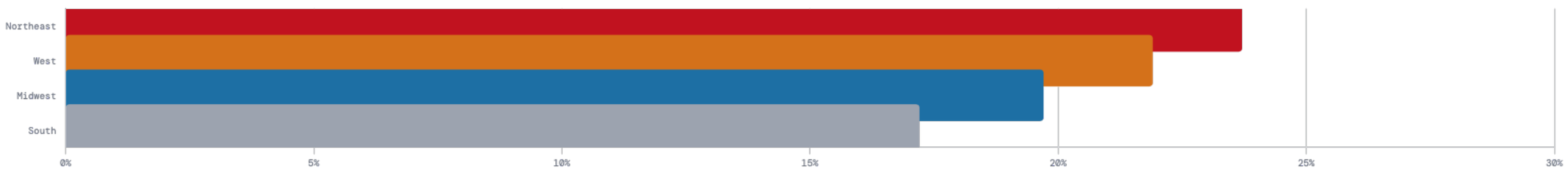


Deployment rates rise steadily with speed limit zones, peaking sharply at **75 mph zones (41%)** — nearly double the 55 mph rate of 24%.

REGIONAL ANALYSIS

Deployment Rate by U.S. Region

Geographic variation in airbag deployment across 36,470 crashes — Northeast leads with 23.7%, South lowest at 17.2%



Data: NHTSA FARS 2023 · Models: XGBoost, Random Forest, Logistic Regression · Built with Python, Scikit-learn, Pandas

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