



**RSS 2022**

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

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Together with:

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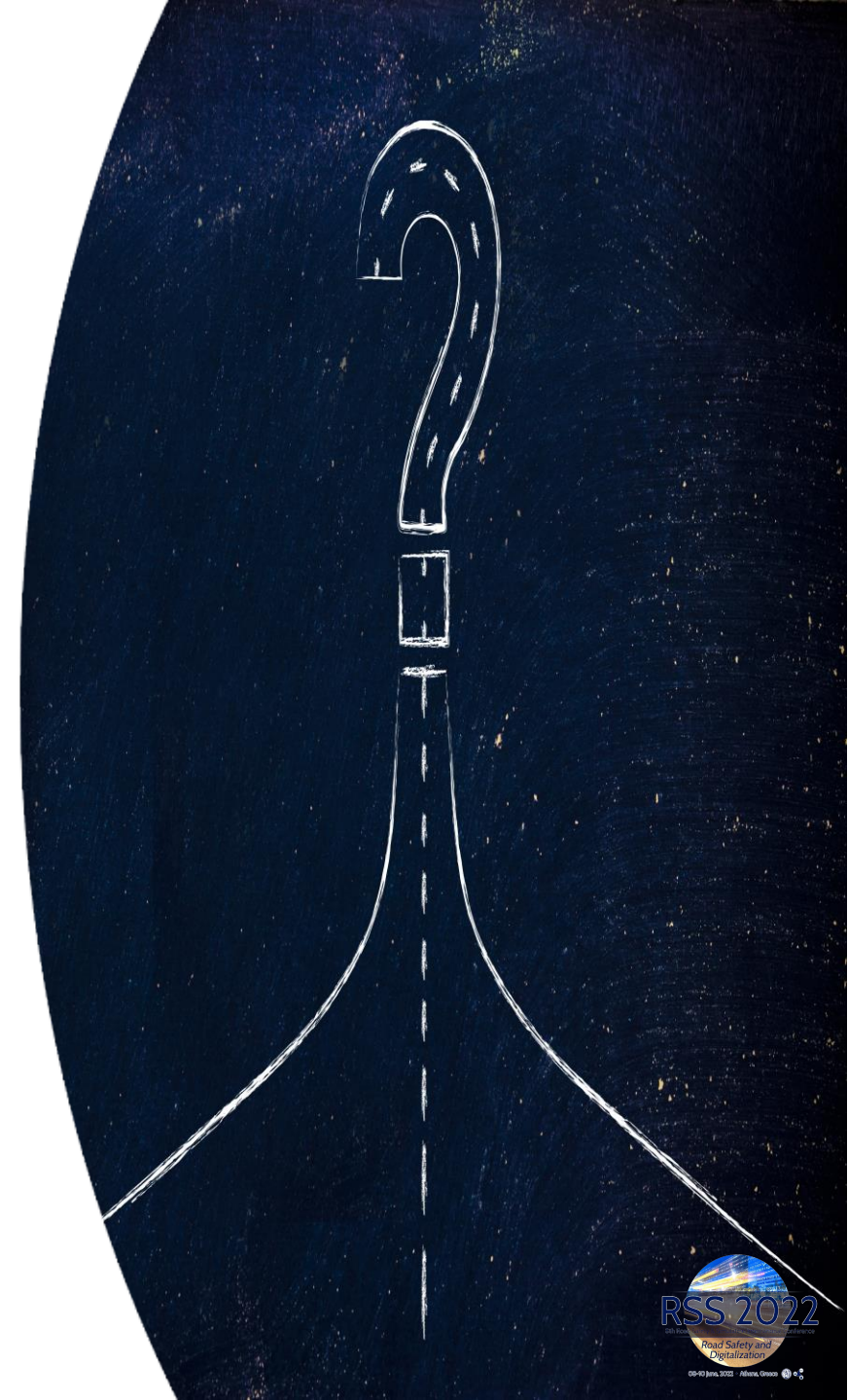


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# Introduction

- 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.





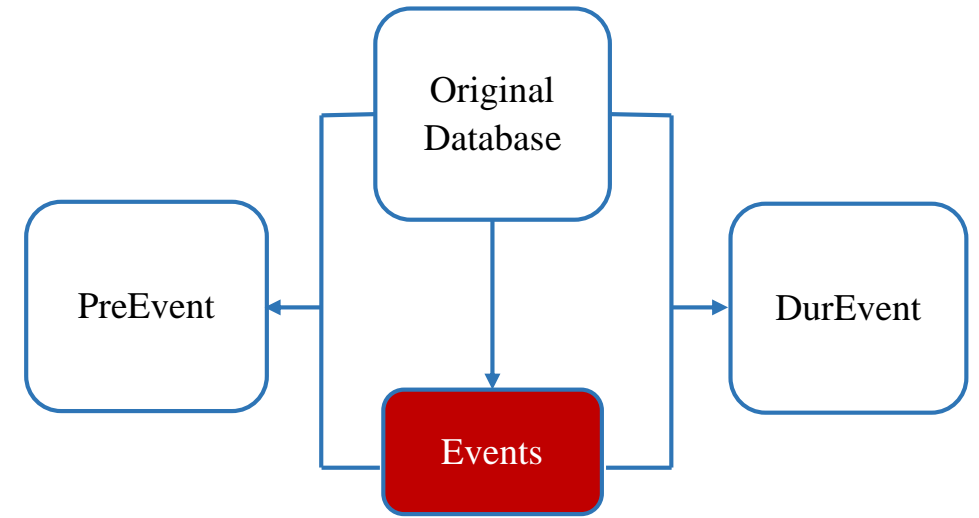
# Data Overview (1/2)

- 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

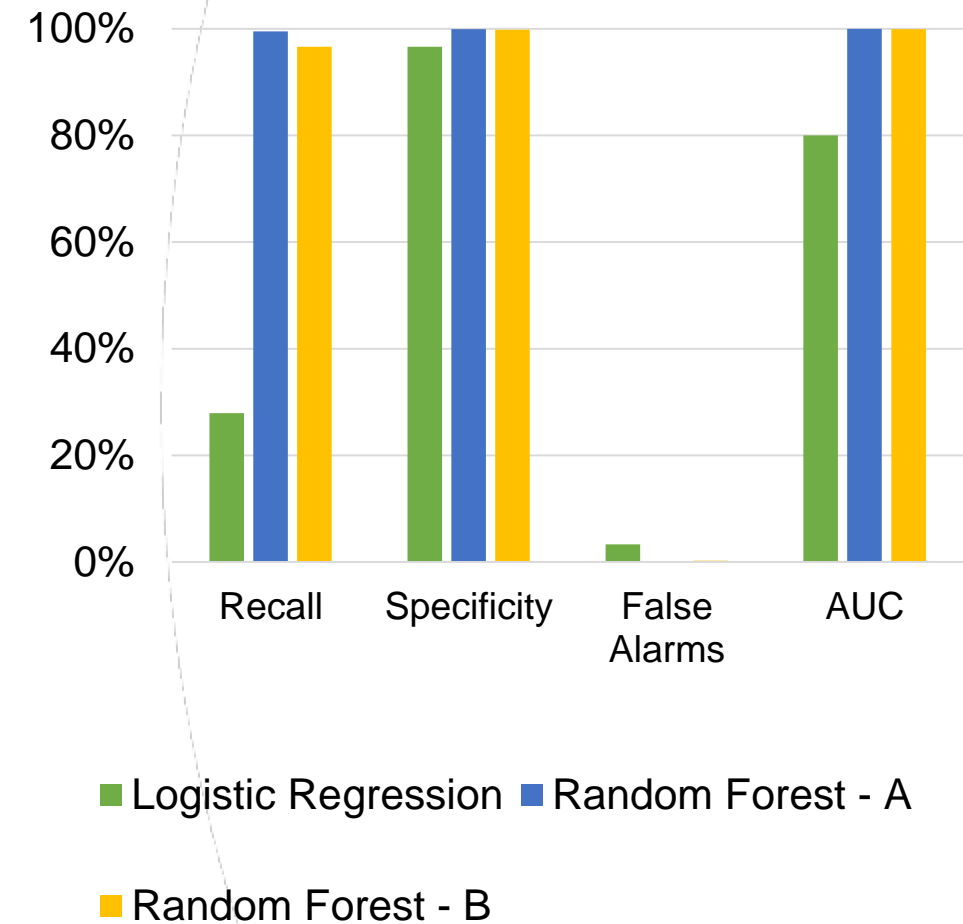




# Results - Classification

- 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**

Comparison of classifiers for event identification



# 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  Long. Acceleration	Distance driven	
During the event	Speed	Distance from median	TTC
Total	Speed  TTC	Distance from median	Distance driven



# 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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