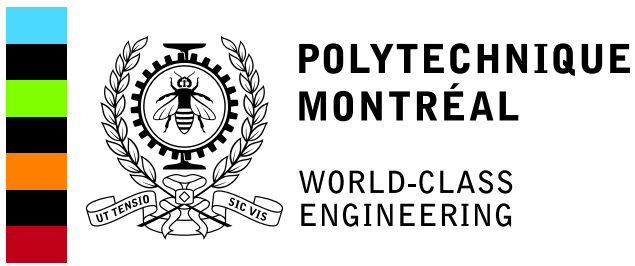
Automated Road Safety Analysis

Lund Universitet, Trafik och Väg

Nicolas Saunier
nicolas.saunier@polymtl.ca



February 23rd 2015

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4. 2009-: Professor in Polytechnique Montréal

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Surrogate Measures of Safety

- Looking for measures of safety that do not require to wait for accidents to happen
- Hypothesis [Svensson and Hydén, 2006]: in the safety hierarchy, all events have a relationship to accidents (safety) that may be of different nature
- Automation using video sensors and computer vision
  - cheap hardware, open source software

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- Automated video analysis
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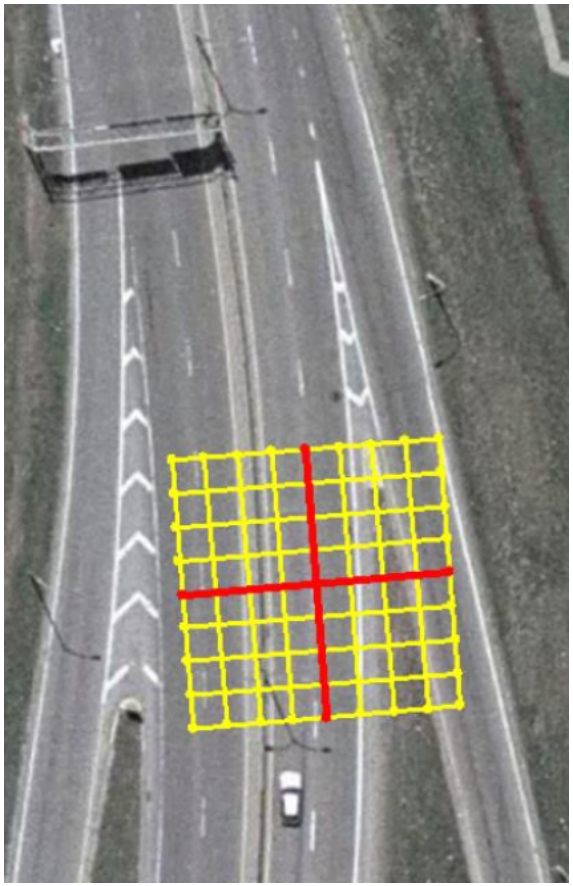
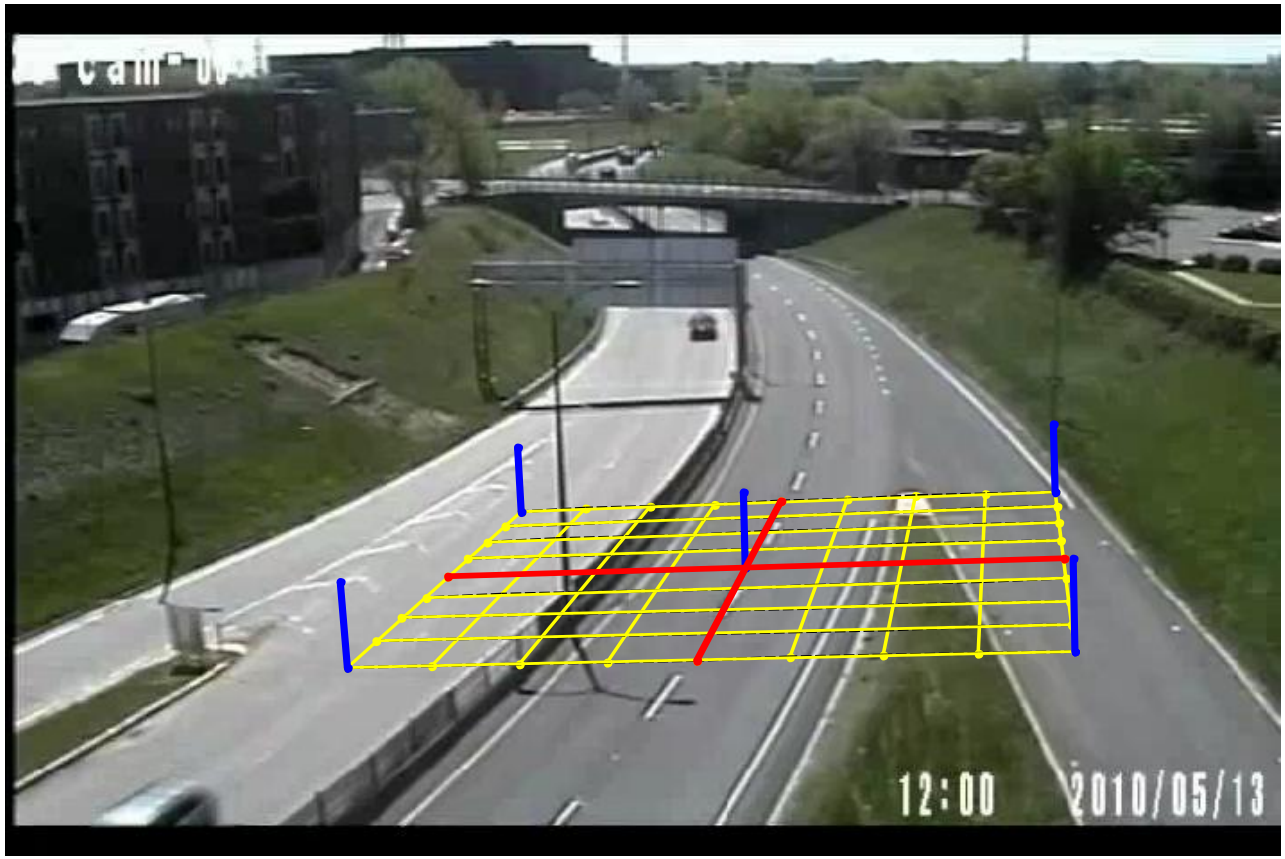
  - for all types of road users and road environments
  - generalize the concept of collision course: importance of motion prediction methods
  - improve existing indicator(s) before inventing new ones
- Better understand collision processes and the similarities between interactions with and without a collision for safety estimation

Step 1: Video Data Collection

Step 2: Data Preparation

In particular, camera calibration: homography and distortion (if any)





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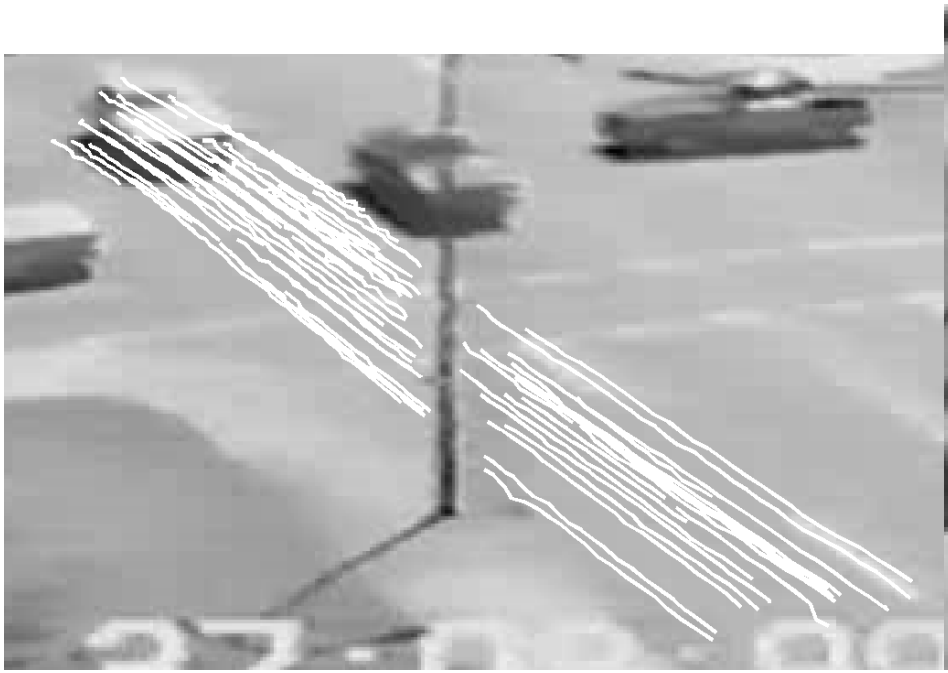
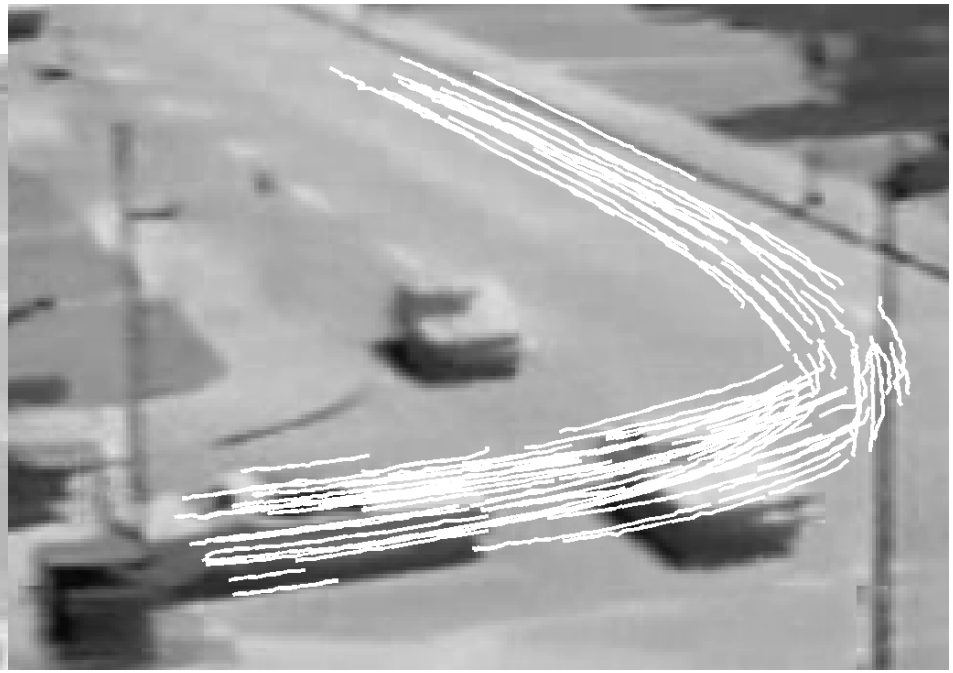
Step 3: Moving Road User Detection, Tracking and Classification





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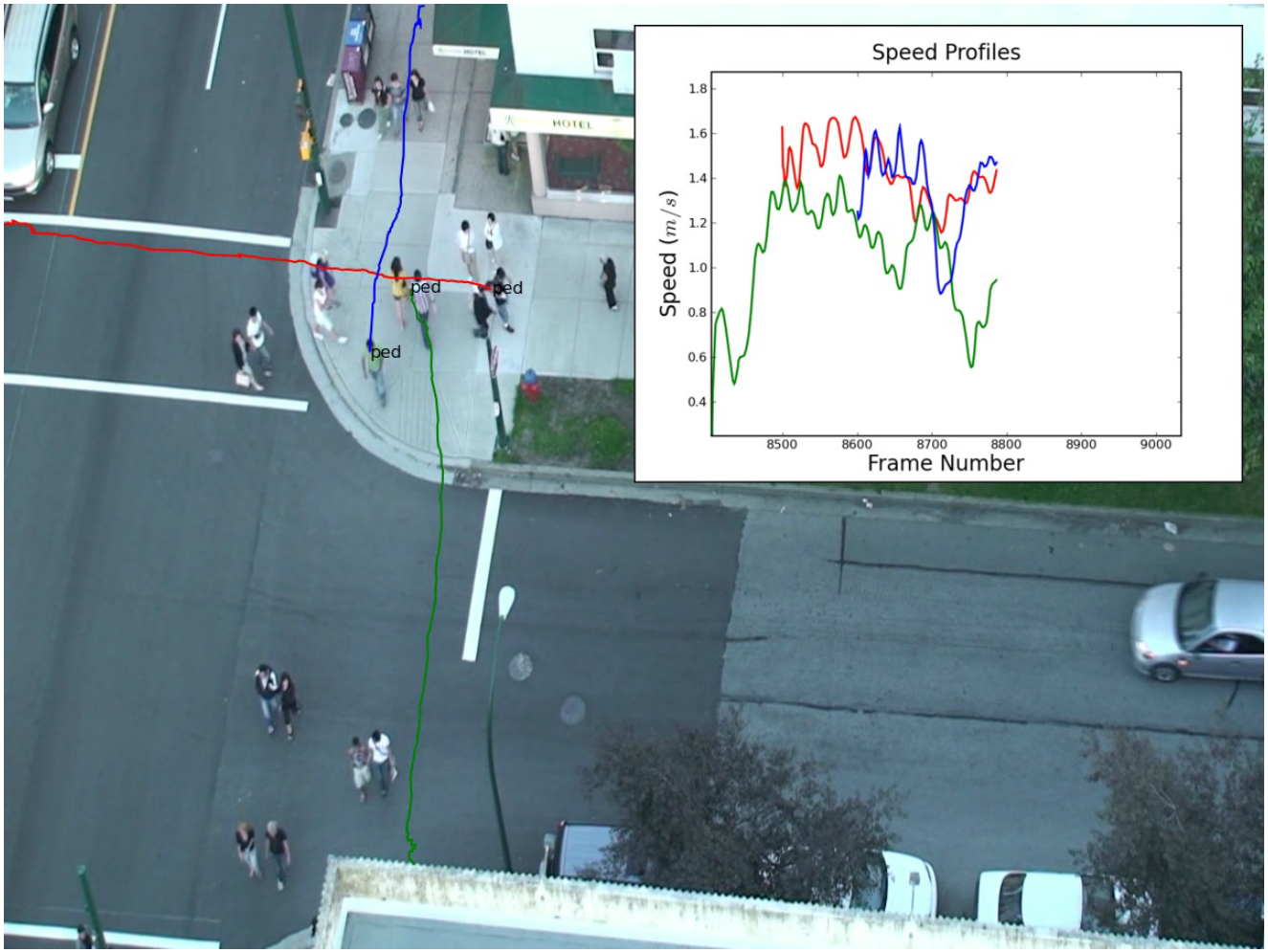

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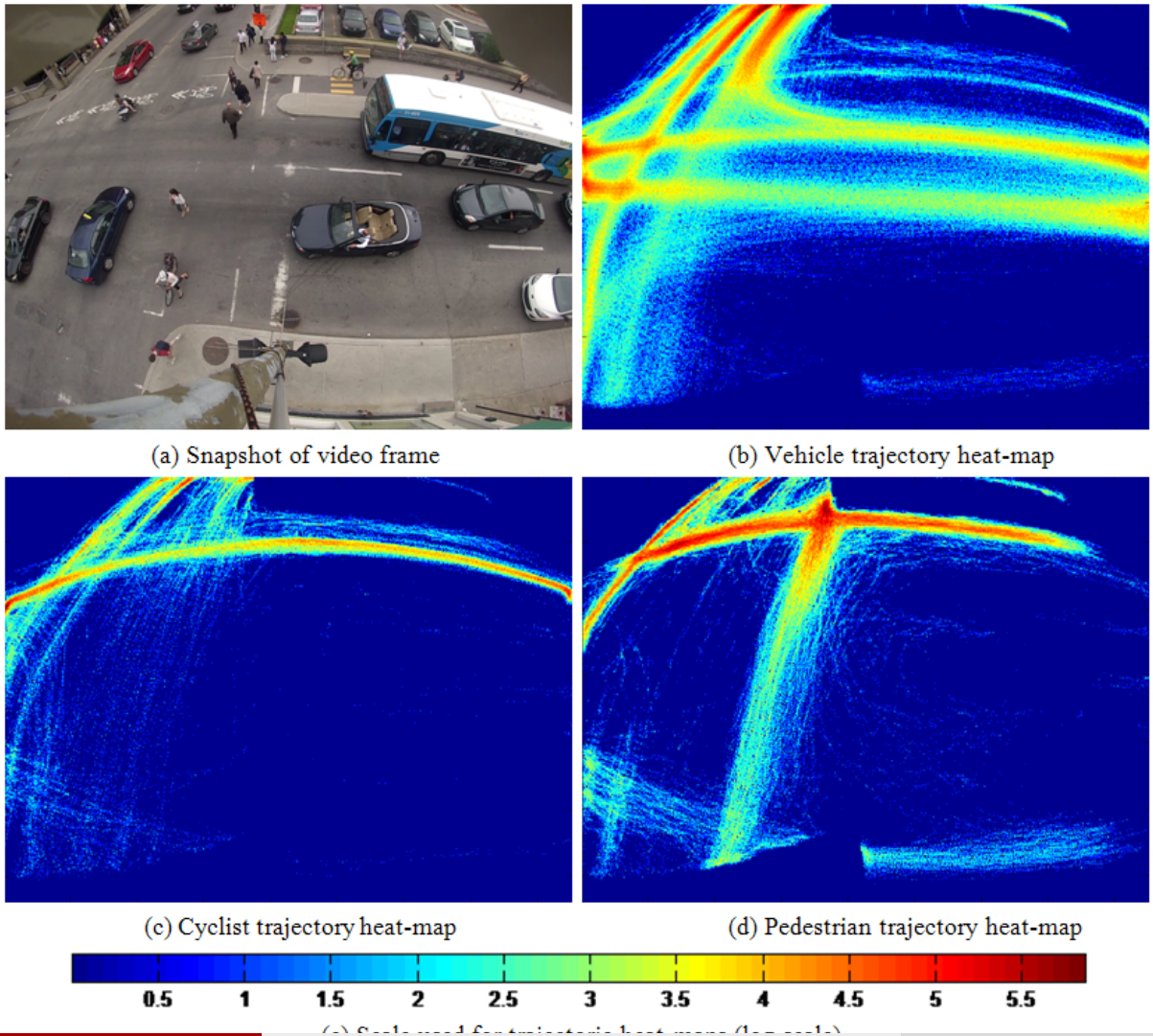


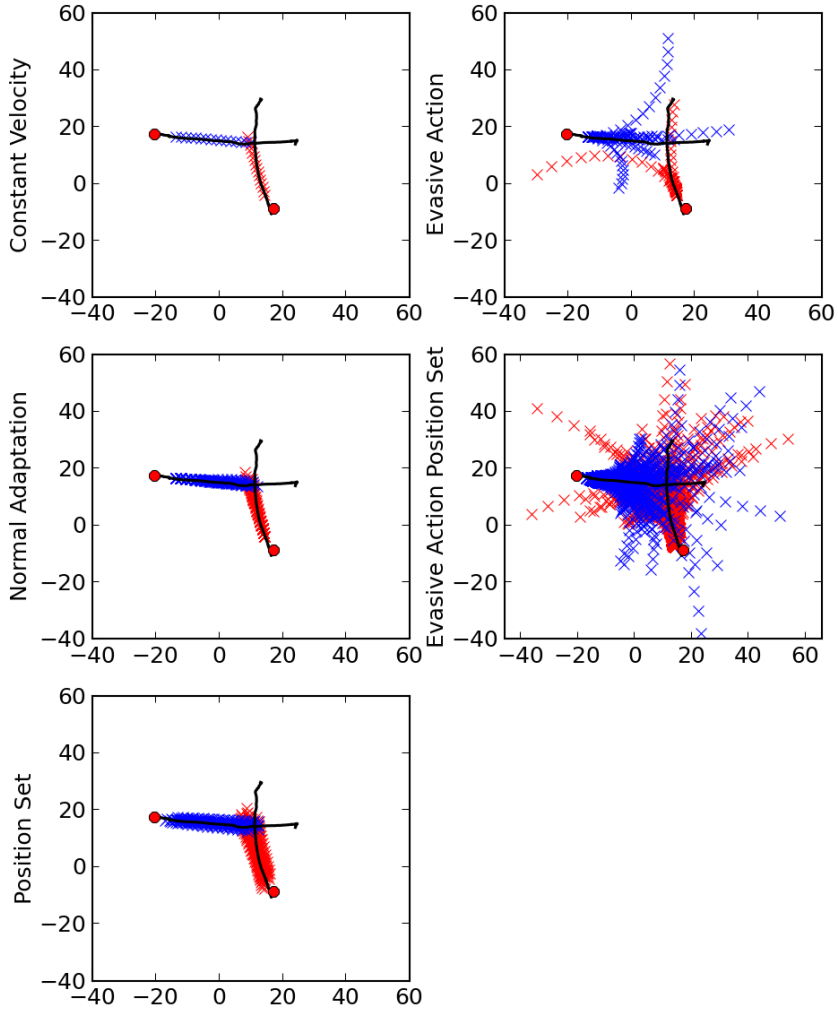
(a) Snapshot of video frame

(b) Vehicle trajectory heat-map

(c) Cyclist trajectory heat-map

(d) Pedestrian trajectory heat-map

Step 4: Motion Prediction



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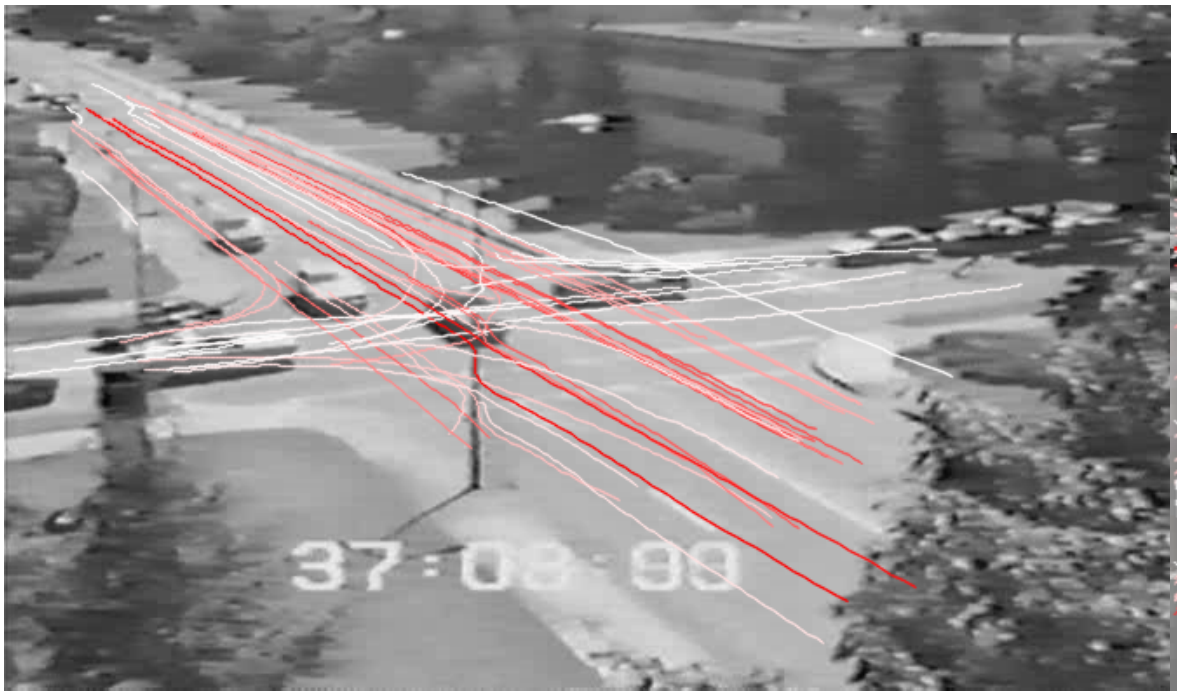

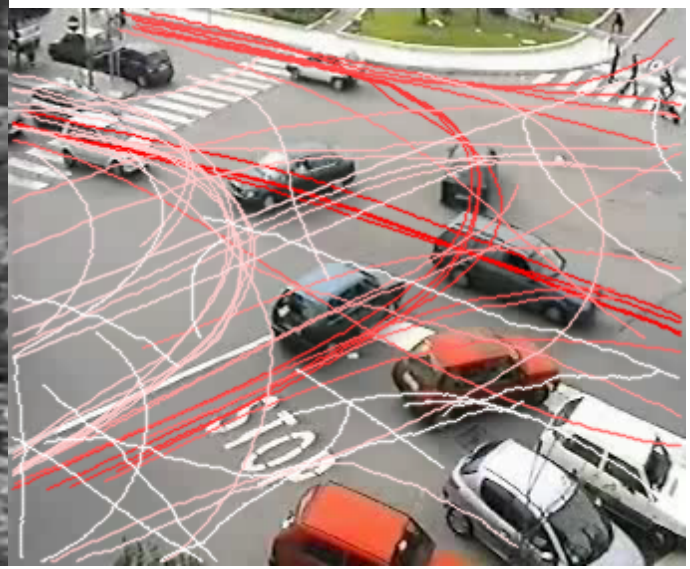

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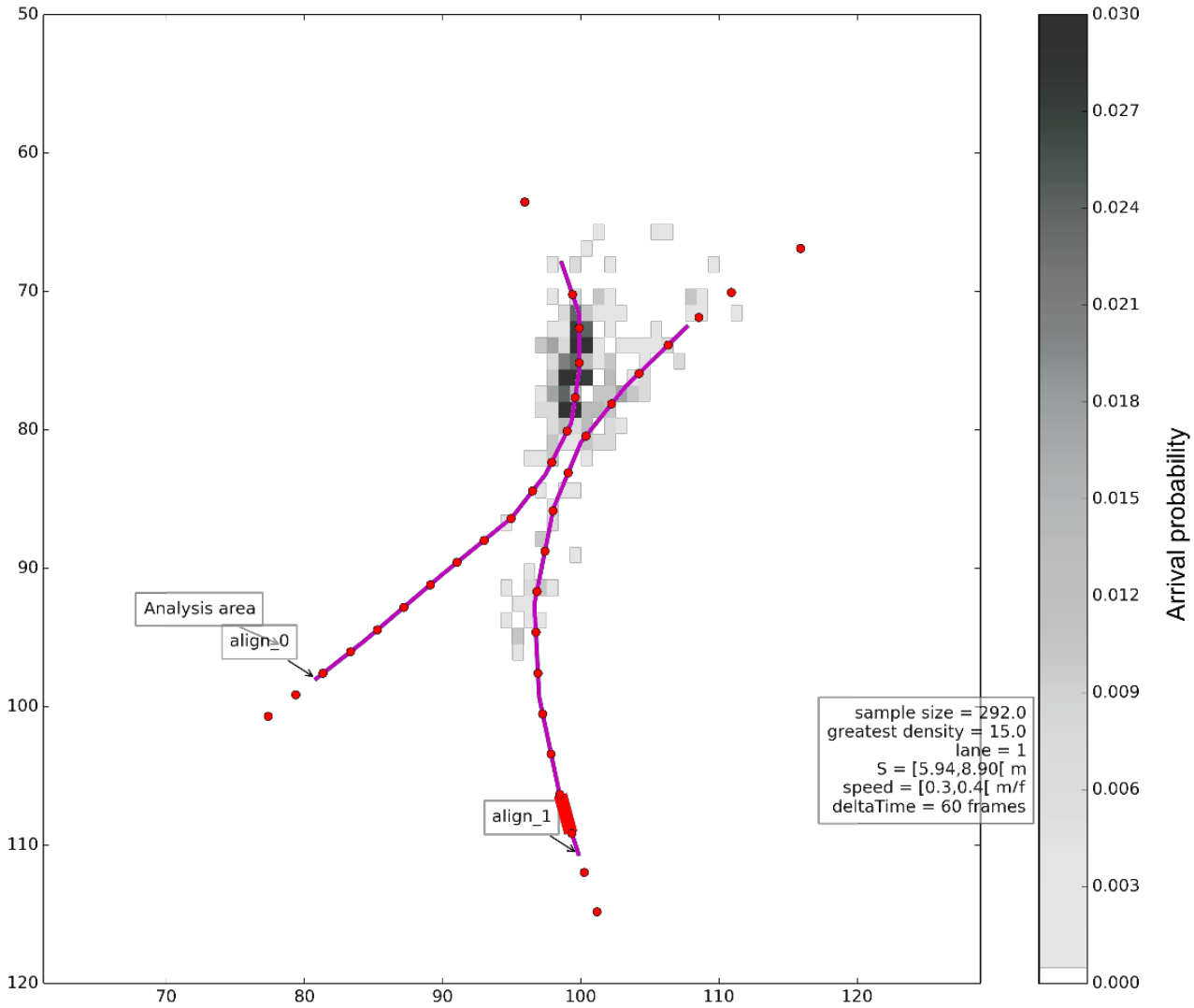
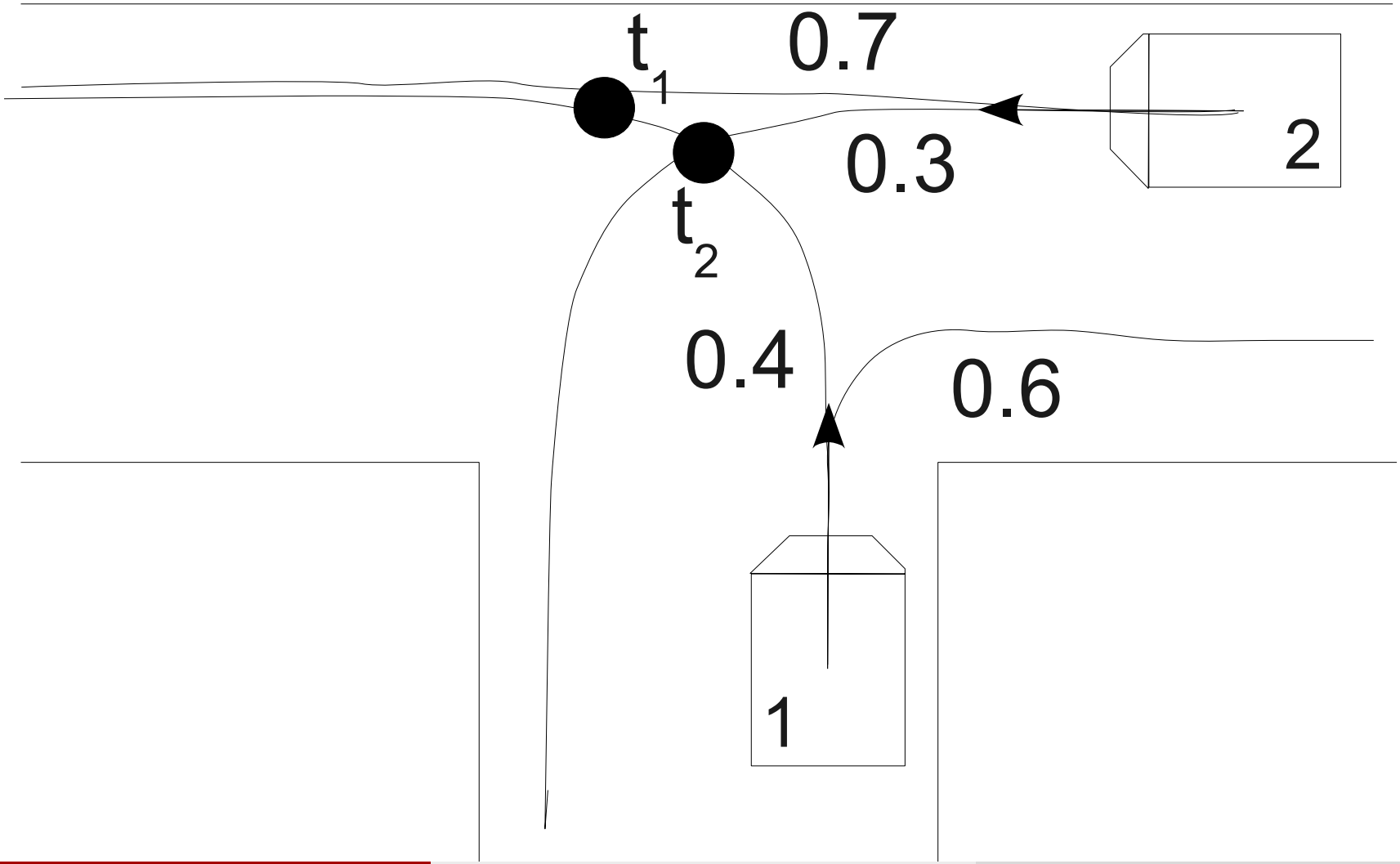


Step 5: Safety Indicators



Step 5: Safety Indicators

Using of a finite set of predicted trajectories, enumerate the collision points CP_n and the crossing zones CZ_m. Safety indicators can then be computed:

$$P(Collision(U_i, U_j)) = \sum_n P(Collision(CP_n))$$

$$TTC(U_i, U_j, t_0) = \frac{\sum_n P(Collision(CP_n))\ t_n}{P(Collision(U_i, U_j))}$$

$$pPET(U_i, U_j, t_0) = \frac{\sum_m P(Reaching(CZ_m))\ |t_{i,m} - t_{j,m}|}{\sum_m P(Reaching(CZ_m))}$$

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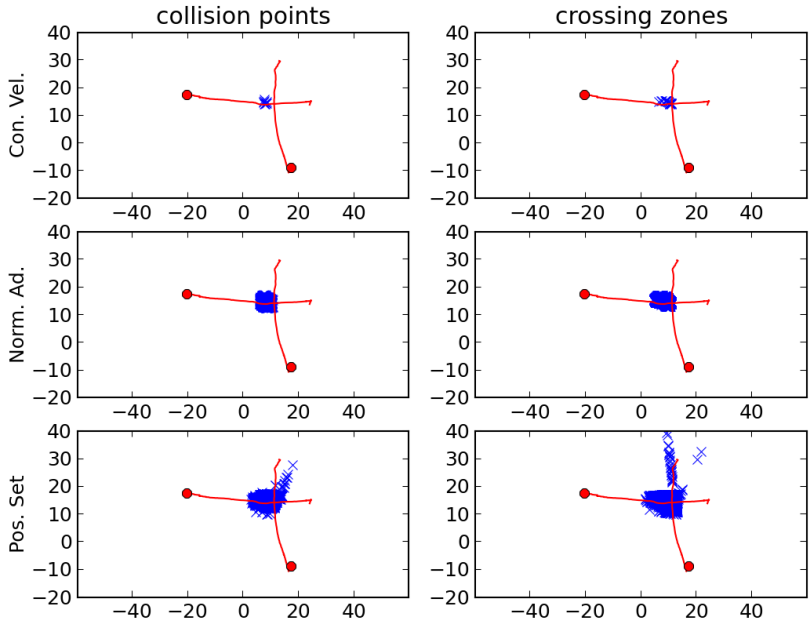

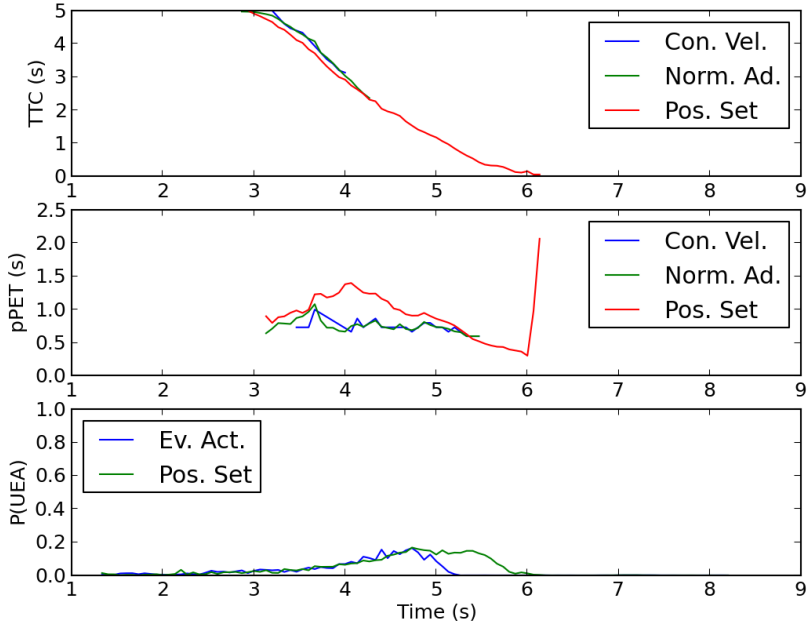

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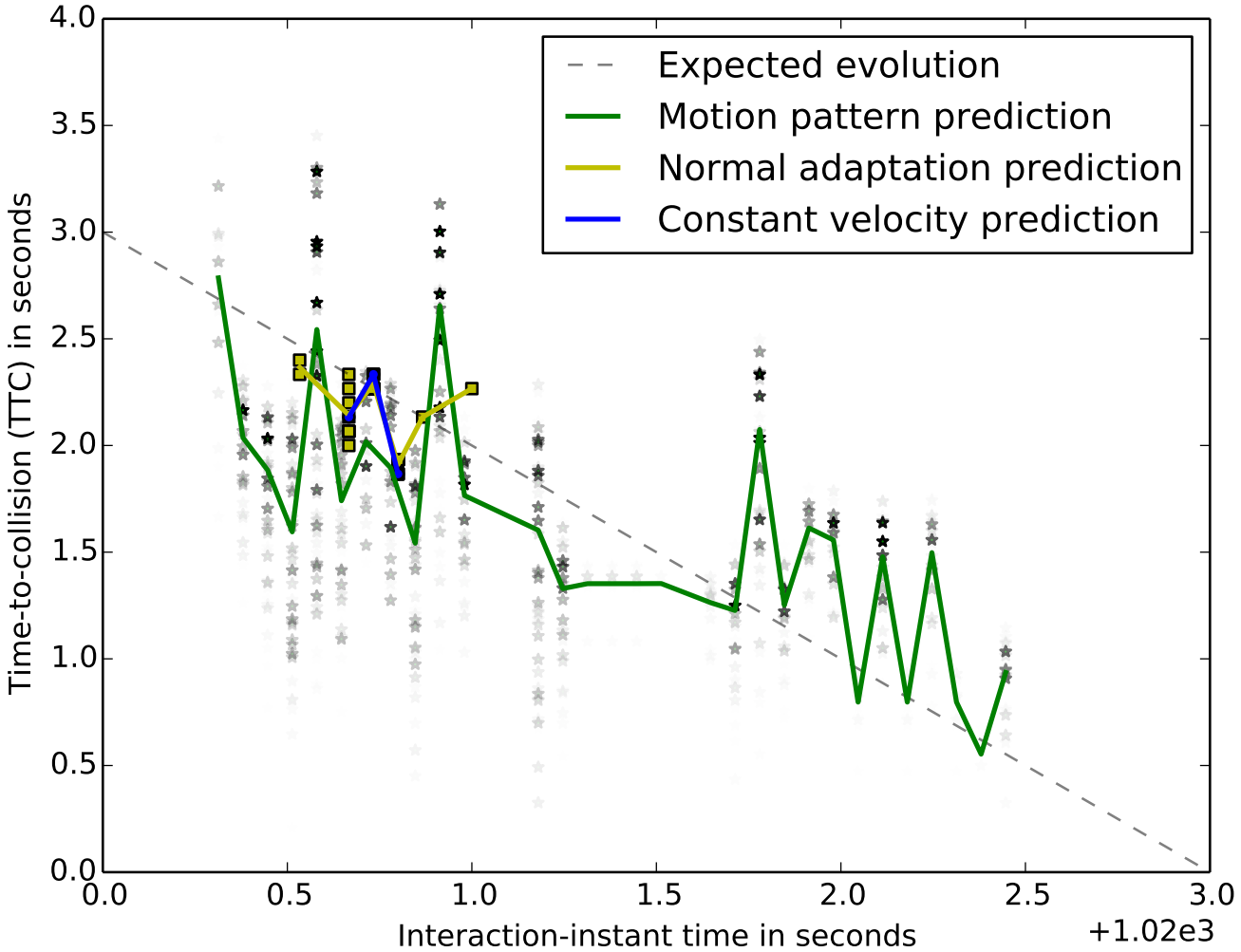
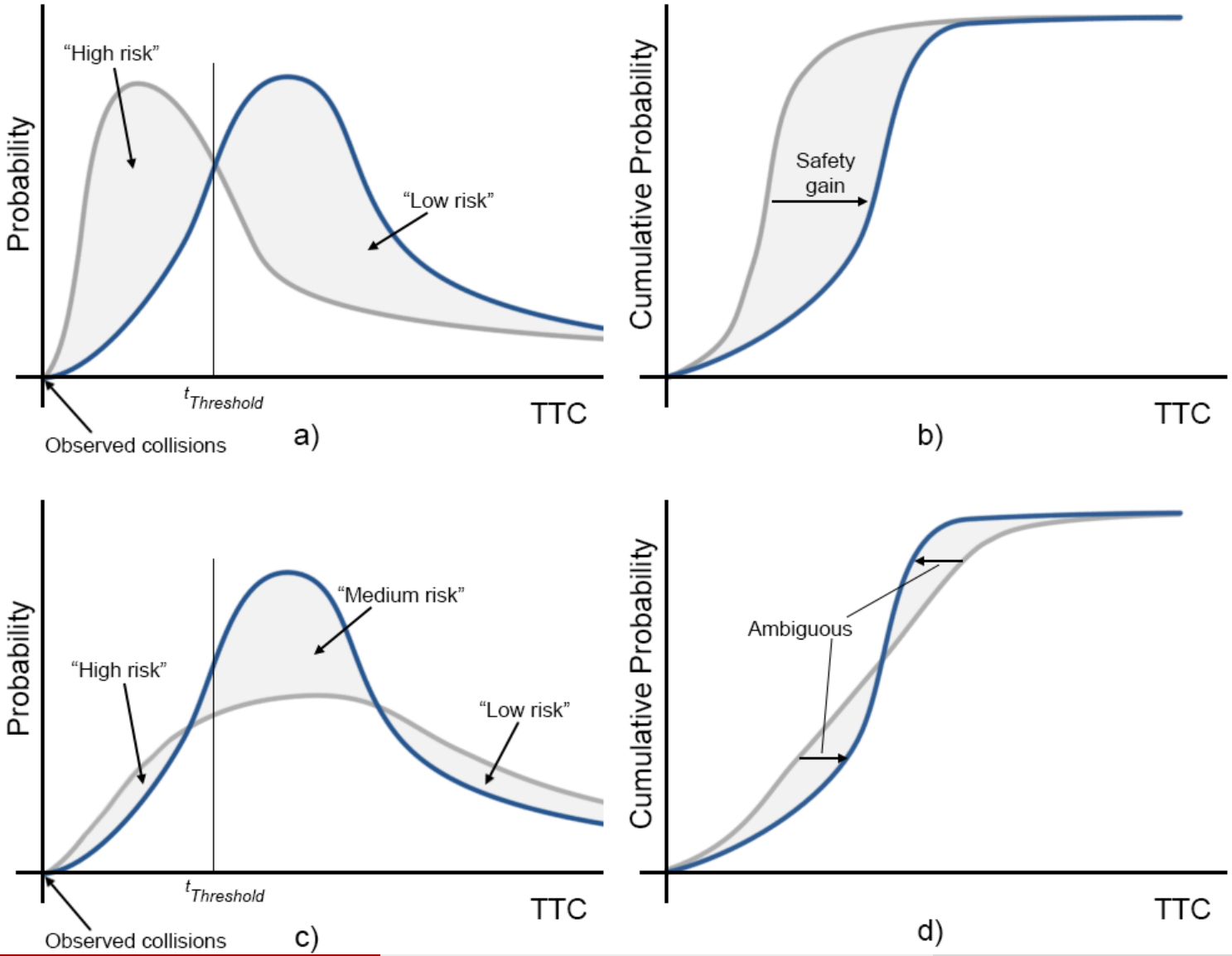


Step 6: Interpretation



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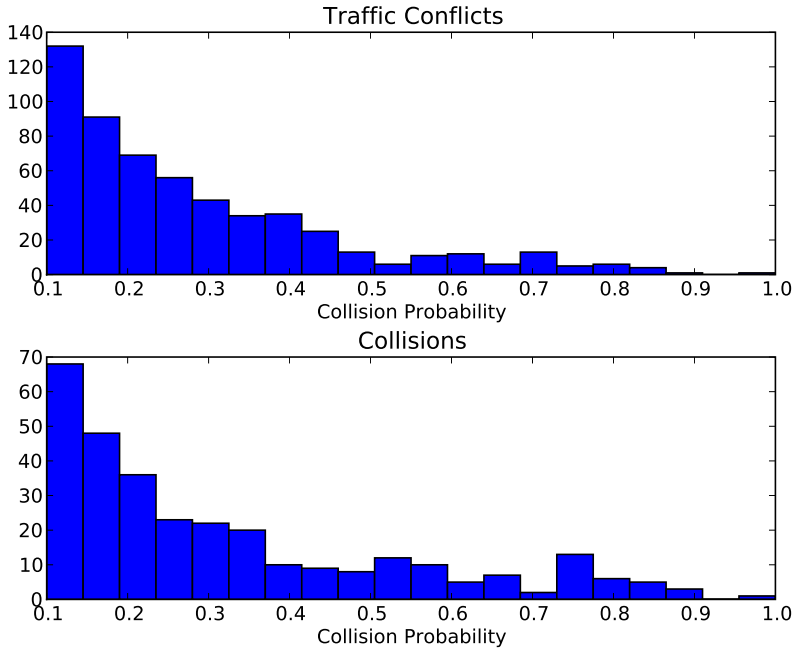
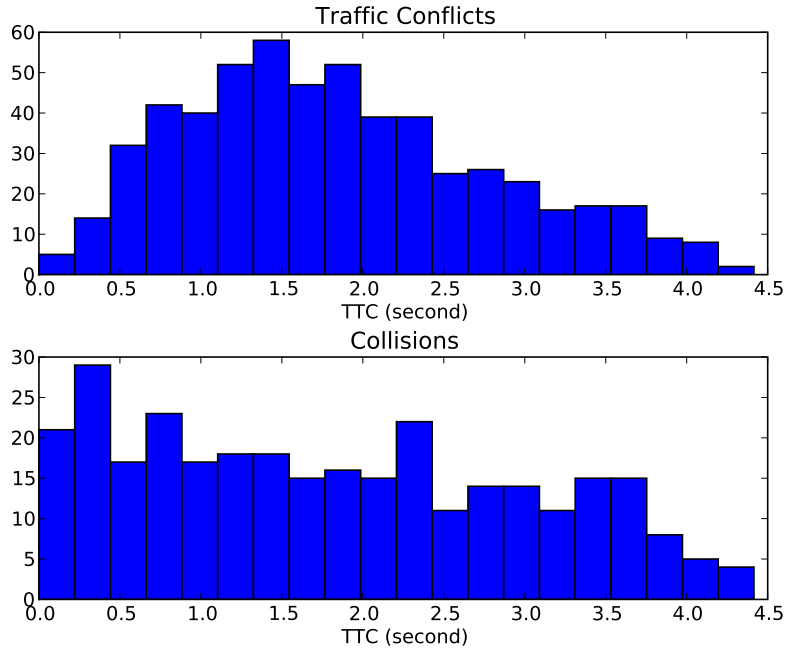
Maximum Collision Probability



Minimum TTC



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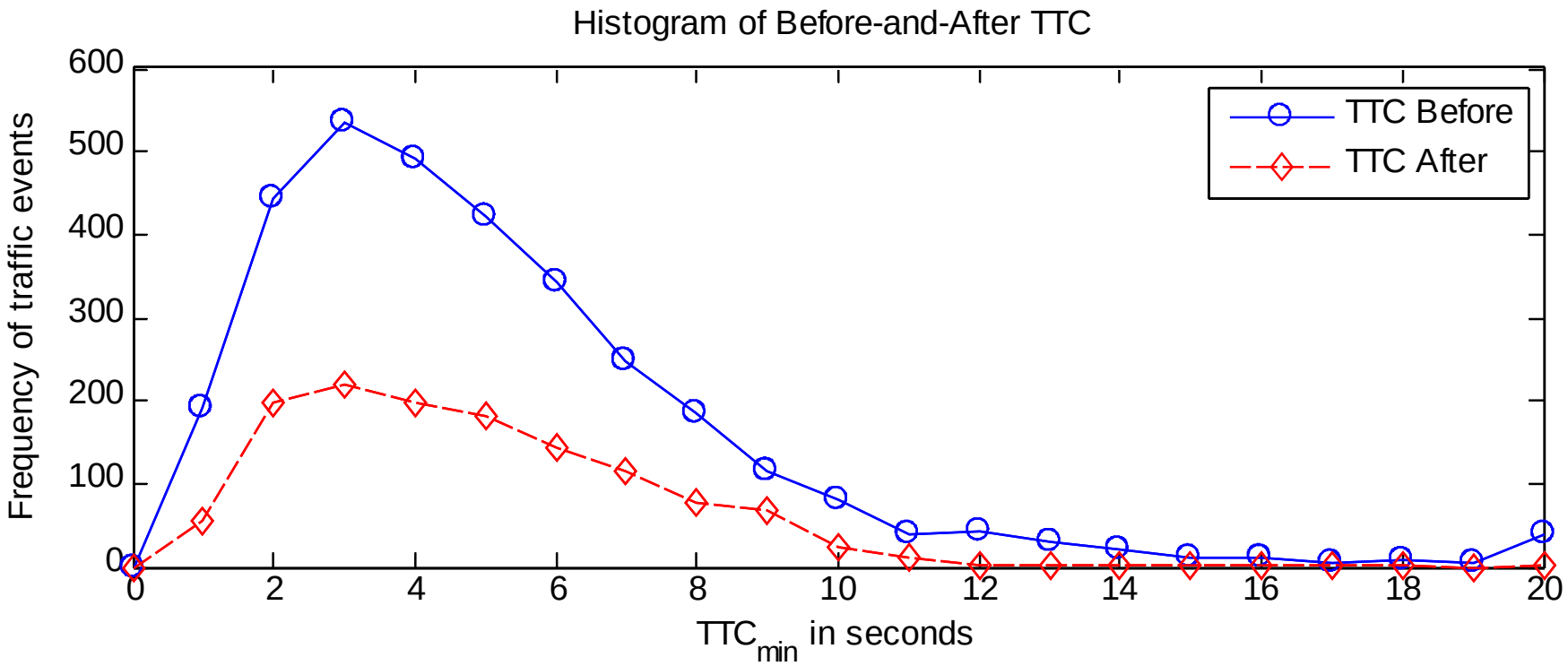

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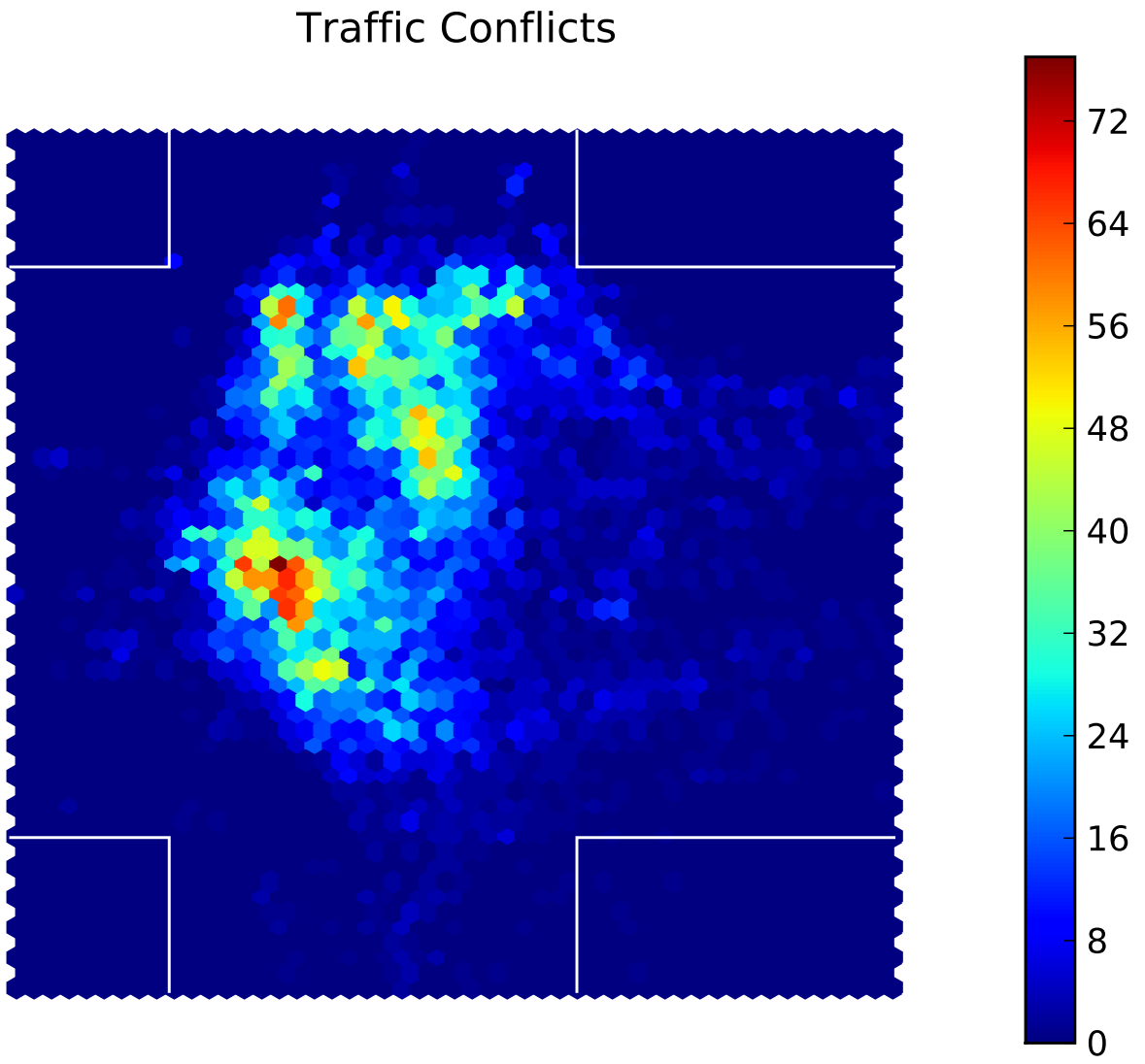

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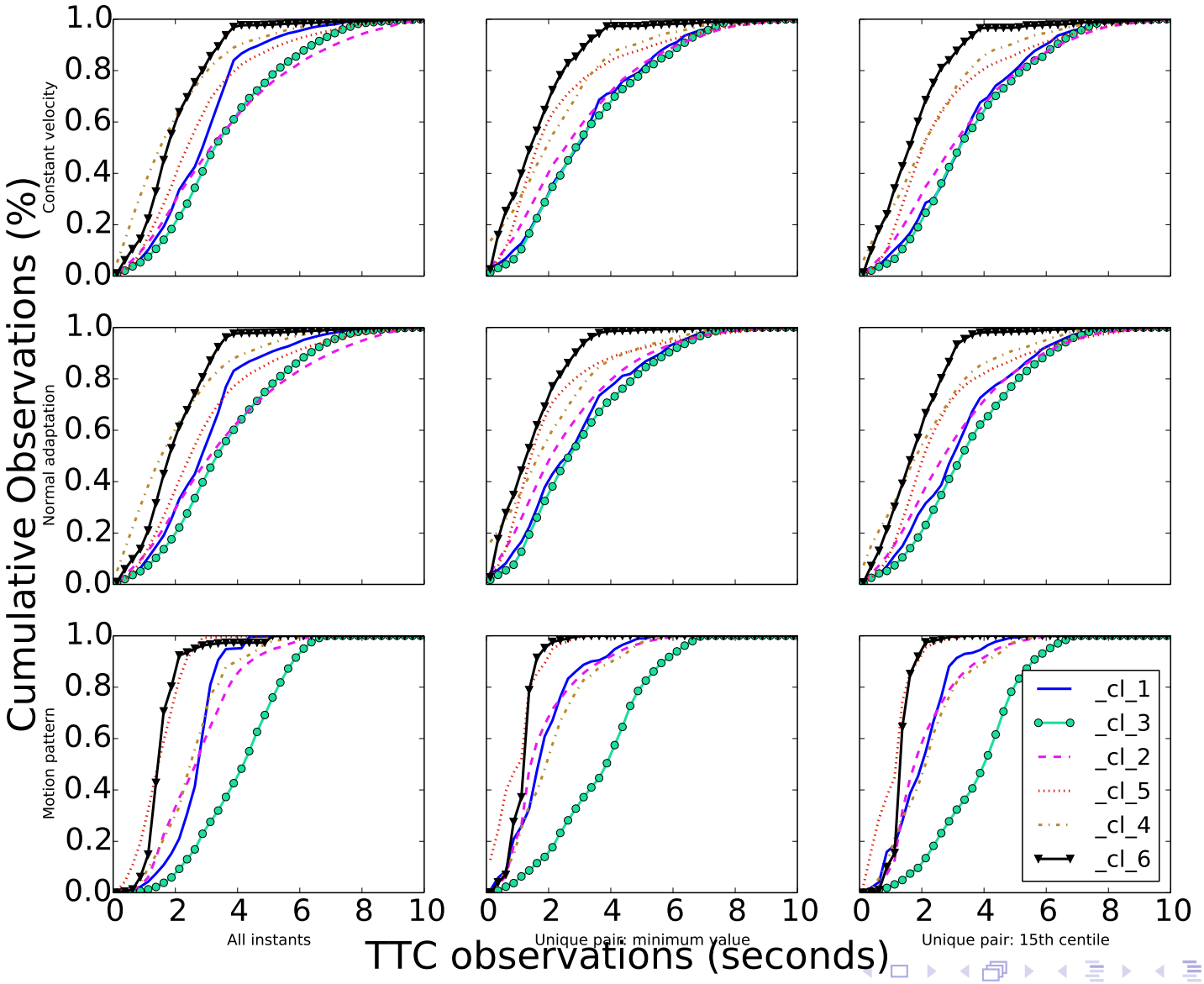

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Model I. Cycle track on the right vs. no cycle track						
Number of Observations = 2880			Log likelihood = -1420		Pseudo R^2 = 0.264	
	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Cycle Track on Right	0.4303	0.1297	3.32	0.001	0.1760	0.6846
Turning-Vehicle Flow for 15s before to 15s after	-1.4089	0.0551	-25.56	0.000	-1.5170	-1.3009
Number of Lane on the Main Road	-0.2354	0.0654	-3.60	0.000	-0.3636	-0.1073
Bus Stop	0.2658	0.1336	1.99	0.047	0.0039	0.5277
Cut-off 1	-6.6884	0.2836			-7.2443	-6.1326
Cut-off 2	-3.8927	0.1968			-4.2785	-3.5070
Cut-off 3	-2.5246	0.1812			-2.8798	-2.1695

Model II. Cycle track on the left vs. no cycle track						
Number of Observations = 4803			Log likelihood = -3241		Pseudo R^2 = 0.288	
	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Cycle Track on Left	-0.1618	0.1186	-1.36	0.172	-0.3941	0.0706
Bicycle Flow for 10s before	0.0827	0.0302	2.74	0.006	0.0235	0.1419
Turning-Vehicle Flow for 15s before to 15s after	-1.3938	0.0342	-40.79	0.000	-1.4608	-1.3268
Cut-off 1	-7.4890	0.2074			-7.8956	-7.0825
Cut-off 2	-3.5944	0.1243			-3.8380	-3.3509
Cut-off 3	-2.0168	0.1132			-2.2387	-1.7950

Model III. Cycle track on the right vs. cycle track on the left						
Number of Observations = 6567			Log likelihood = -4030		Pseudo R^2 = 0.291	
	Coef.	Std. Err.	z	P > |z|	[95% Conf.	Interval]
Cycle Track on Left	-0.5351	0.0921	-5.81	0.000	-0.7155	-0.3546
Bicycle Flow for 10s before	0.6000	0.0268	2.23	0.025	0.0074	0.1126
Turning-Vehicle Flow for 15s before to 15s after	-1.3544	0.0304	-44.52	0.000	-1.4141	-1.2948
Number of Lane on the Main Road	-0.1592	0.0660	-2.41	0.016	-0.2884	-0.0299
Number of Lane on the Turning Road	0.3855	0.1144	3.37	0.001	0.1613	0.6097
Cut-off 1	-7.7501	0.3077			-8.3532	-7.1471
Cut-off 2	-3.7916	0.2684			-4.3177	-3.2655
Cut-off 3	-2.2953	0.2650			-2.8148	-1.7758

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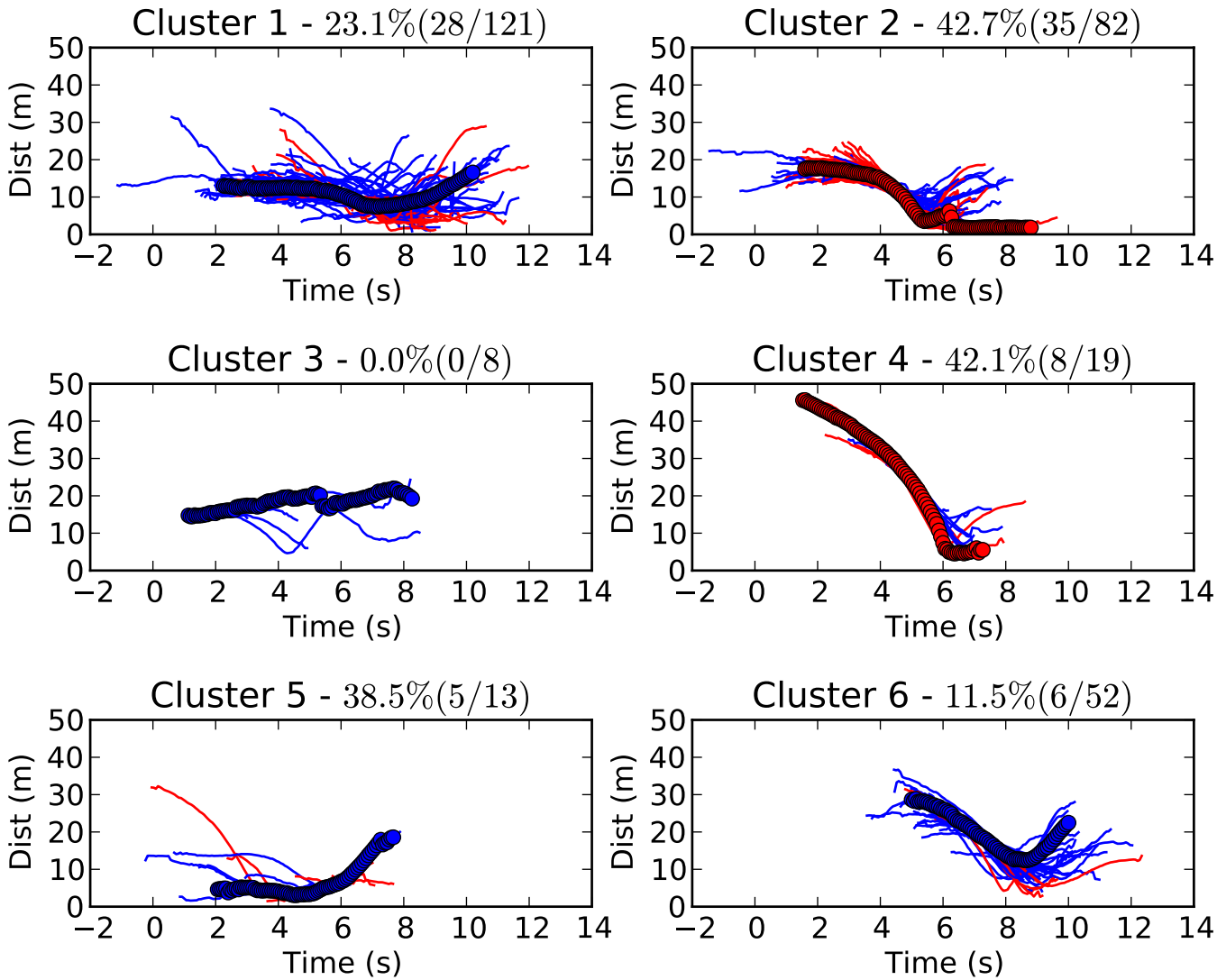

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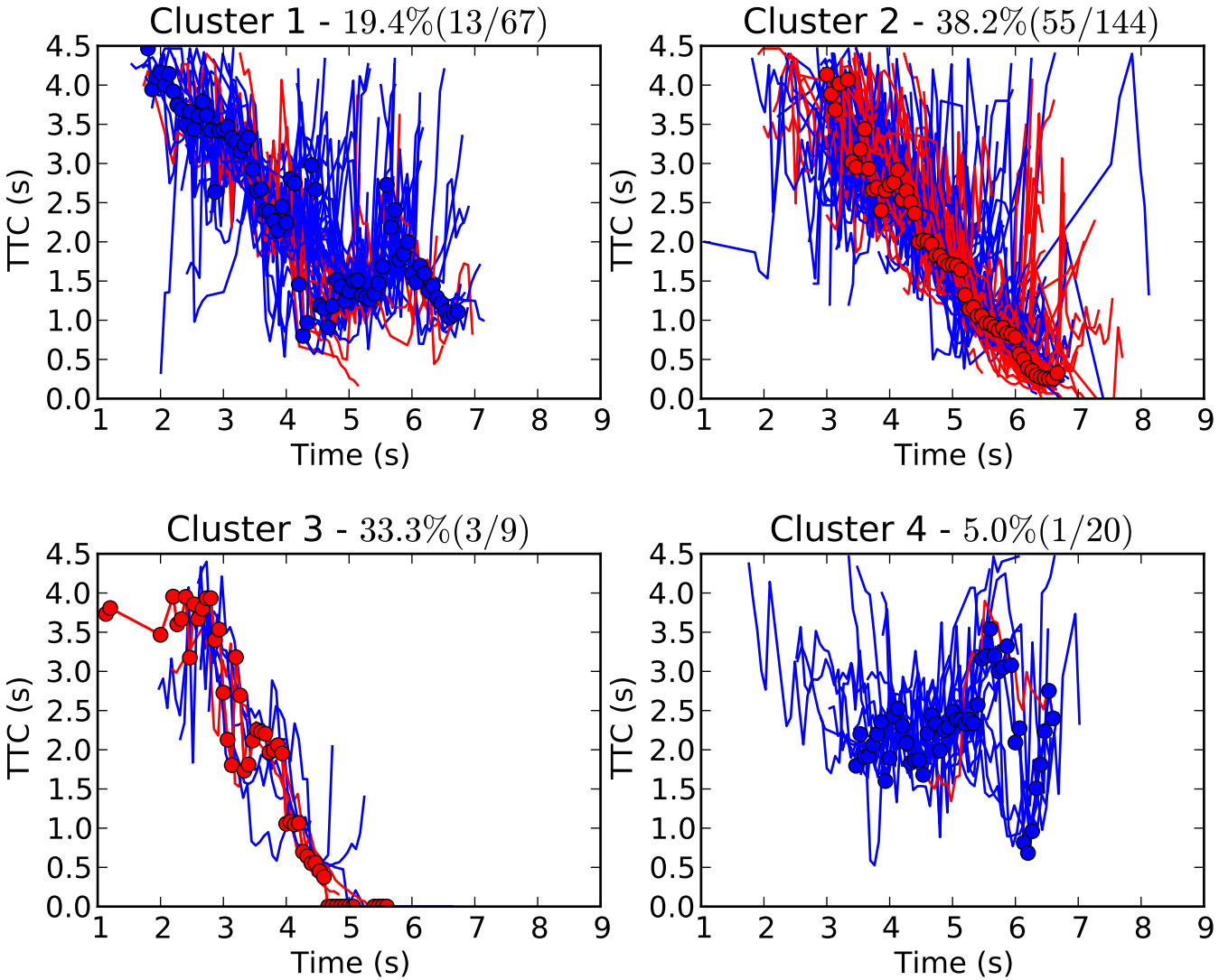

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- How can we compare the various methods and indicators?
- How do we validate the methods? With respect to what?
- How do we account for exposure? Conflicts are, by definition, not exposure [Hauer, 1982]

Other Projects

- Automated calibration and validation of traffic micro-simulation based on video observations
- Lighting and safety
- Traffic monitoring, probe data
- Naturalistic driving studies
- Vehicle automation

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  - we should share our data, use benchmarks to compare to other methods (collaboration with Lund)

- Collaboration with Tarek Sayed (UBC), Karim Ismail (Carleton), Marilyne Brosseau, Mohamed Gomaa Mohamed, Paul St-Aubin (Polytechnique Montréal), Luis Miranda-Moreno, Sohail Zangenehpour (McGill), Aliaksei Laureshyn (Lund)
- Funded by the Natural Sciences and Engineering Research Council of Canada (NSERC), the Québec Research Fund for Nature and Technology (FRQNT) and the Québec Ministry of Transportation (MTQ)

Questions?


Hauer, E. (1982).
Traffic conflicts and exposure.
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