The Need for Speed…. REDUCTI0N: Chicago Traffic Safety Analysis

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Photo by Adrian Williams on Unsplash

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Business Understanding

Background | Goals | Success Criteria

Vision Zero Chicago

Goal: ***0*** traffic deaths by 2026

Reality:

- 2024 (to-date): ***115*** traffic deaths
- 2023: ***136*** traffic deaths

Business Understanding

Background → **Goals** → Success Criteria

- **Develop an *inferential* model**
- **Assist Chicago DOT (CDOT) in resource allocation**

"*Serious crash*"
=
Fatal or incapacitating

To learn more about the City of Chicago's definition of an 'incapacitating injury', visit this link: https://data.cityofchicago.org/Transportation/Traffic-Crashes-Crashes/85ca-t3if/about_data

Business Understanding

Background → Goals → **Success Criteria**

- **Identify top 3 contributing factors**
- **Precision-Recall Area Under the Curve (PR AUC)**

Business Understanding

Background → Goals → **Success Criteria**

- **Precision-Recall Area Under the Curve (PR AUC)**
  - **Focuses on minority case (serious crashes)**

Data Understanding

Source: Chicago Data Portal (updated: Dec 2024)

Datasets:

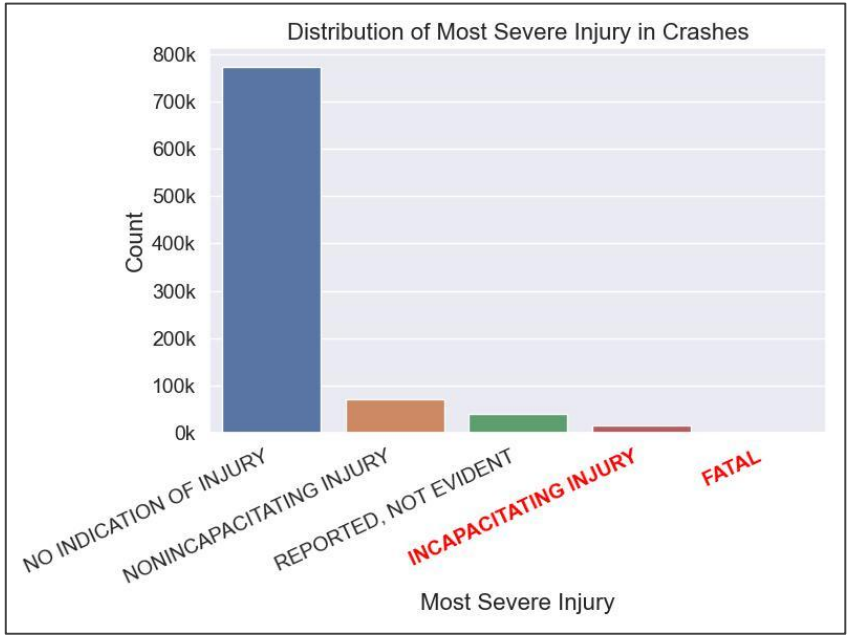
- Crashes: ***900k*** records, ***48*** features
- People: ***~2M*** records, ***29*** features:
- Vehicles: ***1.8M*** records, ***71*** features

Linked by: `crash_record_id`

Data Preparation: Phase 1

1. Processed ***3*** datasets
    a. Removed irrelevant features
    b. Processed features reducing cardinality
    c. Handled Null Values
    d. Reclassified the Target Variable to Binary

Data Preparation: Target Reclassification



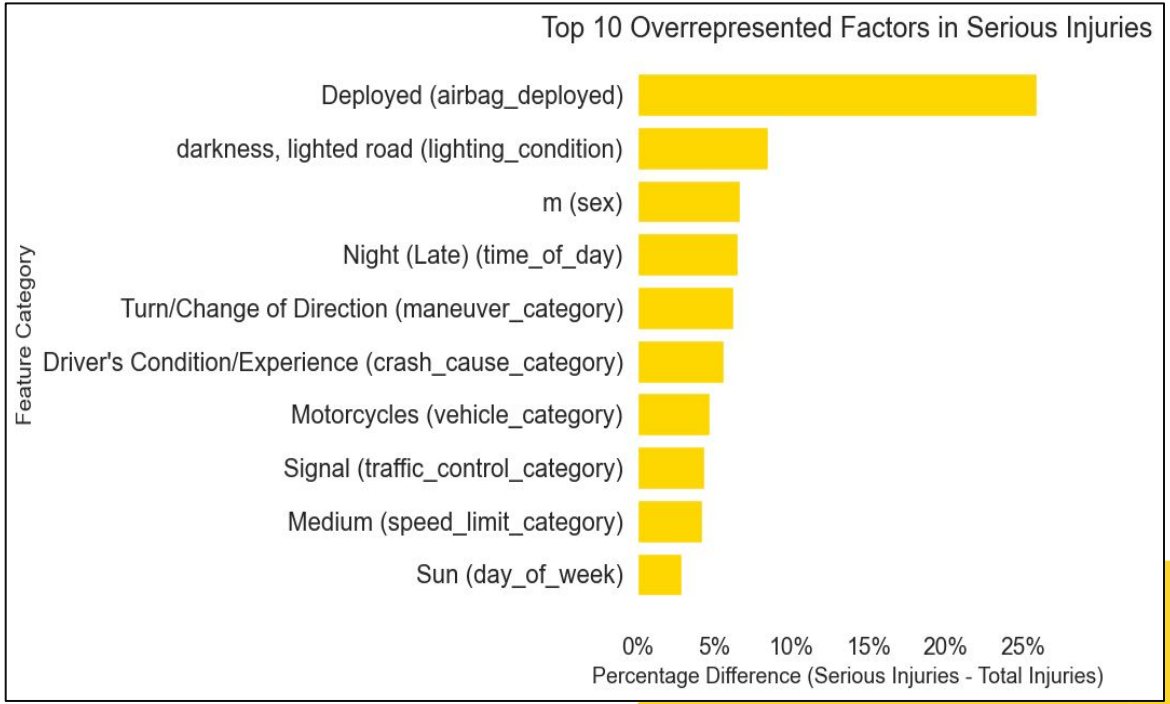
Data Preparation: Phase 2

3. Stratified Sample
    a. Subset: ***15***% of merged_df
    b. Kept target classes proportional
    c. Final dataframe: ***~96k*** records, ***16*** features, ***0*** null values

Exploratory Data Analysis: Key Finding

Overrepresented Categories in Serious Crashes:

- **Sex**: Males
- **Lighting**: Darkness with lighted roads
- **Airbag Deployment**



Modeling: Key Components

Standard Modeling Process:

- Train-test-split = Avoids data leakage
- Baseline models for comparison
- Hyperparameter tuning

Modeling: Addressing Issues

- **Developing interpretable model**
  - White box models (opposite of black box models)

- **Addressing class imbalance**
  - Oversampling (SMOTE) + class weights

Reminder: Minority class = Serious crashes

Evaluation

Metric (PR AUC): Best Decision Tree = ***0.0956***

Class Imbalance: Likely contributing to low performance

Focus: Model inference over predictive accuracy

Perfect Performance:

PR AUC = **1.0**

Evaluation

Decision Trees: Simple, highlight feature importance

Key Features:

- Airbag Deployment (***Not Deployed***)
- Sex (***Male***)
- Seasonality (***Summer, Winter, Spring***)

	Original_Feature	Category	Feature_Importance
0	airbag	Not Deployed	0.0625
1	crash	Unknown/Other	0.0499
2	sex	male	0.0437
3	season	Summer	0.0414
4	season	Winter	0.0397
5	season	Spring	0.0391

Limitations

1. Data Quality: Police-Reported Data

2. Decision Tree Interpretation

3. Computing and Time Constraints

Recommendations

Recommendation 1:
Male Trends Analysis

- Research trend among male *drivers*
- Targeted safety campaign

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Size Regulation

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- Money raised → infrastructure projects

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Recommendation 1: **Male Trends Analysis**

- Research trend among male *drivers*
- Targeted safety campaign

Recommendation 2: **Size Regulation**

- Implement personal vehicle weight fee
- Money raised → infrastructure projects

Recommendation 3: **Airbag Inspection**

- Annual airbag safety inspections

Next Steps

1. Investigate male injury trends in crashes

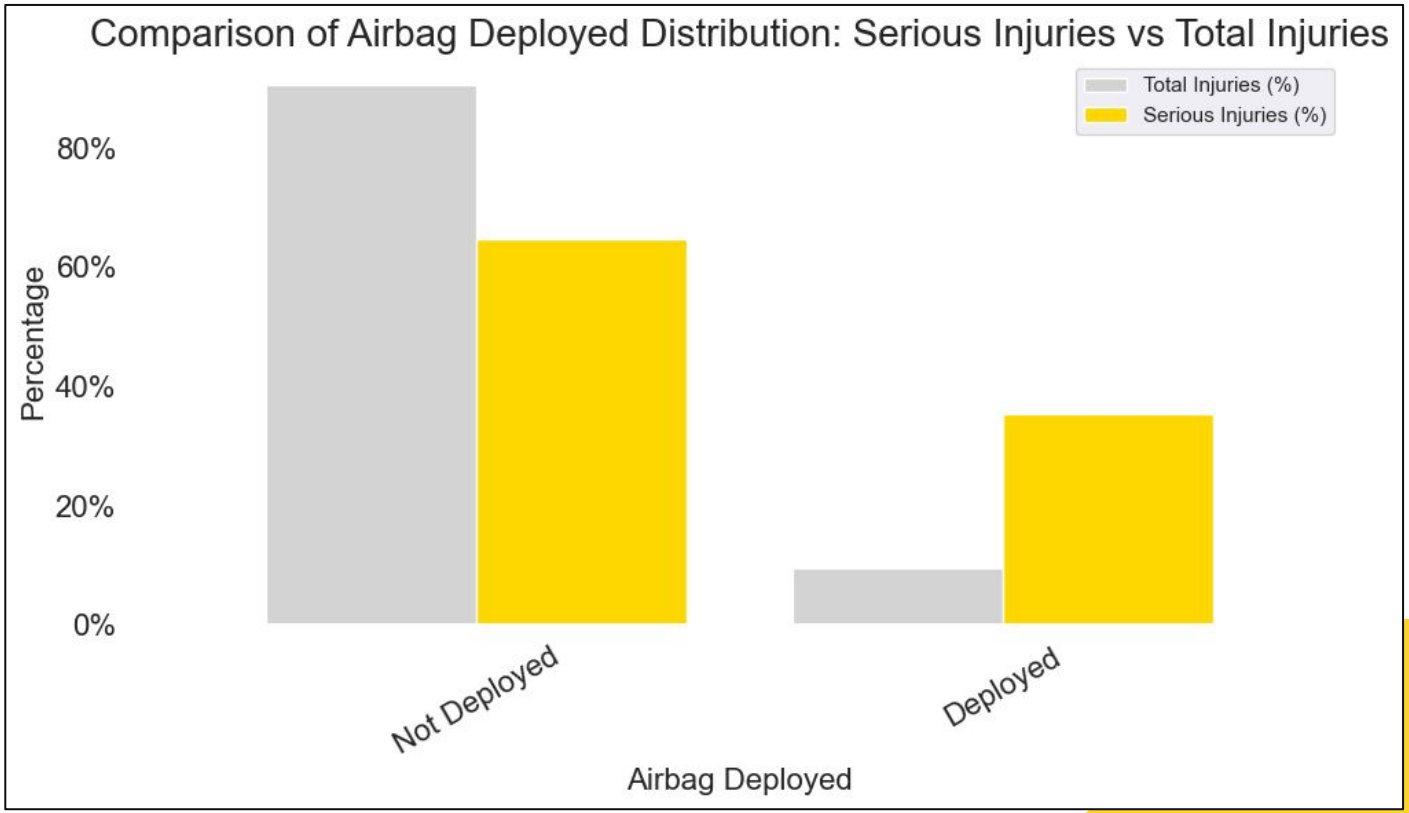
2. Explore key factors contributing to speeding

Thank you!

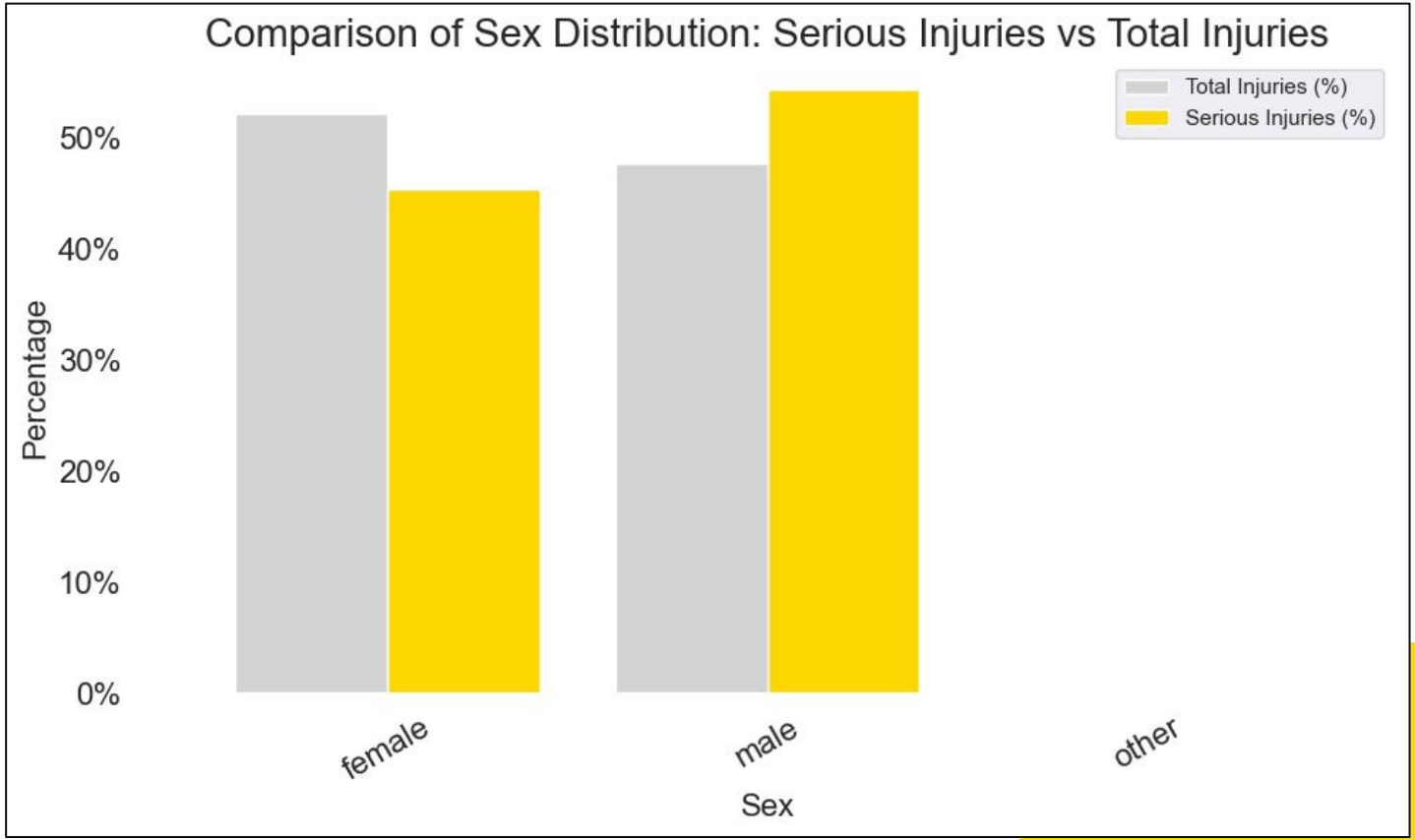
Github Repository:
https://github.com/ckucewicz/traffic_crash_prediction

Contact Chris Kucewicz at
cfkucewicz@gmail.com with additional questions

Additional Visualizations: Airbag Overrepresentation



Additional Visualizations: Male Overrepresentation



Additional Visualizations: Darkness Overrepresentation