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Safety-critical event identification on rural roads based on driving characteristics

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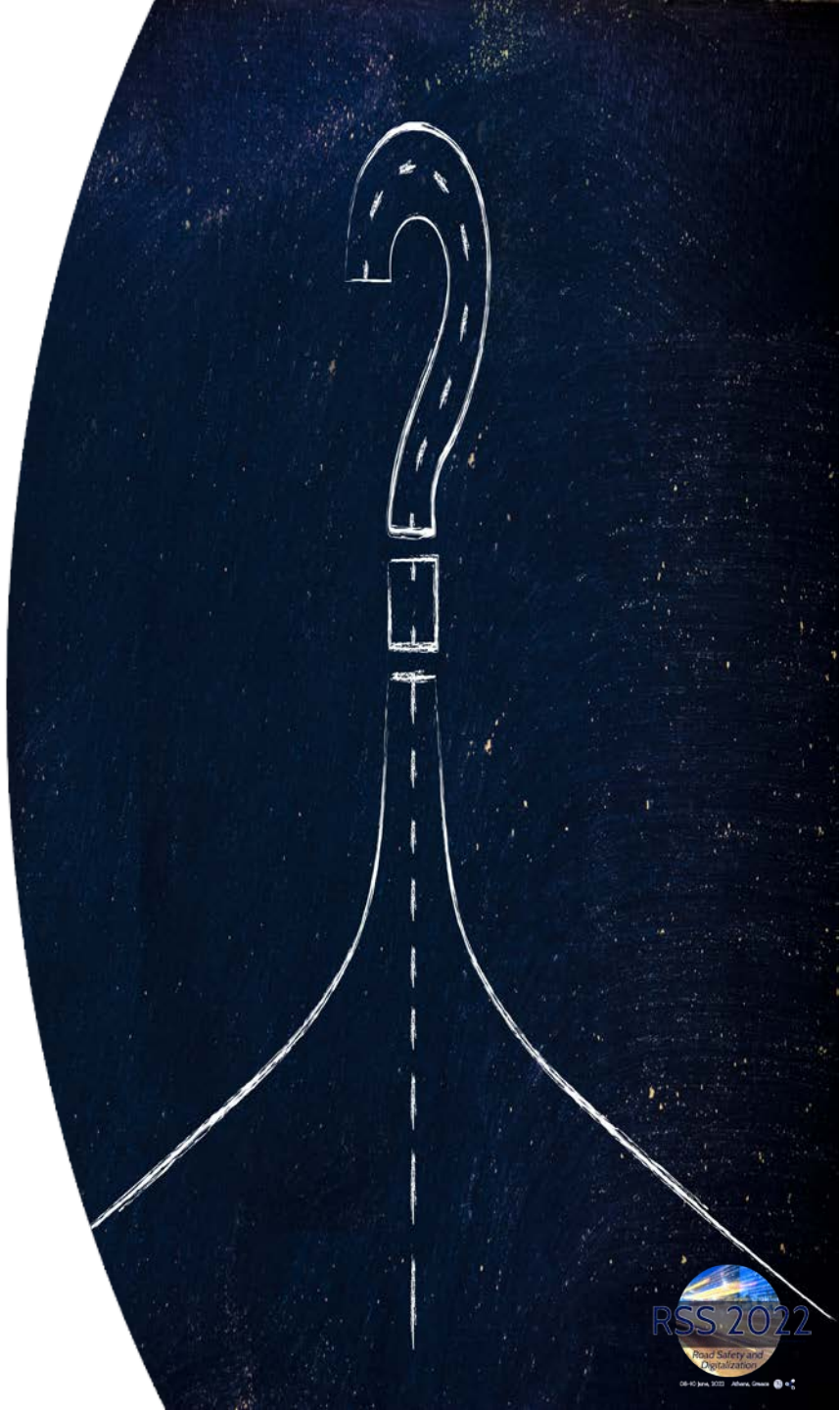
Introduction

- Ensuring safe mobility and traffic management is highly associated with safety-critical incidents.
- Recent studies have focused on the entire collision sequence in order to detect deviations from normal driving.
- There is insufficient research on the sequence of safety-critical events and the identification of factors being prominent before the event, during one and after the occurrence of an event.



Study Aim

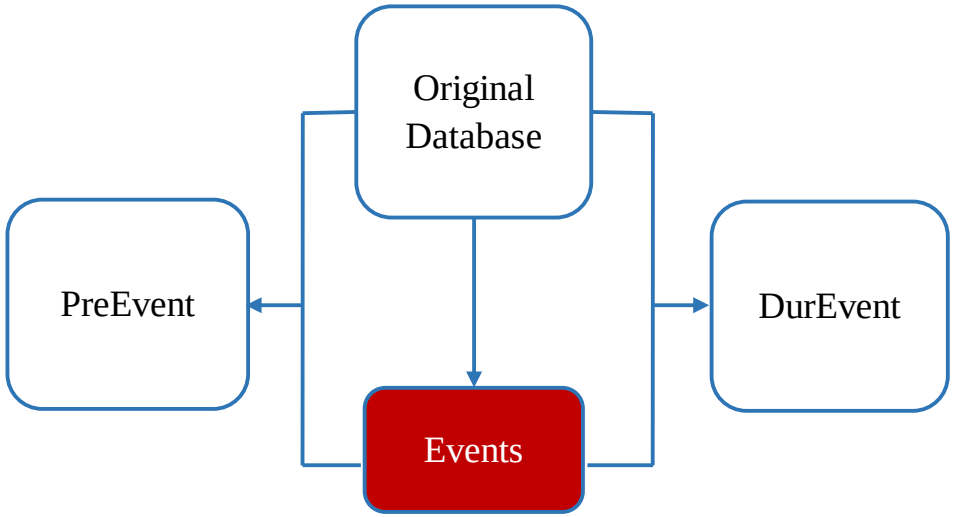
- The aim of this paper is to identify safety-critical events based on driving characteristics on rural roads

- Determine the main factors that can describe the situation before and during an event.

Data Overview (1/2)

- The data used were collected from a driving simulator experiment in rural roads.
- 27 drivers in total
  - 428 events (in 10ms observations)
  - 52 % male – 48% female
  - 70% young – 30 % elderly
- Two scenarios:
  - Rural Road – High traffic volume
  - Rural 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)

Dependent variable

Occurrence of safety-critical event

Independent variables

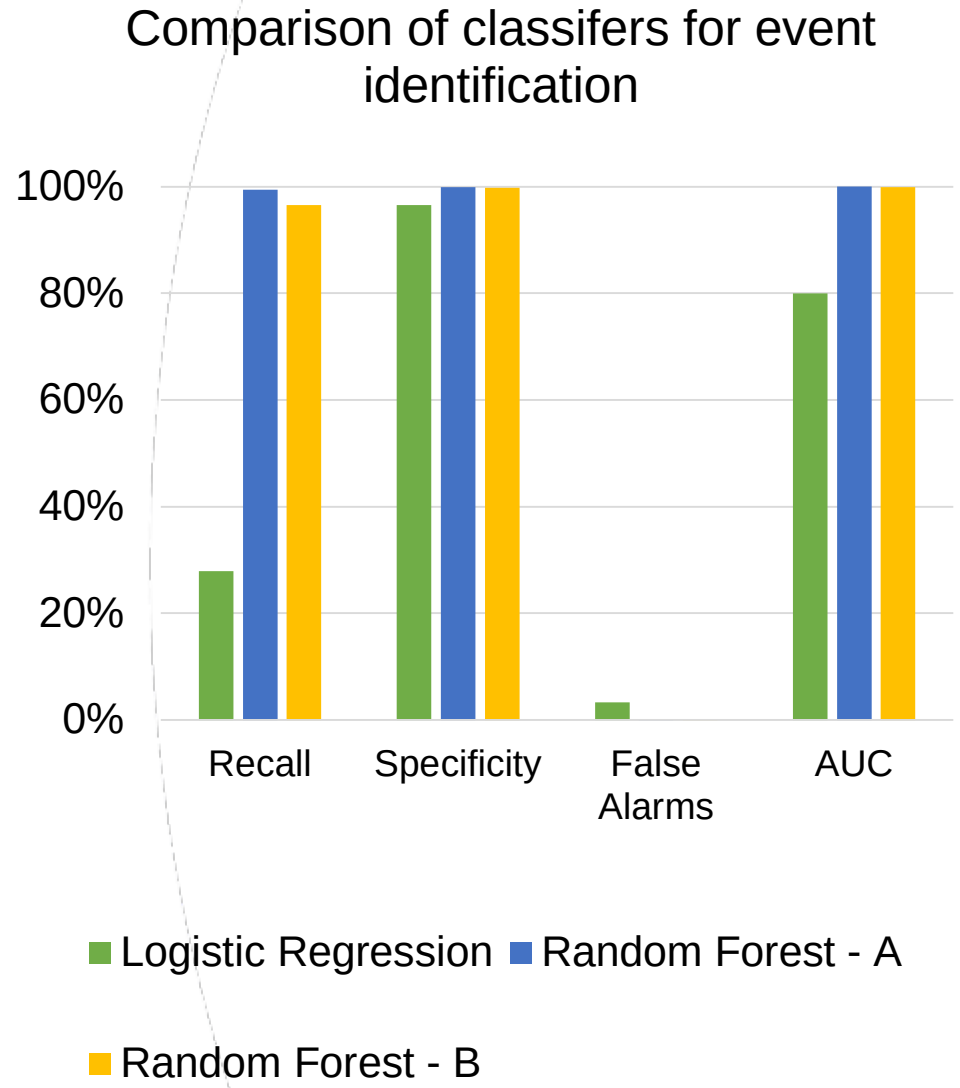
Speed
Longitudinal Acceleration
Time to collision (TTC)
Distance driven
Distance from the middle of the lane
Driving Experience
Steering angle

Analysis methods

- Binary logistic regression and random forests were used to predict the occurrence of a safety-critical event
- Factor analysis was used to group significant predictors before, during and after the event
- A training set with 80% of the data and a testing set with 20% of the elements of the original base was used.
- 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 its sphericity was checked

Results - Classification

- Random Forests perform better in identifying events as well as normal driving conditions
- Logistic Regression can identify better normal driving conditions rather than events (high specificity vs low recall)
- All classifiers have a low false alarm rate



Results – Factor Analysis

- Speed as well as total distance travelled and distance of the vehicle from the median play a significant role prior and during events
- The conditions before unexpected events can be better described through values from speed and time headway
- During the event speed and distance from the median are extremely important

Conditions	Factor 1	Factor 2	Factor 3
1 minute before the event	Speed	Distance driven	
	Long. Acceleration		
During the event	Speed	Distance from median	TTC
Total	Speed	Distance from median	Distance driven
	TTC		

Conclusions (1/2)

- Speed, longitudinal acceleration, distance driven and driving experience are the most significant precursors of safety-critical events
- Random Forests performed better than binary logistic regression in identifying events
- More independent variables included in the model lead to better classification results

Conclusions (2/2)

- Conditions before events can be better described by speed, acceleration and total distance as shown by the factor analysis
- Factors such as speed, distance from the median and TTC play a significant role during events
- The total evolution of the event sequence can be better described by speed, TTC, distance from the median and total distance driven

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