TRB 90th Annual Meeting: Session on Surrogate Measures of Road Safety for Modeling and Management

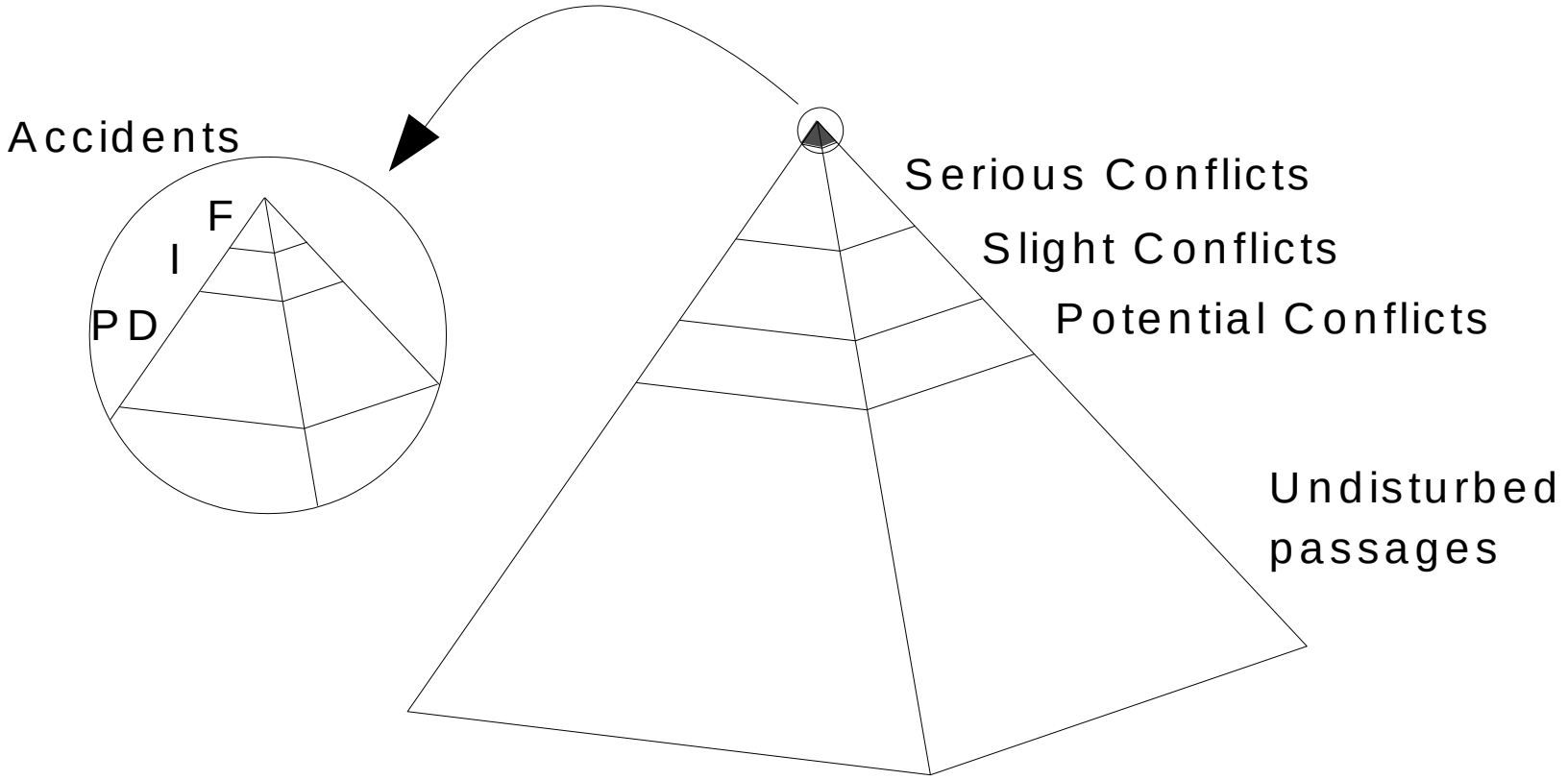
Investigating Collision Factors by Mining Microscopic Data of Vehicle Conflicts and Collisions

Nicolas Saunier, Nadia Mourji and Bruno Agard
École Polytechnique de Montréal

Motivation

- Need for surrogate measures of road safety
- Difficult validation of surrogate measures of safety, debates about conflicts, definitions…

Hypothesis: the Safety Hierarchy



Objective

- Understand collision processes to
  - design better counter-measures
  - develop better surrogate measures based on better-known relationships between interactions with and without a collision
- How?
  - continuous traffic data collection: record all traffic events, e.g. using video sensors
  - Knowledge Discovery and Data Mining (KDD) techniques

Trajectories Extraction from Video Data

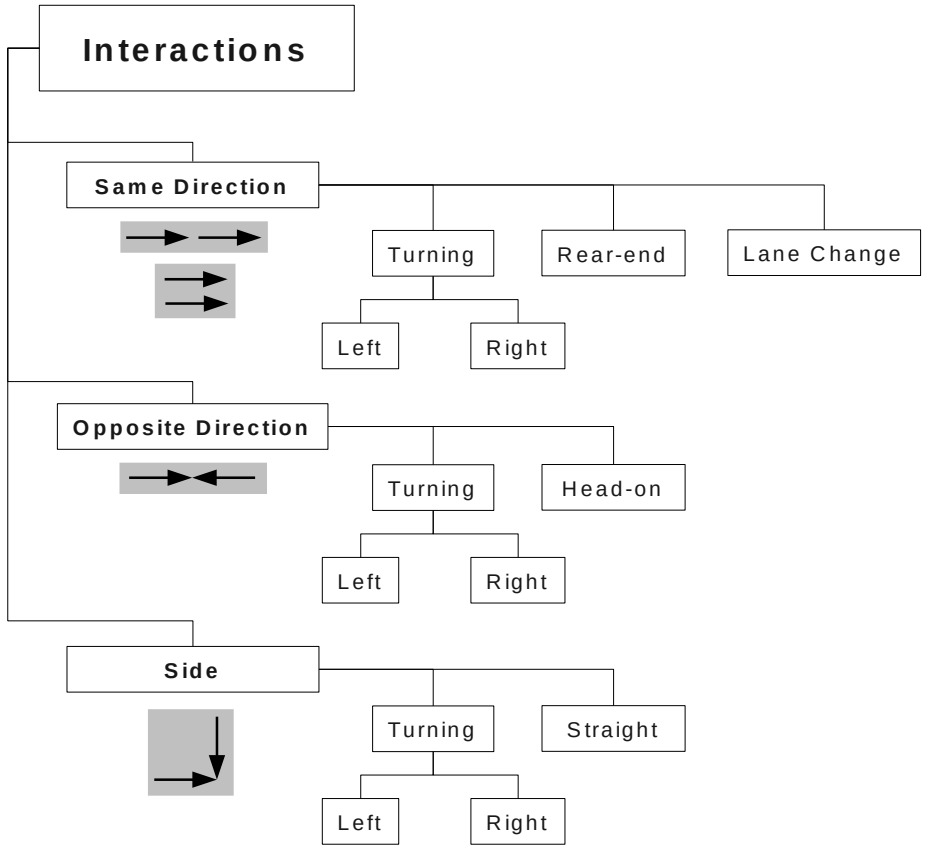
Conflicts

Collisions

(Saunier, Sayed and Ismail 2010)

Interaction Description: Categorical Attributes

Categorical Attributes	Values
Type of day	weekday, week end
Lighting condition	daytime, twilight, nighttime
Weather condition	normal, rain, snow
Interaction category	see figure
Interaction outcome	conflict, collision

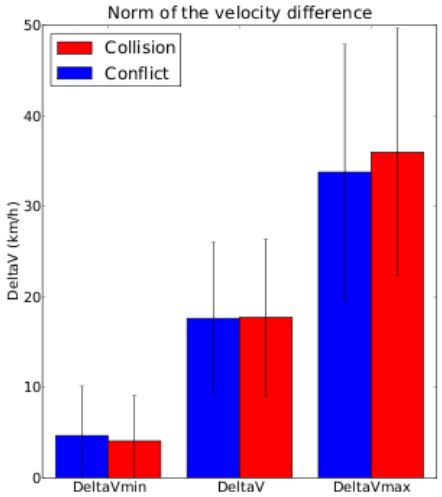


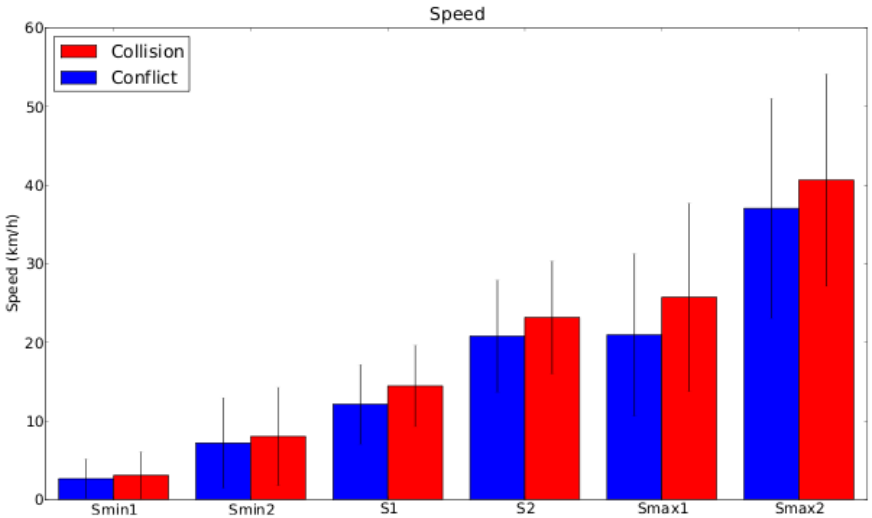
Interaction Description: Numerical Attributes

Numerical Attributes	Units
Road user type passenger car van, 4x4, SUV bus…	number of road users per type
Road user origin…	number of road users per origin
Type of evasive action No evasive action Braking Swerving Acceleration	number of evasive actions per evasive action
3 attributes from the speed differential Δv (min, max and mean)	km/h
6 values from the road users' speeds (min, max and mean for each)	km/h

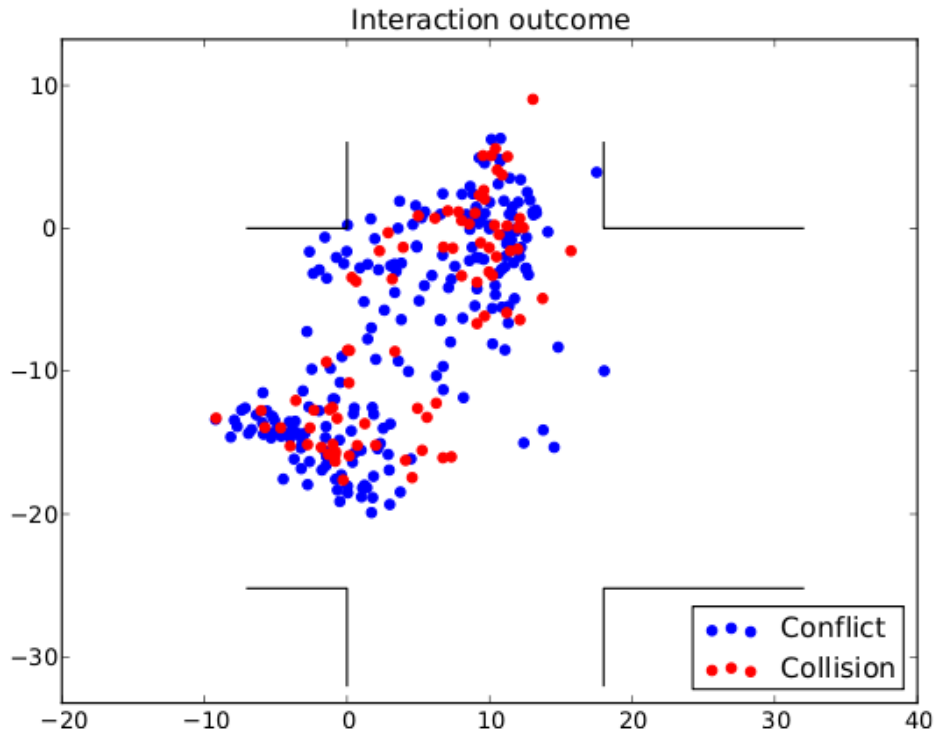
Coarse symmetric description of the relative road users' trajectories

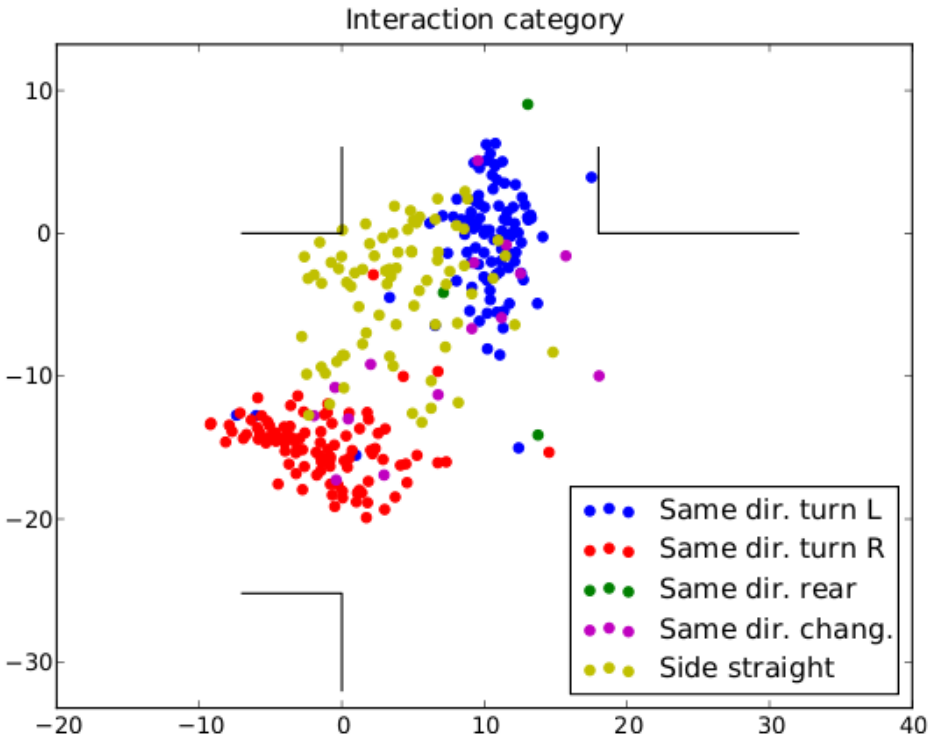
Descriptive Analysis





Descriptive Analysis



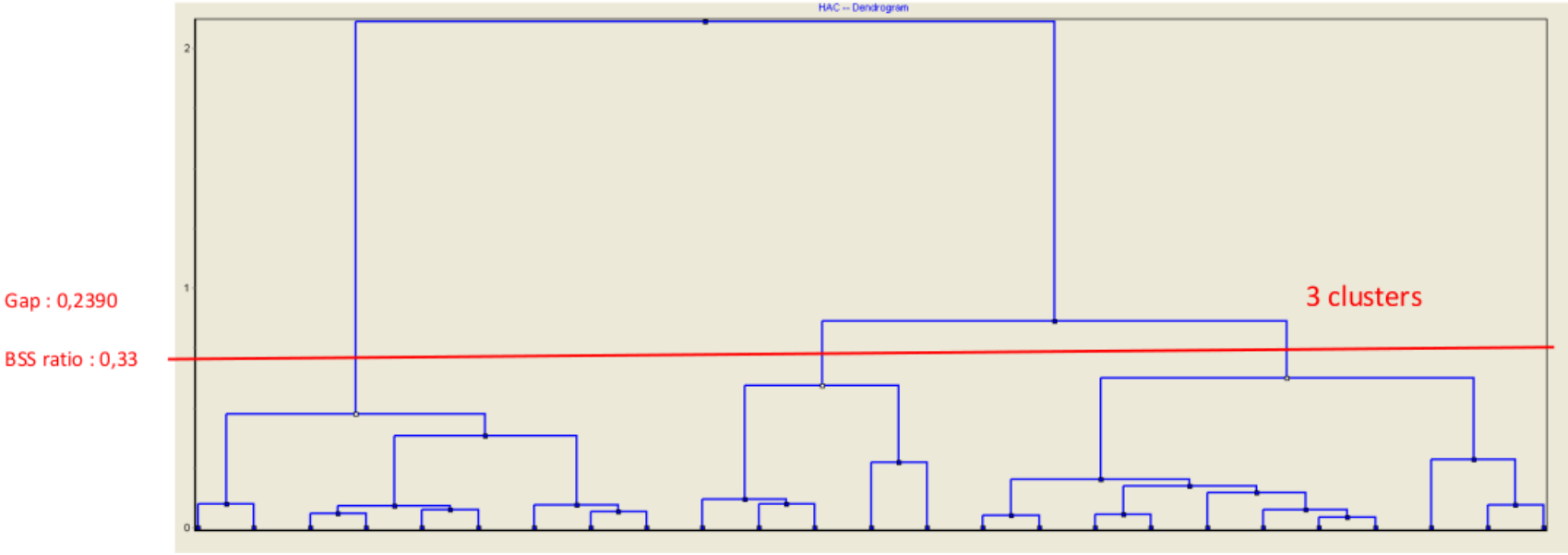


Decision Tree

- Evasive actions in [braking/no evasive action]
  - $\overline{\Delta v} < 12.6183$
    - $\overline{s1} < 13.4022$ then Interaction outcome = conflict (83.33 % of 12 examples)
    - $\overline{s1} \geq 13.4022$ then Interaction outcome = collision (83.33 % of 6 examples)
  - $\overline{\Delta v} \geq 12.6183$ then Interaction outcome = conflict (95.31 % of 64 examples)
- Evasive actions in [no evasive action/no evasive action] then Interaction outcome = collision (91.18 % of 68 examples)

Cluster Analysis using Speed Attributes

- The k-means and hierarchical agglomerative clustering algorithms yield 3 clusters



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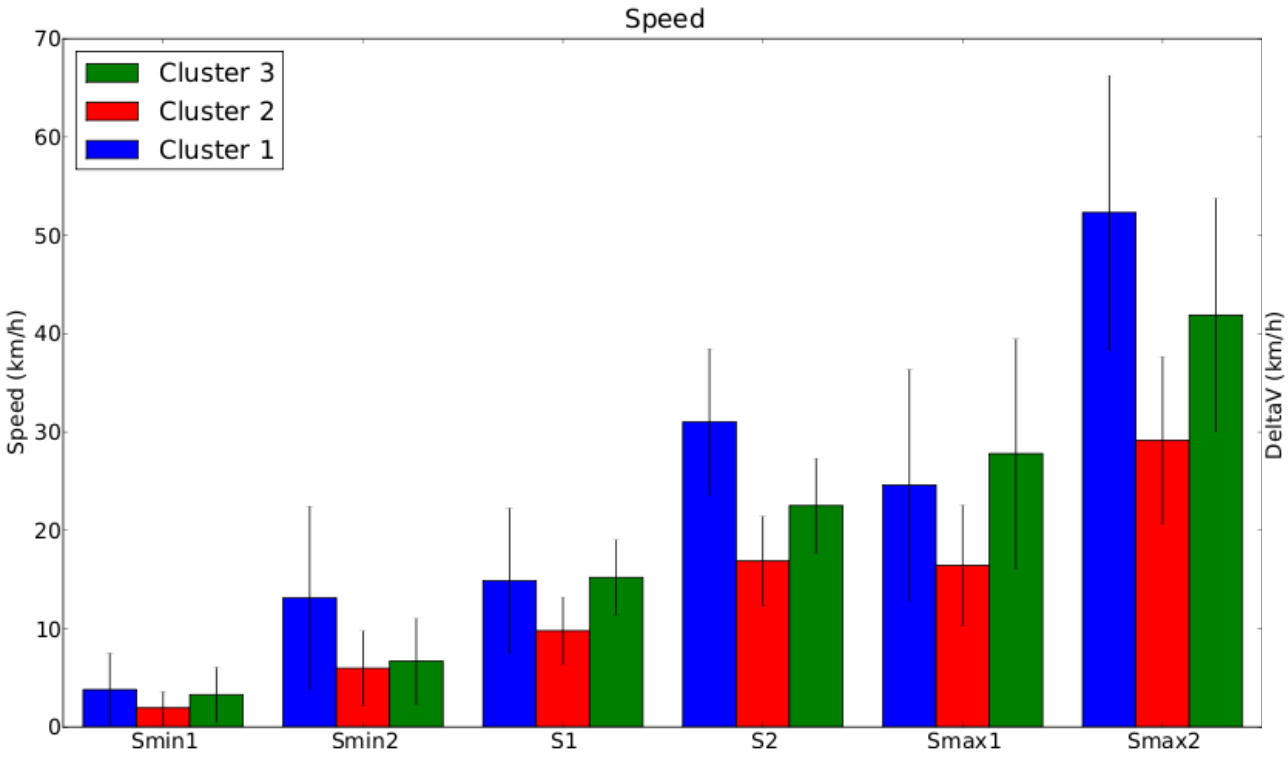
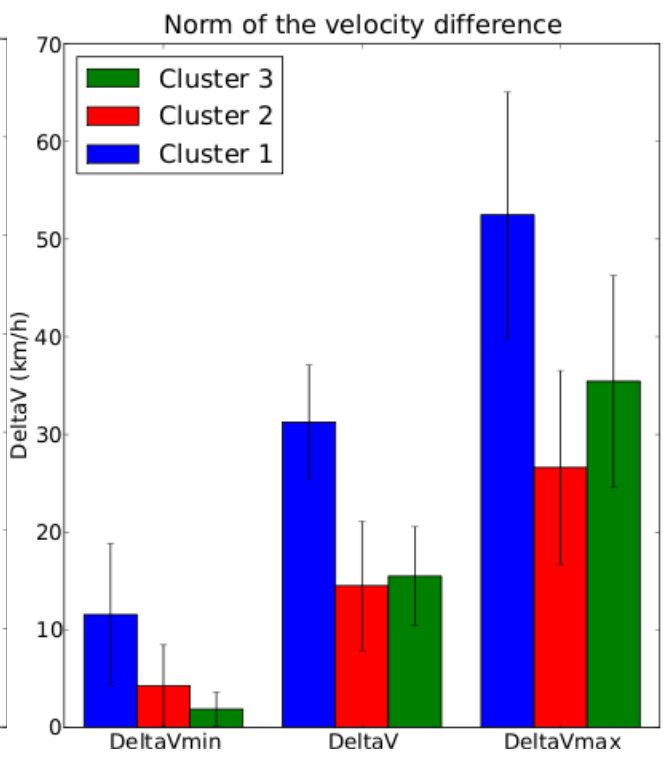
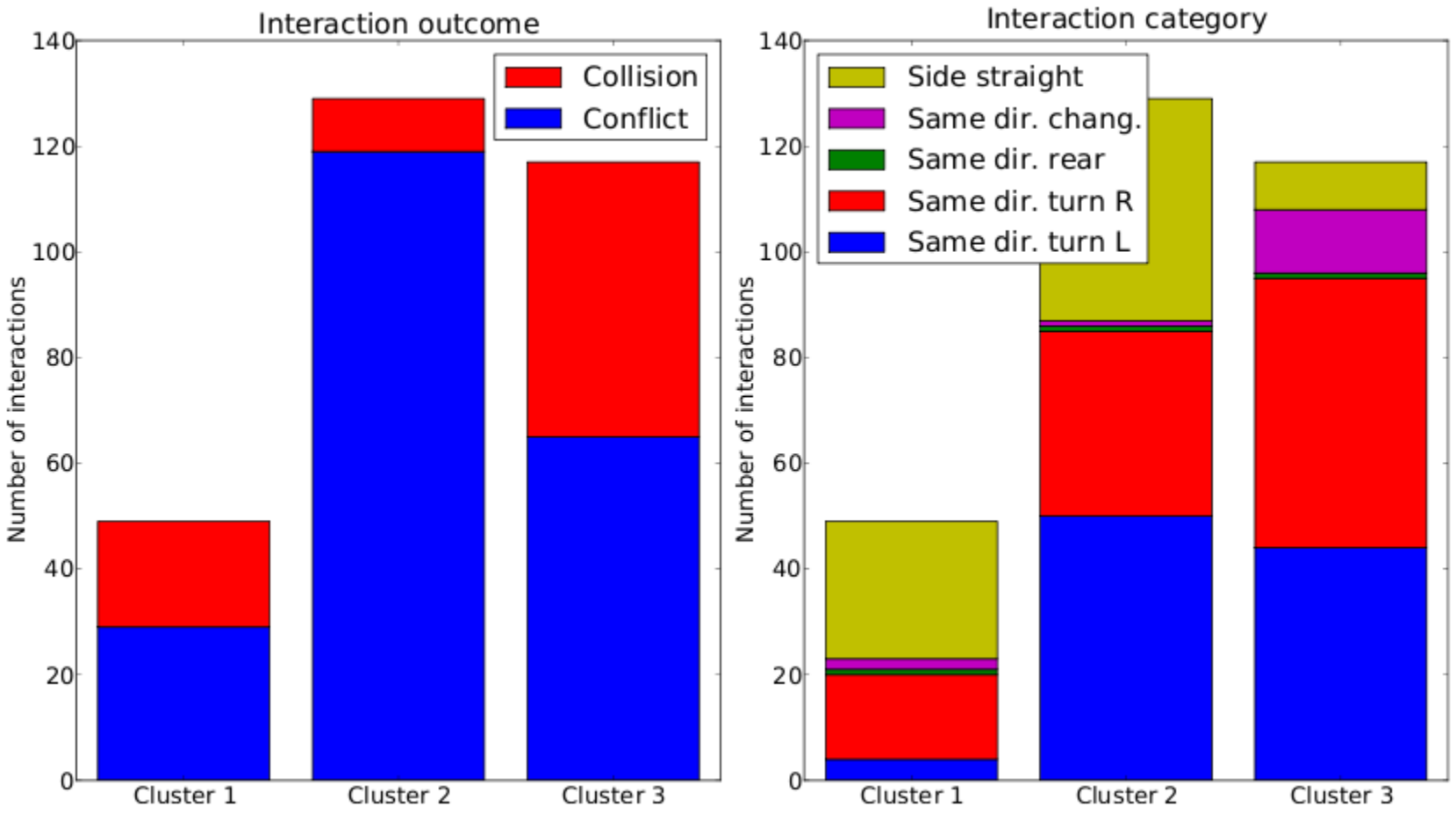


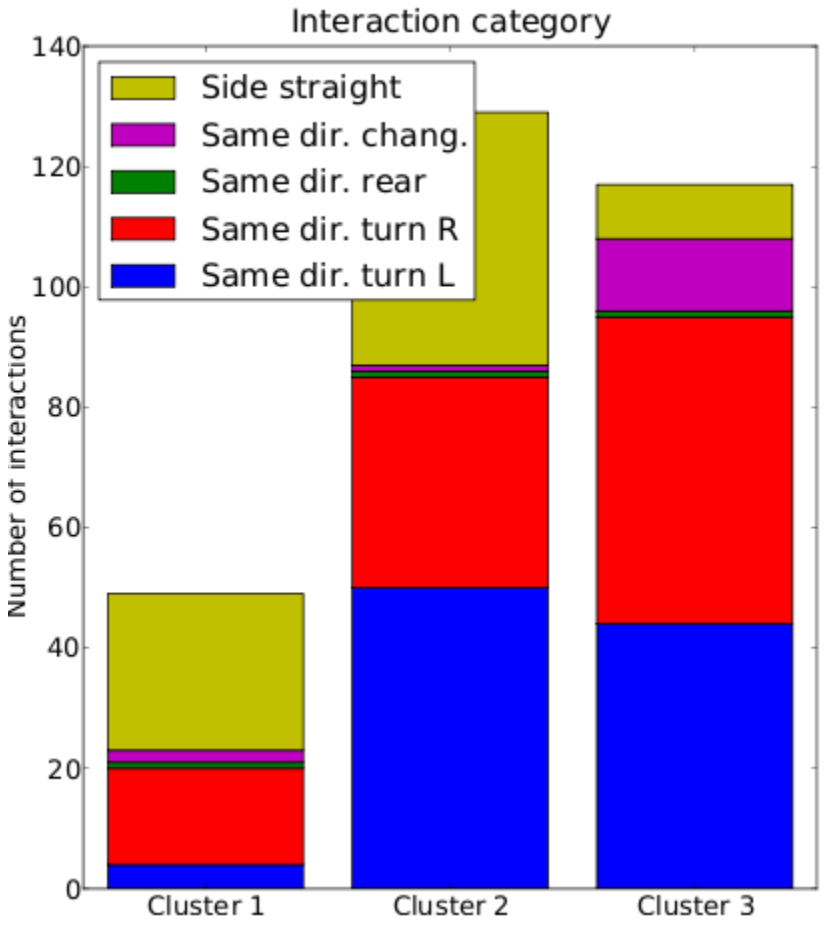


Cluster Analysis using Speed Attributes



Cluster Analysis using Speed Attributes

- **Cluster 1**: collisions, highest speeds, categories side straight and same direction turning right
- **Cluster 2**: almost pure conflicts, lowest speeds
- **Cluster 3**: collisions, medium speeds, categories same direction turning left and right and same direction changing lanes



Conclusion

- Method to understand collision processes
  - find groups of similar conflicts and collisions
  - supplementary evidence that not all conflicts should be used as surrogates for all collisions
- Work in progress:
  - compare the whole time series of interaction description variables
  - collect large datasets of trajectories
- Open science: share data and code (as open source)

Questions?

Contact

nicolas.saunier@polymtl.ca

More on

http://nicolas.saunier.confins.net

Background

- There is some evidence that evasive actions undertaken by road users involved in conflicts may be of a different nature than the ones attempted in collisions (Davis et al., 2008)
  - Importance for surrogate safety measures: what interactions without a collision may be used as surrogates for collisions?

Kentucky Dataset

- Video recordings kept for a few seconds before and after the sound-based automatic detection of an interaction of interest
  - 213 traffic conflicts (229)
  - 101 collisions (82)
- The existence of an interaction or its severity is not always obvious
- The interactions recorded in this dataset involve only motorized vehicles
- Limited quality of the video data: resolution, compression, weather and lighting conditions
- Calibration done using the tool developed by Karim Ismail (Ismail, Sayed and Saunier, 2010)

Descriptive Analysis