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Surrogate Safety and Behavioural Analysis of Roundabout Merging Zones Using Computer Vision

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POLYTECHNIQUE MONTRÉAL
WORLD-CLASS ENGINEERING

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Empirical data collection in the field – from hard core traffic conflicts to qualitative data collection

Paul St-Aubin[1], Nicolas Saunier[1*], Luis F. Miranda-Moreno[2]
[1]Department of civil, geological and mining engineering, École Polytechnique de Montréal
[2]Department of Civil Engineering and Applied Mechanics, McGill University
paul.st-aubin@mail.mcgill.ca, *nicolas.saunier@polymtl.ca

Affiliates: McGill, Concordia University, Carleton University
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DATA SAMPLE

- 20 different roundabouts across the province of Quebec
  - From these, **40 roundabout merging zones** are studied
- **600 hours** of video data collected
  - Video data is processed using computer vision, **Traffic-Intelligence** project https://bitbucket.org/Nicolas/trafficintelligence
  - X,Y coordinates of all moving vehicles and pedestrians tracked in scene up to 30 times per second
  - **Over 120 000 vehicles tracked**, driving a total distance of over 9 500 km
- Sites are clustered via k-means into **6 clusters** according to:
  - **Geometry**: Number of lanes (internal, approach, exit), radius, lane widths, approach and exit distances to nearest intersection
  - **Built environment**: Land use, urban density, network class
  - **Traffic characteristics**: Primarily flow rate and approach speed.

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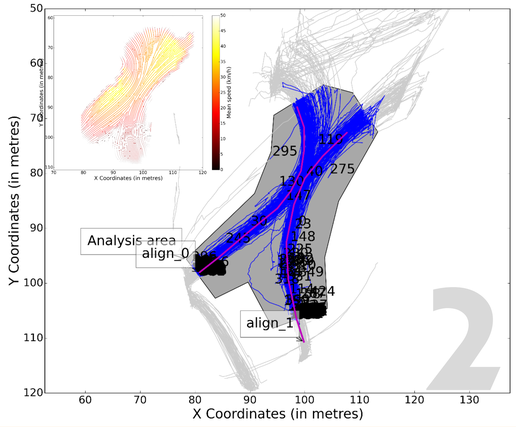
TRAJECTORY DATA PROCESSING AND VISUALISATION



2

CONFLICT DETECTION

One of the more egregious examples of a traffic conflict with a) a series of collision courses, b) corresponding time-to-collision (TTC) measures, and c) evasive action (when the collision course is altered before TTC = 0).
Many interactions present these elements, but most are not as serious.

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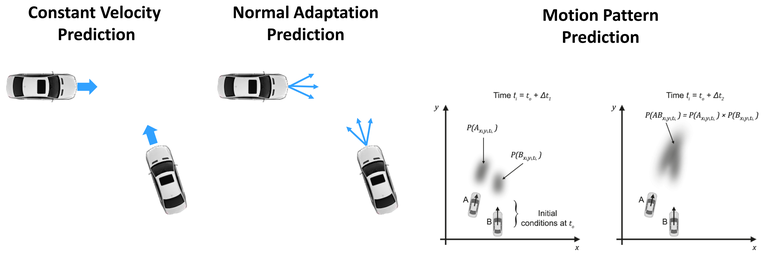
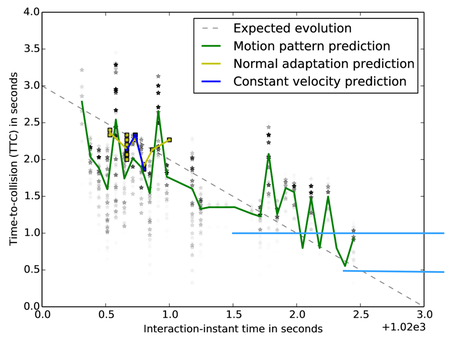
THREE DIFFERENT TTC PREDICTION METHODS



TTC TIMESERIES AGGREGATION



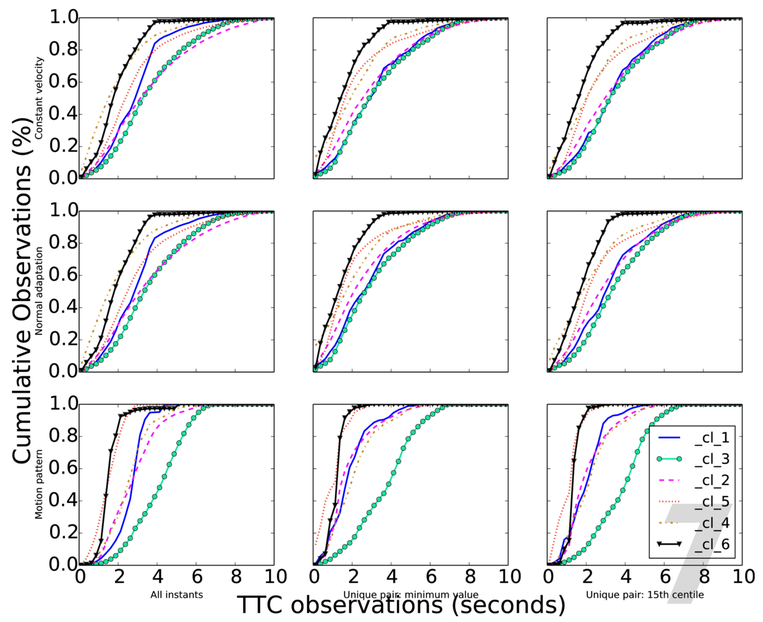
All values (disaggregated)

Unique 15th value

Unique minimum value

4

CUMULATIVE TTC DISTRIBUTIONS BY SITE CLUSTER



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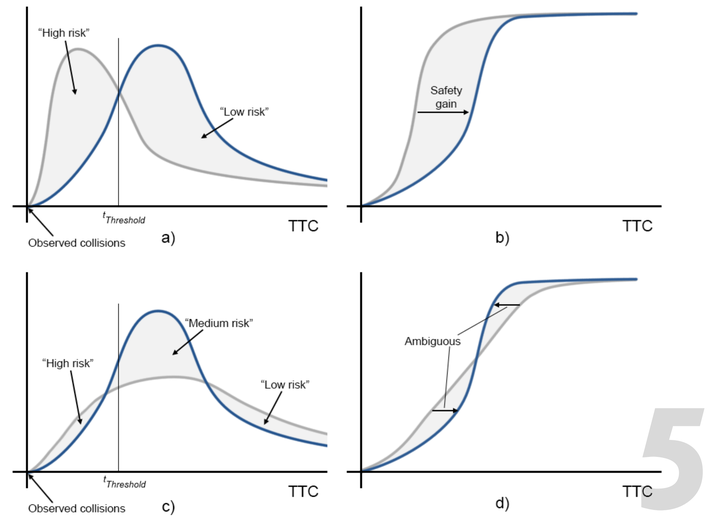
TTC FREQUENCY INTERPRETATION



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CLUSTER DETAILS

Cluster	Description	Group size	Unique 15th Observations
cl_1	Arterial with wide lanes, far distance to upstream intersections, and very low flow ratios, mixed land-usage	6	5,232
cl_2	Regional, single lane highways in industrial complex with mixed flow ratios	6	13,267
cl_3	A mix of highway ramps and arterials with extremely polarized flow ratios	13	17,130
cl_4	Residential collectors with reasonably well mixed flow ratios and short upstream distance to nearest intersection	6	325
cl_5	Traffic circle converted to roundabout (2 lanes, extremely large diameters, tangential approach angle)	4	10,295
cl_6	2 lane arterials near commercial or institutional land use and very high flow ratios.	6	14,840

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CONCLUSION

- Motion patterns are intrinsically superior as motion prediction models as they make vastly fewer assumptions and are better adapted to natural behaviour.
  - Collision probability is an intrinsic property of motion patterns.
  - Motion patterns are computationally expensive and are limited to predicting movement only inside of camera space.
- Minimum value TTCs are impractical as they over-sample noisy data and outliers.

Future work:
- TTC validation
- Development of more robust traffic exposure framework

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