RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022 • Athens, Greece

Factors contributing to safety-critical events in urban areas: a driving simulator study

Christos Katrakazas

Post-Doc Research Associate, Transportation Engineer

Together with:

Foteini Bardi and George Yannis

National Technical University of Athens

Department of Transportation Planning and Engineering

Introduction

- The analysis of factors that lead to unsafe driving behavior and investigation of precursors for safety-critical events have been heavily researched in the literature
- The majority of studies are focused on the identification of such events for real-time safety evaluation.
- However, there is yet no focus on factors that play an important role both before and during such an event.

Aim

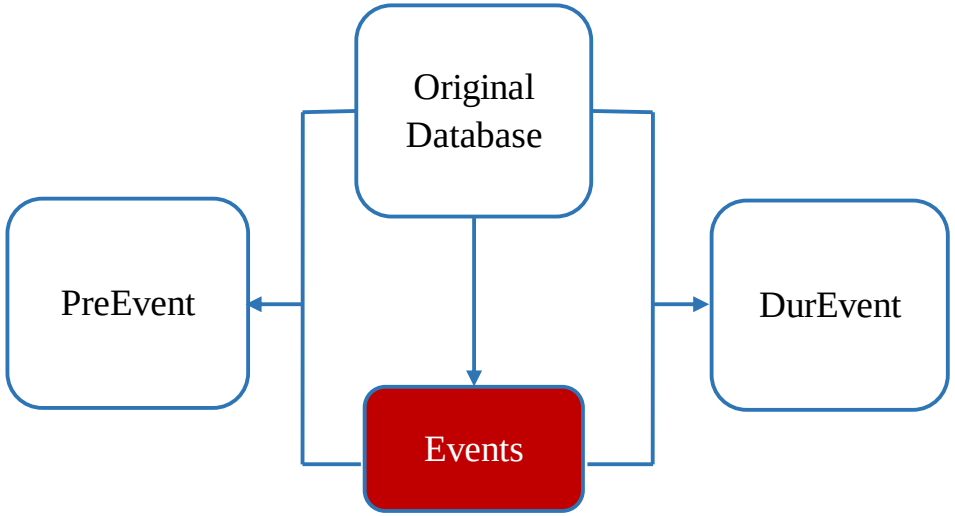
- The aim of this paper is the determination of critical factors for safety- critical events in urban areas

- Investigation of the main factors in the group of independent variables that describe the situation before and during an event

Data Overview (1/2)

- The data used were collected from a driving simulator experiment in urban roads
- 61 drivers in total
  - 656 events (in 10ms observations)
  - 59 % male – 41% female
  - 66% young – 34 % elderly
- Two scenarios:
  - Urban Road – High traffic volume
  - Urban Road – Low traffic volume

Data Overview (2/2)



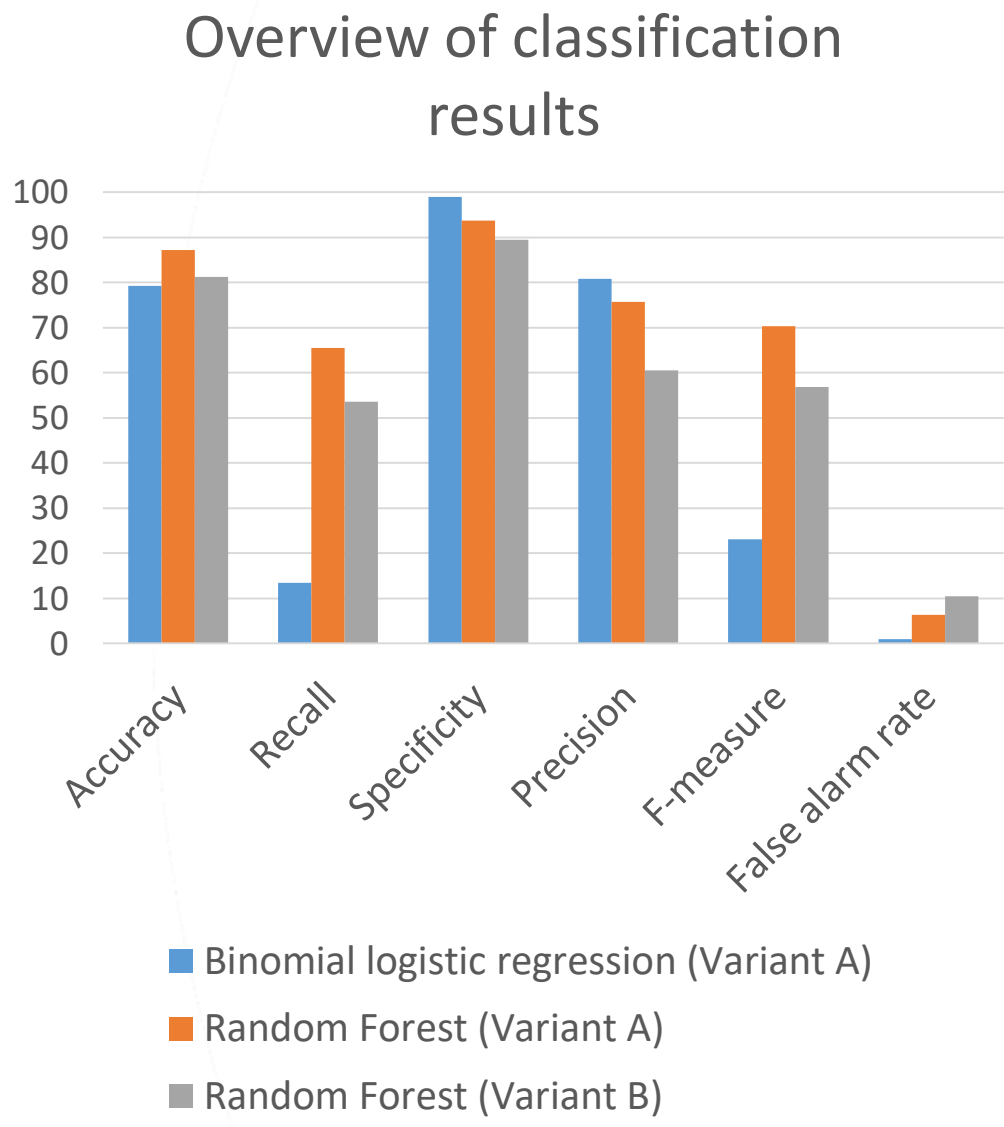
- Original database was used for the classification analysis
- Pre-event and during event databases were used for factor analysis
- Two independent variable variants:
  - All independent variables (Variant A)
  - Most important ones (Variant B)

Analysis methods

- Identifying an unexpected events is a binary classification problem
- Binary logistic regression and random forests were used to classify safety-critical events in urban roads
- Factor analysis was used to group significant predictors before and during events
- Results were evaluated using the confusion matrix and the statistical significance of results
- For factor analysis the Kaiser-Meyer-Olkin (KMO>0.6) test and sphericity was checked

Classification results

- The binomial logistic regression demonstrates a decent accuracy, but fails to predict correctly all event occurrences
- Random forests can sufficiently identify up to 60% of events (as shown by recall) along with very low false alarm rate (10% max)
- Variant A, which includes all independent variables performed better that the variant with less variables



Results – Factor Analysis

- Lane position, speed and distance from the median explain significantly conditions prior of a safety-critical event
- The situation during the event can be expressed through the influence of speed and longitudinal and lateral acceleration
- The total event duration can be explained by lane position, lateral acceleration and speed.

Condition	Factor 1	Factor 2	Factor 3
1 min before the event	Lane position	Speed	Distance from the median
During the event	Speed	Lat. Acceleration Lon. Acceleration	
Total	Lat. Acceleration	Speed	Lane position

Conclusions (1/2)

- The most significant factors for predicting safety-critical events on urban roads are speed, distance driven, lane position, steering angle and driving experience
- Random Forests had the most successful classification performance, in contraty with logistic
- Classifiers including more independent variables led to better event identification with lower false alarm rate

Conclusions (2/2)

- Speed acts as a significant indicator for the whole event duration. Factor analysis showed it can explain conditions both prior and during one event
- Lane position is significant in conditions before an event, while acceleration (both lateral and longitudinal) are important during one
- The combination of the aforementioned three factors (i.e. speed, acceleration and lane position) explain the total evolution of the event sequence

RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022 • Athens, Greece

Factors contributing to safety-critical events in urban areas: a driving simulator study

Christos Katrakazas

Post-Doc Research Associate, Transportation Engineer

Together with:

Foteini Bardi and George Yannis

National Technical University of Athens

Department of Transportation Planning and Engineering