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Exploring critical driving parameters affecting speeding using data from smartphones

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Objective

- Aim of this study is:
- To identify critical driving parameters affecting speeding using data obtained from smartphone sensors during naturalistic driving
- To determine the influence of road type (urban and rural) on the percentage of speeding as well as any underlying correlations with other factors such as driving duration

Outline

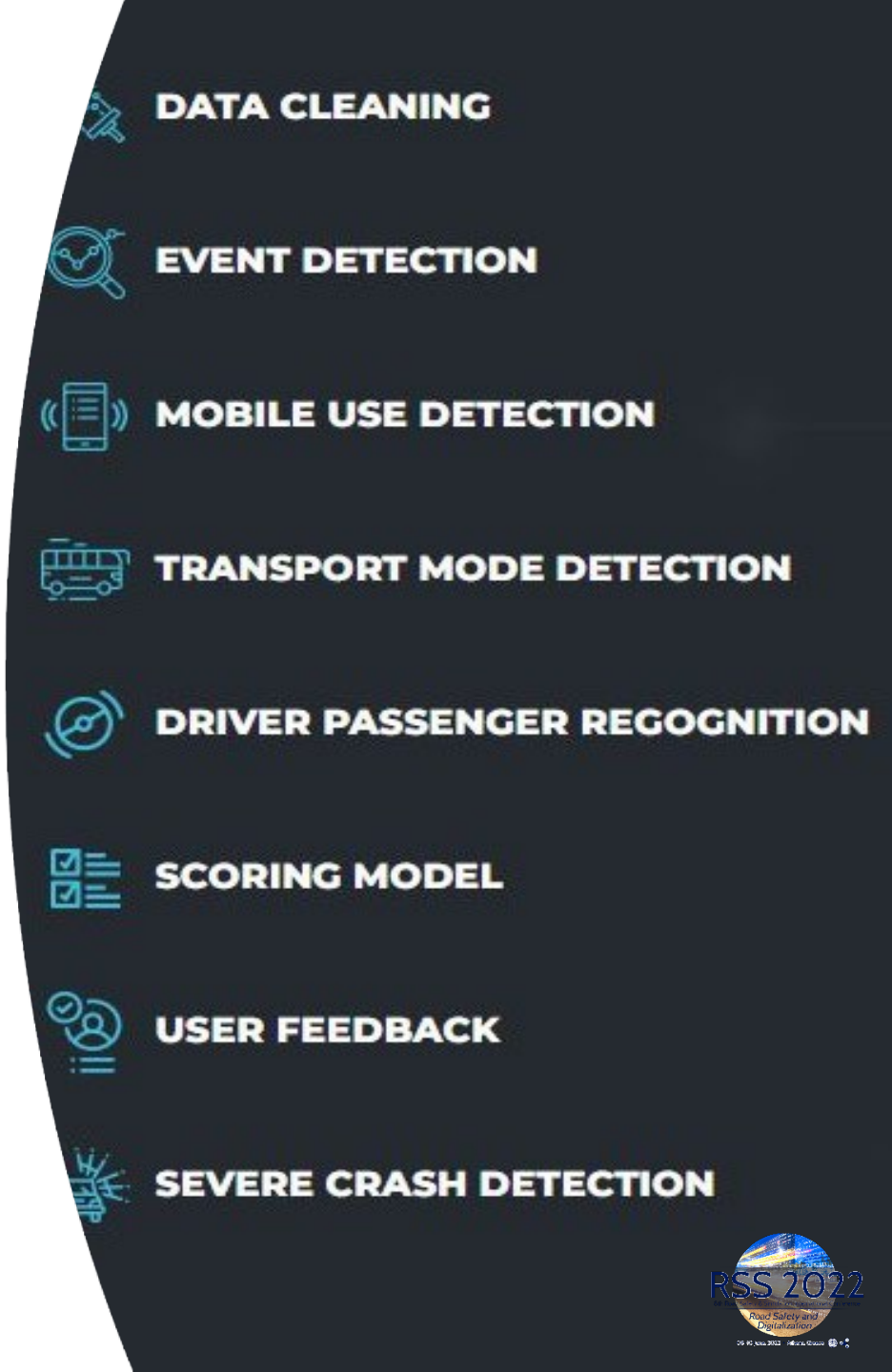
- Background
- Procedure of Data Collection
- Experimental Process
- Descriptive Statistics
- Methodology
- Results
- Conclusions
- Future Research

Background

- The frequency, the risk and the severity of road accidents are affected by the type of the road
- The possibility of a severely or fatal accident is more increased in long driving distance trips
- Young drivers have the tendency to provoke more accidents
- Male drivers exceed the speed limits and do speeding more often compared to female drivers
- Older male drivers present an aggressive behavior in comparison with younger ones

Procedure of Data Collection (1/2)

- An innovative data collection system using a smartphone application was exploited
- The recording starts automatically when smartphone sensors detect a driving condition
- The data are temporally stored and sent in the central database of the OSeven backend office via wi-fi or 3G / 4G
- Sophisticated and personalized interactive tools and Machine Learning techniques are implemented to detect the driving characteristics and conditions



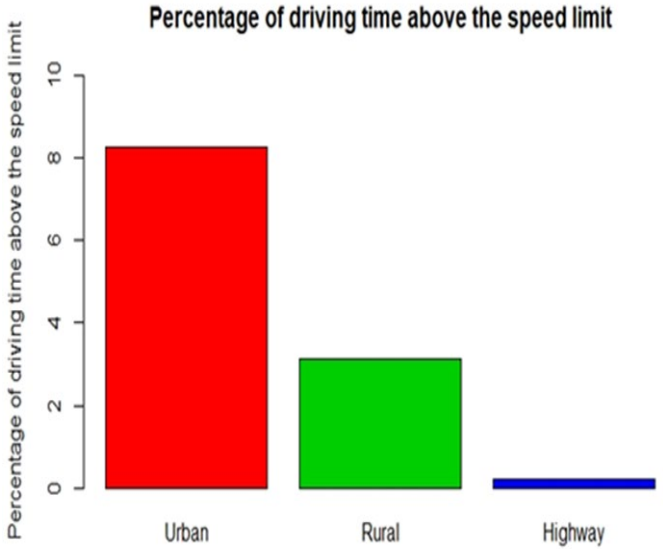
Procedure of Data Collection (2/2)

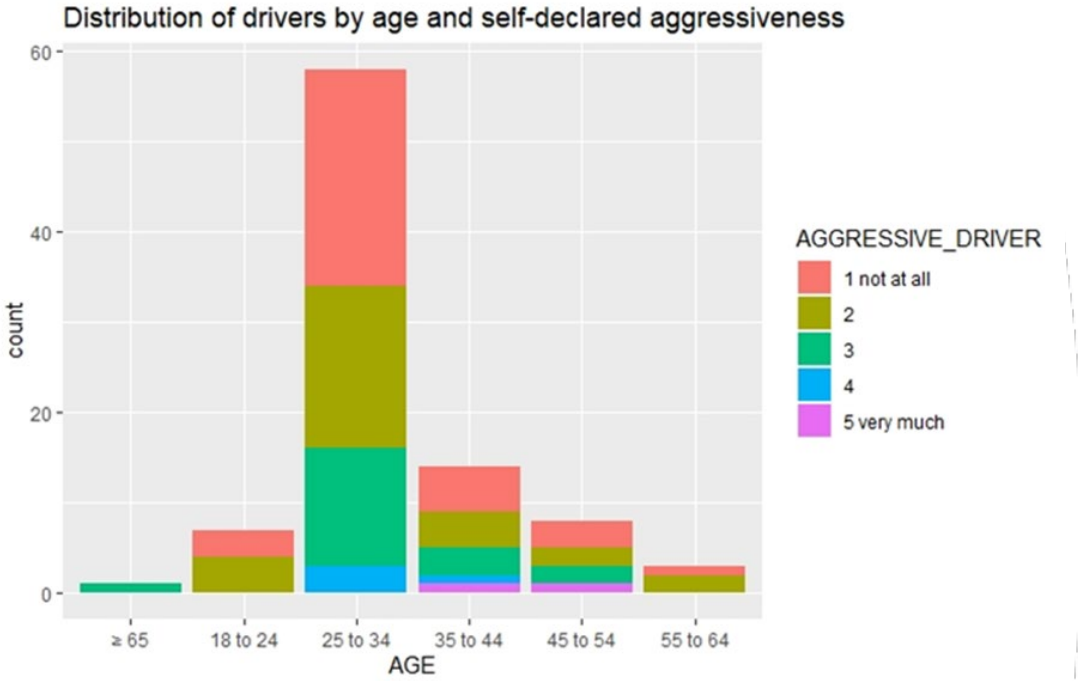
- This procedure results to the creation of risk exposure and driving behavior indicators
- With these tools:
  - the system can recognise for every route the driving conditions and sets average values for all driving characteristics
  - the drivers are informed, when they were speeding or how long they use their mobile phone
- The OSeven platform has very clear privacy policy statements uses technologies in compliance with (GDPR)

Experimental Process

- A naturalistic driving experiment
- Participants: 100 participants
- Duration: 6-months
- Two databases were constructed:
  1. A large database of 49,019 trips, which include all risk exposure and driving behavior indicators
  2. A detailed questionnaire design with 4 sections
     - 1st part: driving experiences
     - 2nd part: vehicle's characteristic
     - 3rd part: driving behavior
     - 4th part: demographic characteristics

Descriptive statistics





In urban environment the percentage of speeding time is the highest while on highways drivers exceed the speed limits the least, probably because the speed limits on highways are already high enough

Most of the drivers are between 25 and 34 years old. This outcome is no wonder because the younger people are more acquainted with numerous technology tools and applications in comparison with elder people

Methodology

- 3 GLM Poisson Models were developed to identify the critical driving parameters

The linear prediction is: $\log(\lambda_i) = \beta_o + \beta_n + x_n + \varepsilon$

Model 1	• model for speeding for all road types (overall model)
Model 2	• models for speeding for urban road
Model 3	• models for speeding for rural road

- Correlation coefficient of variables Correlation Pearson

Highly correlated variables were excluded from the models (cor>=0,6)

Correlation Pearson

	mbu	harsh_acc	acc_avg	distance_total	speed_avg	duration	duration_rural
mbu	1	0.301	0.152	0.256	0.214	0.142	0.12
harsh_acc	0.301	1	0.521	0.283	0.356	0.354	0.262
acc_avg	0.152	0.521	1	-0.284	-0.315	-0.142	-0.157
distance_total	0.256	0.283	-0.284	1	0.753	0.821	0.703
speed_avg	0.214	0.356	-0.315	0.753	1	0.495	0.528
duration	0.142	0.354	-0.142	0.821	0.495	1	0.784
duration_rural	0.12	0.262	-0.157	0.703	0.528	0.784	1

Results (1/2)

- GLM model for speeding for all road types (overall model)

Trip Characteristic	βi	s.e	p-value	Relative Risk Ratio
Intercept	3.694	0,656	<0.001	40.205
mbu	3.655	0,864	<0.001	38.668
harsh_acc	0.485	0,126	<0.001	1.624
acc_avg	-1.244	0,39	<0.001	0.288
self-declared speeding never	-1.648	0,461	<0.001	0.192
self-declared speeding often	-1.148	0,350	<0.001	0.317
self-declared speeding rarely	-1.386	0,338	<0.001	0.250
self-declared speeding smt	-1.073	0,331	0.002	0.342
AIC		406.96		
McFadden		0.209		

- GLM models for speeding for urban and rural roads separately

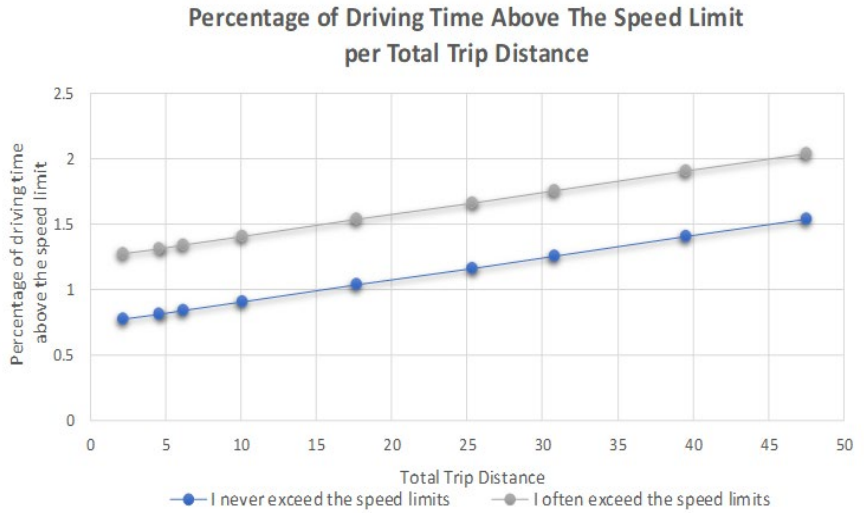
	Urban Model				Rural Model			
Trip Characteristic	βi	s.e.	p-value	Relative Risk Ratio	βi	s.e.	p-value	Relative Risk Ratio
Intercept	3.225	0.554	<0.001	25.154	2.031	0.634	0.002	7.622
distance	0.163	0.035	<0.001	1.177	-	-	-	-
duration	-	-	-	-	0.002	0.0004	<0.001	1.002
mbu	3.355	0.726	<0.001	28.646	5.842	1.236	<0.001	344.468
harsh_acc	-	-	-	-	1.485	0.402	<0.001	4.415
self-declared speeding never	-1.59	0.372	<0.001	0.204	-2.758	0.828	<0.001	0.063
self-declared speeding often	-	-	-	-	-1.569	0.458	<0.001	0.208
self-declared speeding rarely	-1.118	0.281	<0.001	0.327	-1.804	0.446	<0.001	0.165
self-declared speeding smt	-0.804	0.276	0.003	0.448	-1.949	0.441	<0.001	0.142
AIC		511.16				352.72		
McFadden		0.203				0.263		

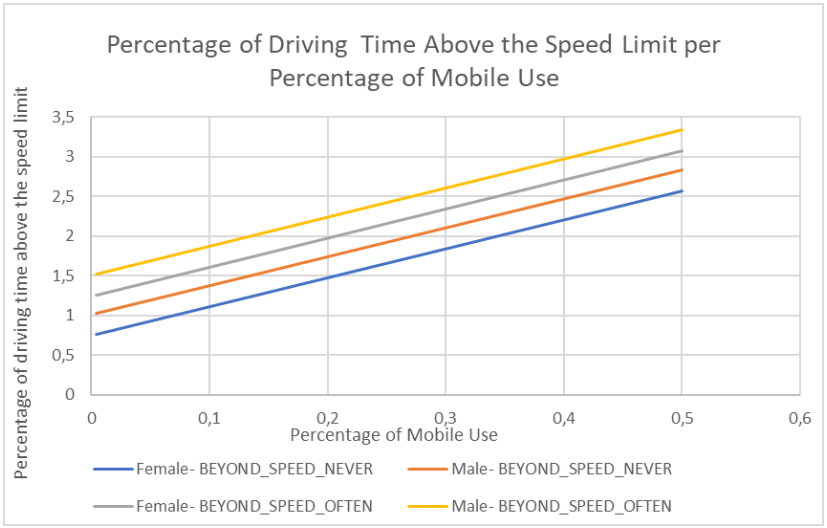
- Description of the selected variables

Variables	Explanation
mbu	percentage of mobile phone use while driving (%)
distance	trip distance (km)
harsh_acc	number of harsh accelerations per trip
acc	average acceleration per trip (m/s^2)
duration	trip duration (sec)
self-declared speeding	self-declaration of exceeding the speed limits (never=1, rarely=2, sometimes=3, often=4, always=5)
AIC	Akaike information criterion
McFadden	McFadden's pseudo R^2

Results (2/2)

- In longer distances drivers show an aggressive behavior by more often exceeding the speed limits
- Speeding is positively correlated with the distraction from mobile phone use. The high impact of mobile phone use on speeding is an impressive finding which reveals a quite dangerous driving behavior style
- The more the harsh accelerations per trip, the higher the probability of exceeding the speed limits
- The less often the drivers declare to exceed the speed limits, the lower the probability of speeding while driving
- The naturalistic driving parameters are more significant in comparison with driver characteristics from the questionnaire, pinpointing the superiority of naturalistic driving data over self-declared data





Conclusions (1/2)

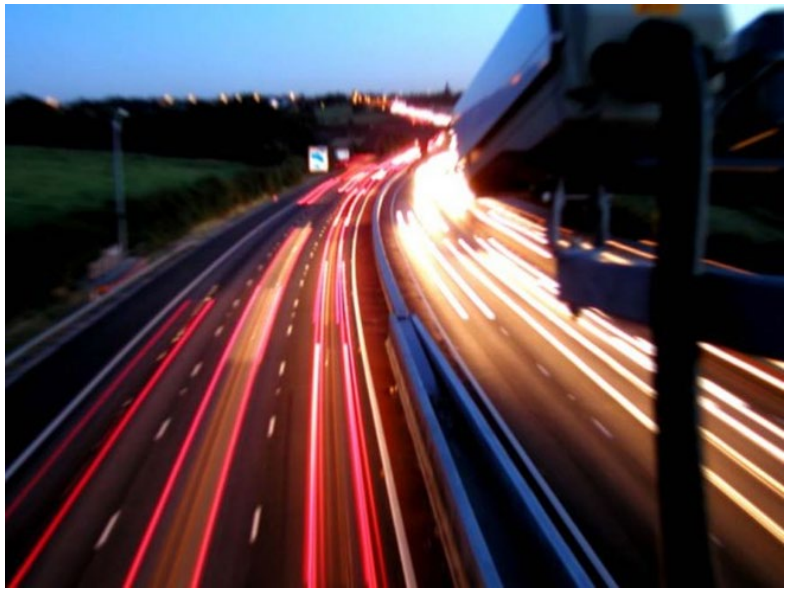
- Trip duration, trip distance, the number of harsh accelerations and mobile phone use while driving have all been determined as statistically significant and positively correlated with the percentage of speeding

- The average acceleration and the low frequency of speeding as declared by participants on the questionnaire, are statistically significant and negatively correlated with speeding percentage

- The results of the analysis show that driving characteristics appear to have a higher influence on speeding instances compared to self-reported questionnaire answers

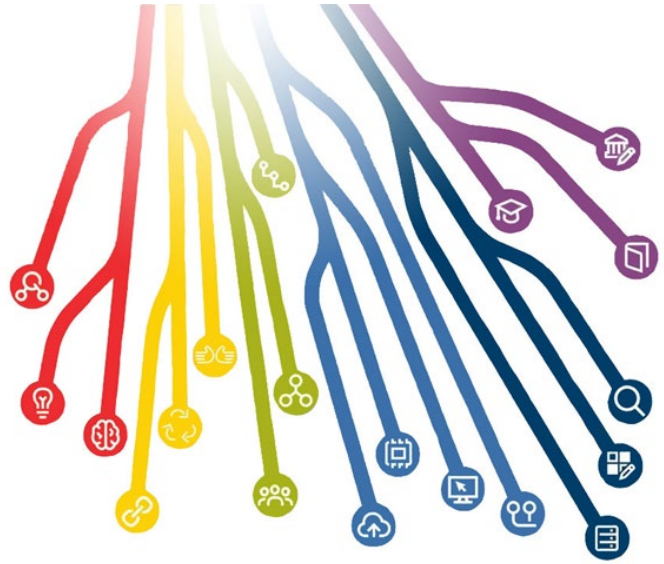
Conclusions (2/2)

- The percentage of mobile phone use in a trip is crucial for forecasting the percentage of speeding time during driving
- The longer the distance and the duration are, the higher the percentage of speeding
- Harsh accelerations seem to affect the percentage of speeding while driving in an aggressive way, as the higher the number of harsh accelerations, the higher the speeding percentage while driving



Future Research

- The influence of weather and traffic conditions while driving by using naturalistic driving data
- The presence of a passenger in terms of distraction
- Alcohol consumption and the use of seat belt
- The examination of additional methods of analysis:
  - factor analysis
  - logistic regression
  - econometric techniques such as time-series analysis



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