Video Analysis for Cyclist Safety: Case Studies in Montreal, Canada

Bicycle infrastructure design and interplay in traffic
OsloTech science park, Oslo

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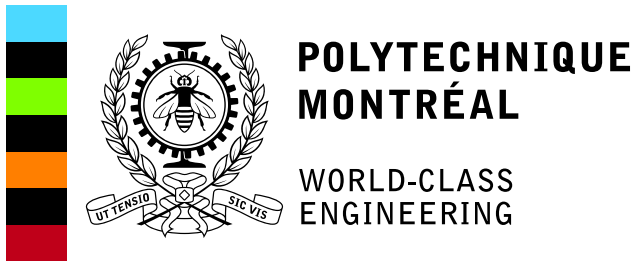

February 26th 2015

Outline

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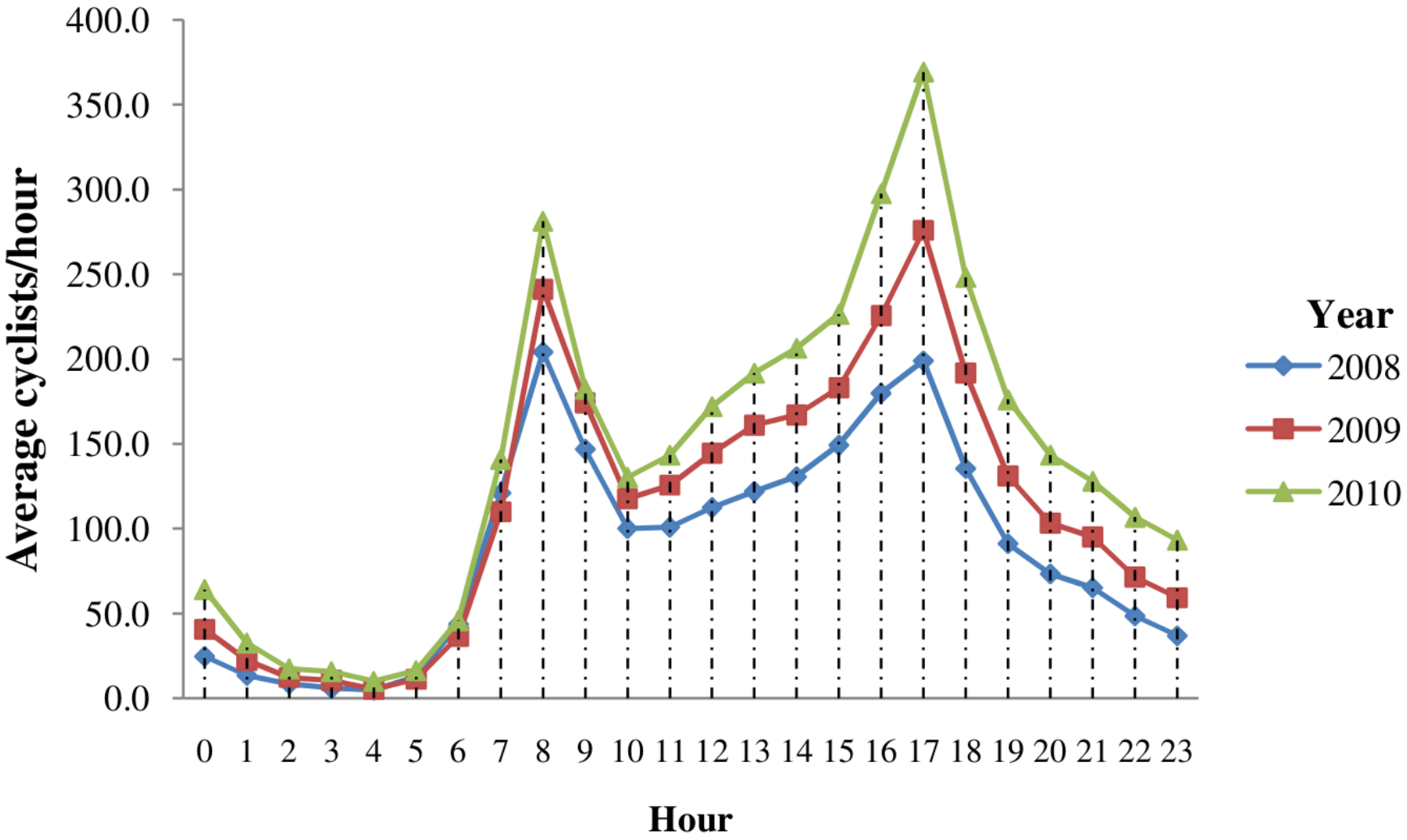
Context

- Cycling is on the rise in North America, in particular in Montréal



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- Cycling safety is an important concern, in particular when promoting it for improving public health
- Dedicated cycling facilities are needed to improve objective and subjective (perceived) safety
  - e.g. bicycle boxes and cycle paths
- Focus on intersections: in Montréal, 60 % of cyclist injuries occur at intersections

Cycling in Montréal and Québec

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- Heavily affected by the seasons, a.k.a. Winter
- The bike lobby, Vélo Québec, was created in 1967 and managed to have cycle paths and lanes built when it was not fashionable in North America

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- Need for proactive methods based on direct observation

Two Case Studies

1. Manual and automated analysis of cyclist behaviour and interactions at bicycle boxes
2. Automated analysis of the safety effect of cycle tracks at intersections and the side of the cycle track

Outline

Site Selection

Without bicycle box (before) With bicycle box (after)

Site Selection

Control Sites (no bicycle box)

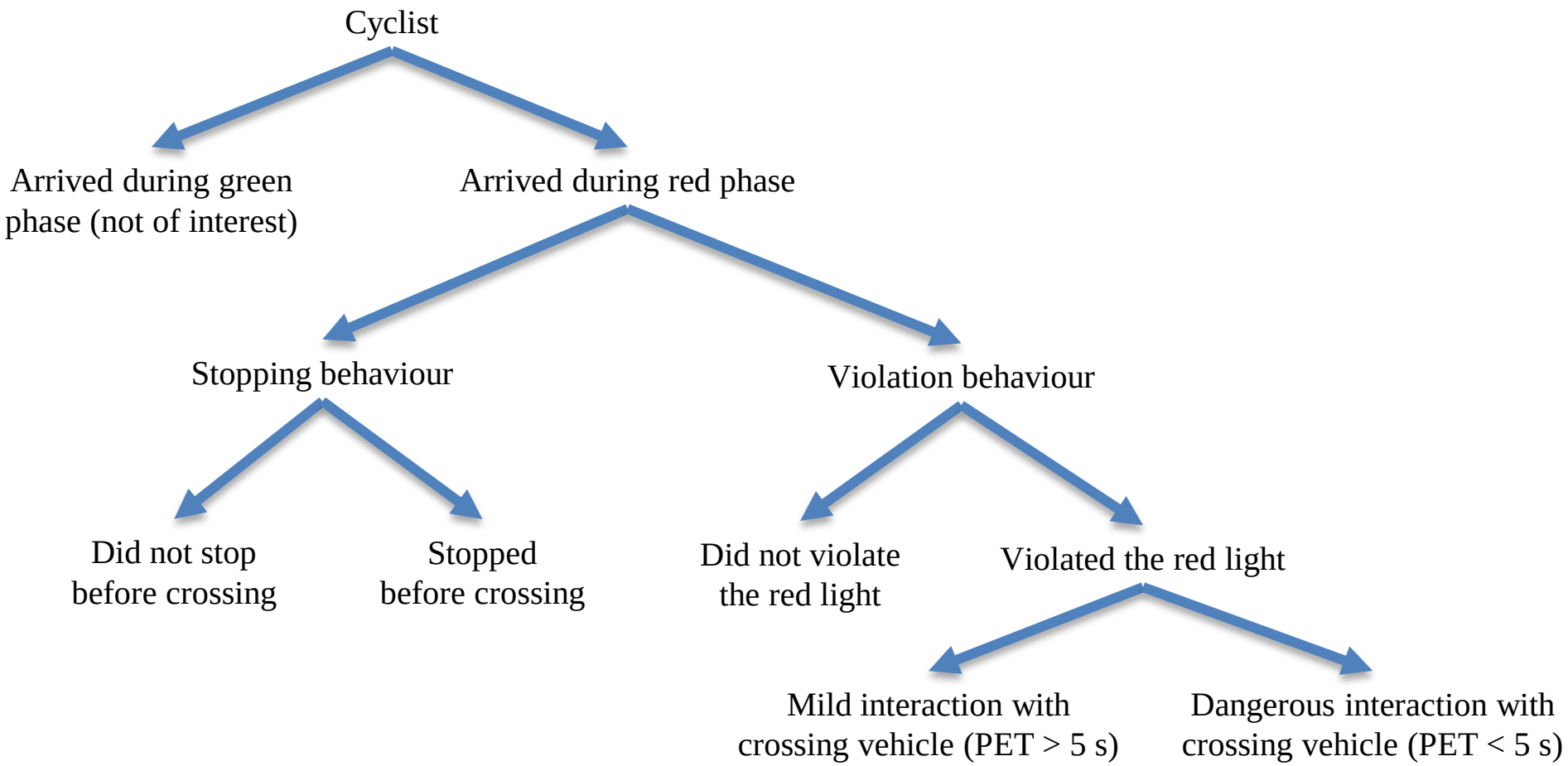
Site Selection

	Without (before)	With (after)
Milton/University	4.7 h	7.3 h
(automated)	-	4.6 h
St-Urbain/Villeneuve	2.5 h	5.5 h
(automated)	2.5 h	5.3 h
St-Laurent/Villeneuve	5.4 h	-
(automated)	5.4 h	-
St-Urbain/Mont-Royal	3.8 h	-
(automated)	3.8 h	-

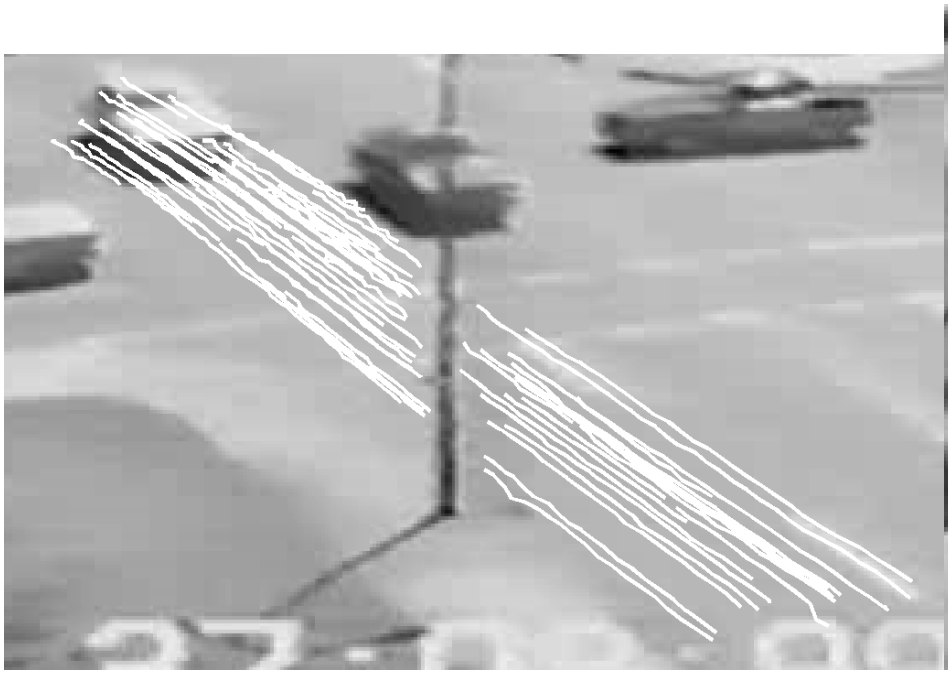
Manual Data Collection

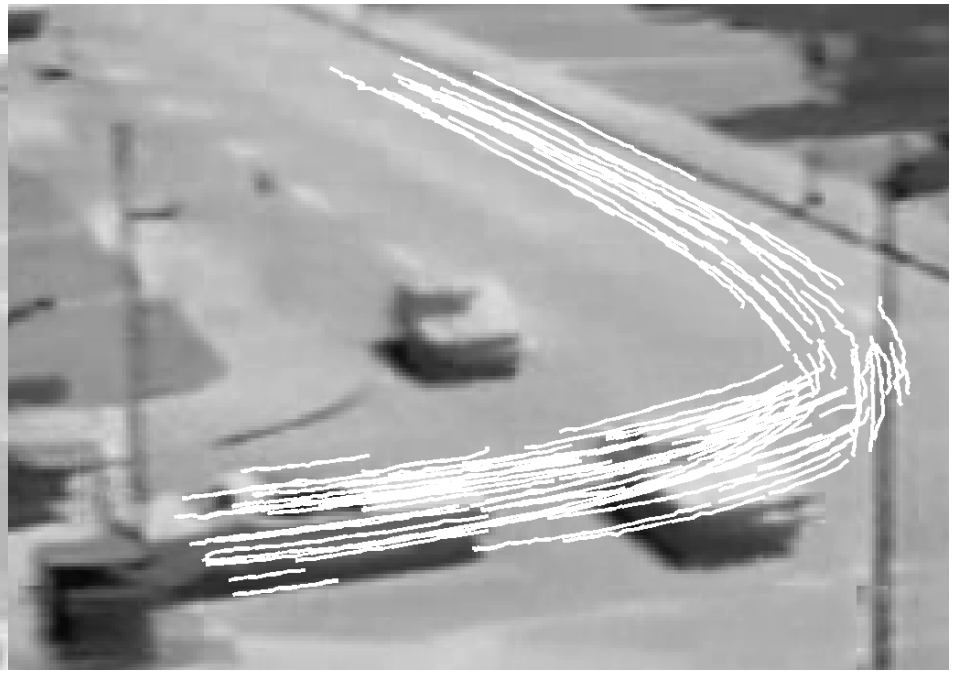
- Gender
- Age category divided into
  - Very young (under 18)
  - Young adult (18 to 35)
  - Middle age (35 to 60)
  - Old (over 60)
- Helmet use
- Arrival pattern: single or group arrival

Manual Data Collection



Automated Video Analysis: Moving Road User Detection, Tracking and Classification





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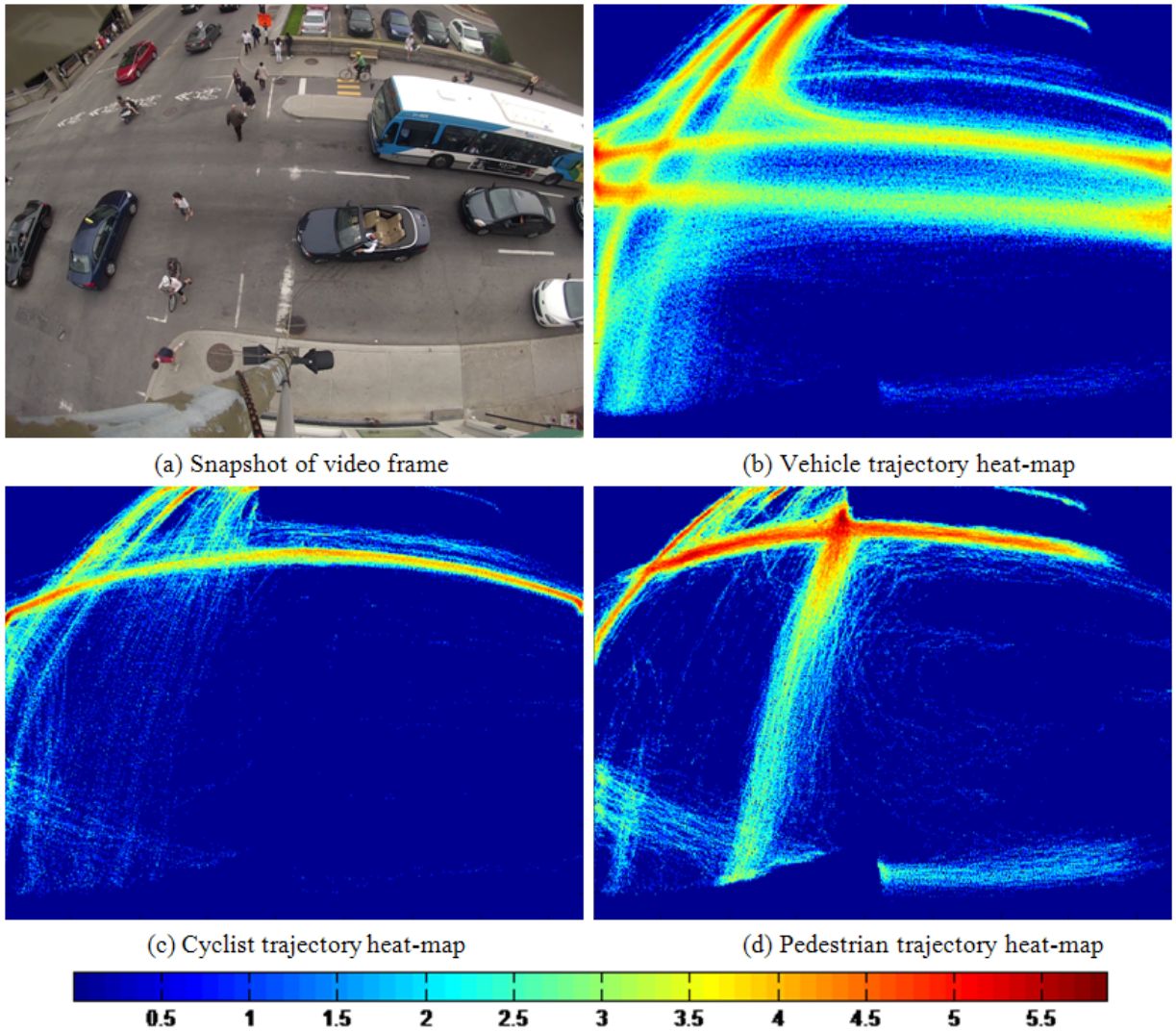


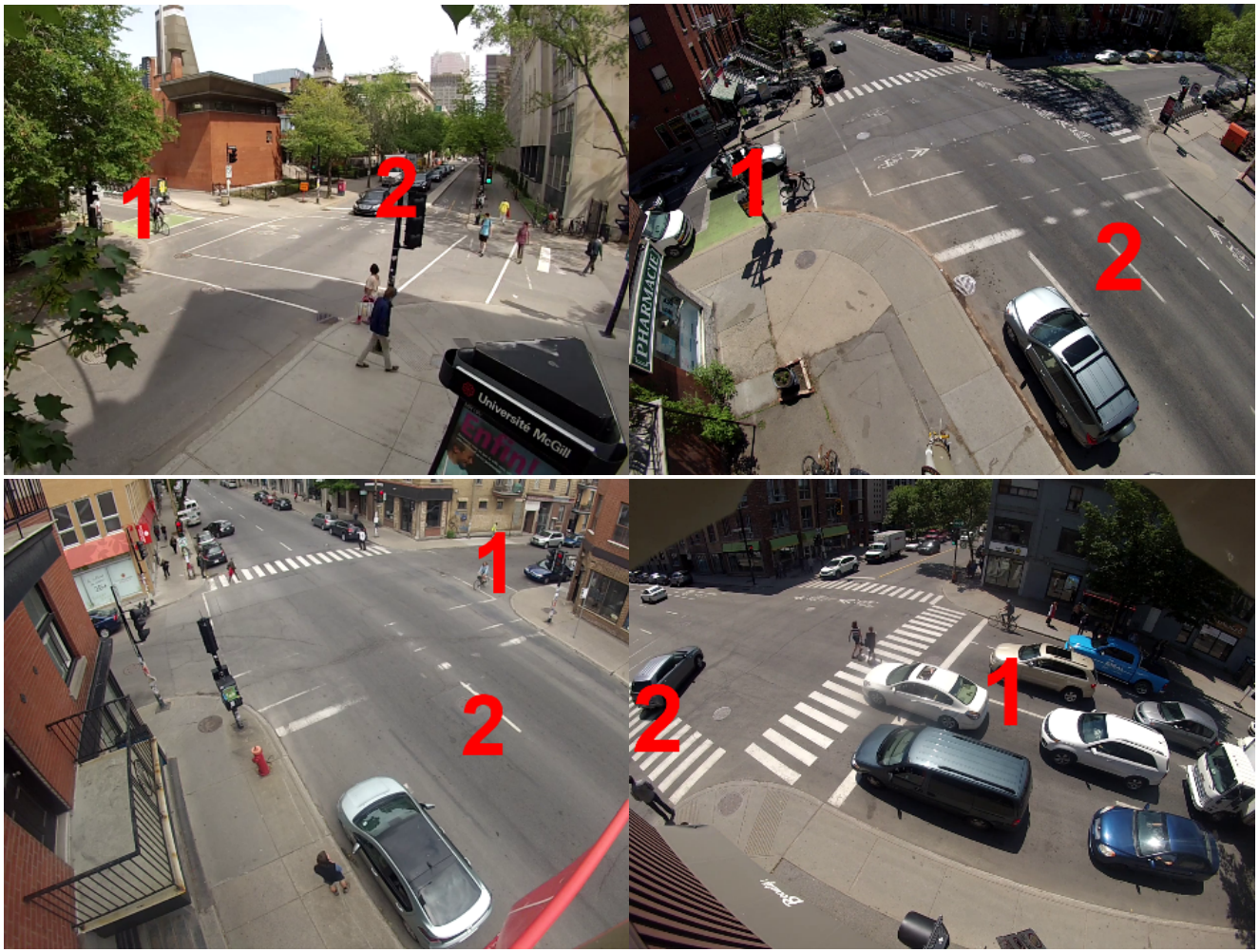
(a) Snapshot of video frame

(b) Vehicle trajectory heat-map

(c) Cyclist trajectory heat-map

(d) Pedestrian trajectory heat-map

Selection of Road Users and Interactions



Selection of Road Users and Interactions

- Bicycle flow (number of cyclists) during the 30 s before the arrival of the cyclist
- Vehicle flow of type 1, during the 30 s before the arrival of the cyclist
- Vehicle flow of type 2, during the 30 s before the arrival of the cyclist
- Smallest PET of the cyclist with a vehicle originating from 1
- Smallest PET of the cyclist with a vehicle originating from 2

Behaviour Logit Models (Manual), Milton/University

Explanatory variables	Violation			No Stop Before Crossing			Dangerous Violation		
	Coef.	p-val.	Elas.*	Coef.	p-val.	Elas.*	Coef.	p-val.	Elas.*
Constant	0.532	0.00	-	-1.724	0.00	-	-3.237	0.00	-
Male	0.330	0.01	8 %	0.380	0.01	7 %	0.959	0.00	4 %
Young Adult	-	-	-	0.924	0.01	15 %	-	-	-
Wear Helmet	-0.466	0.00	-11 %	-	-	-	-0.790	0.01	-3 %
Group Arrival	-0.308	0.01	-8 %	-0.825	0.00	-15 %	-1.077	0.00	-4 %
Bicycle Box	**-0.251**	**0.04**	**-6 %**	-	-	-	**0.578**	**0.04**	**2 %**
Number of observations	1115			1115			1115		
Percentage of positive obs.	56 %			27 %			5 %		
Log-likelihood	-747.71			-626.13			-218.73		
Pseudo R^2	0.026			0.039			0.075		

* Elasticity for discrete change of dummy variable from 0 to 1

A positive coefficient indicates an association with an unsafe behaviour

Behaviour Logit Models (Manual), St-Urbain/Villeneuve

Explanatory variables	Violation			No Stop Before Crossing			Dangerous Violation		
	Coef.	p-val.	Elas.*	Coef.	p-val.	Elas.*	Coef.	p-val.	Elas.*
Constant	-1.107	0.00	-	-2.064	0.00	-	-3.176	0.00	-
Male	0.770	0.00	19 %	0.807	0.00	13 %	0.790	0.01	5 %
Young Adult	0.839	0.00	19 %	0.928	0.00	12 %	0.951	0.05	4 %
Wear Helmet	-	-	-	-0.505	0.00	-8 %	-	-	-
Group Arrival	-0.782	0.00	-19 %	-0.823	0.00	-13 %	-0.842	0.01	-5 %
Bicycle Box	-	-	-	-	-	-	**-0.796**	**0.00**	**-5 %**
Number of observations	832			832			832		
Percentage of positive obs.	45 %			23 %			8 %		
Log-likelihood	-536.87			-419.12			-212.73		
Pseudo R^2	0.062			0.068			0.057		

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Behaviour Logit Models (Manual), All Sites

Explanatory variables	Violation			No Stop Before Crossing			Dangerous Violation		
	Coef.	p-val.	Elas. *	Coef.	p-val.	Elas. *	Coef.	p-val.	Elas. *
Constant	-0.987	0.00	-	-2.045	0.00	-	-3.941	0.00	-
Male	0.569	0.00	14 %	0.576	0.00	10 %	0.844	0.00	4 %
Young Adult	0.803	0.00	19 %	0.851	0.00	12 %	1.161	0.00	4 %
Wear Helmet	-0.343	0.00	-9 %	-0.290	0.01	-5 %	-0.560	0.01	-2 %
Group Arrival	-0.337	0.00	-8 %	-0.742	0.00	-12 %	-0.839	0.00	-4 %
Bicycle Box	**0.211**	**0.01**	**5 %**	**0.273**	**0.01**	**5 %**	-	-	-
Number of observations	2291			2291			2291		
Percentage of positive obs.	47 %			24 %			6 %		
Log-likelihood	-1530.32			-1198.82			-482.99		
Pseudo R^2	0.034			0.046			0.054		

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Interaction Models (Automated)

Explanatory variables	Interaction Type 1						Interaction Type 2					
	Interaction (PET < 5s)			Dangerous Interaction (PET < 1.5s)			Interaction (PET < 5s)			Dangerous Interaction (PET < 1.5s)		
	Coef.	p-val.	Elas.	Coef.	p-val.	Elas.	Coef.	p-val.	Elas.	Coef.	p-val.	Elas.
Constant	-0.559	0.00	-	-1.954	0.00	-	-2.994	0.00	-	-4.354	0.00	-
Bicycle Flow during 30s before	0.423	0.00	7.7 %	0.434	0.00	2.1 %	-	-	-	-	-	-
Vehicle Flow 1 during 30s before	0.091	0.00	1.6 %	0.040	0.04	0.2 %	0.063	0.00	0.4 %	-	-	-
Vehicle Flow 2 during 30s before	-0.086	0.00	-1.6 %	-0.082	0.01	-0.4 %	0.117	0.00	0.8 %	0.097	0.00	0.1 %
Presence of Bicycle Box	**-0.739**	**0.00**	**-14 %***	**-1.226**	**0.00**	**-7 %***	**-0.726**	**0.00**	**-5 %***	**-2.050**	**0.00**	**-2 %***
Observations	1054						1054					
Percentage of positive obs.	27.6 %			7.5 %			9.8 %			1.3 %		
Log-likelihood	-544.00			-251.48			-299.85			-66.44		
Pseudo R^2	0.133			0.109			0.117			0.110		

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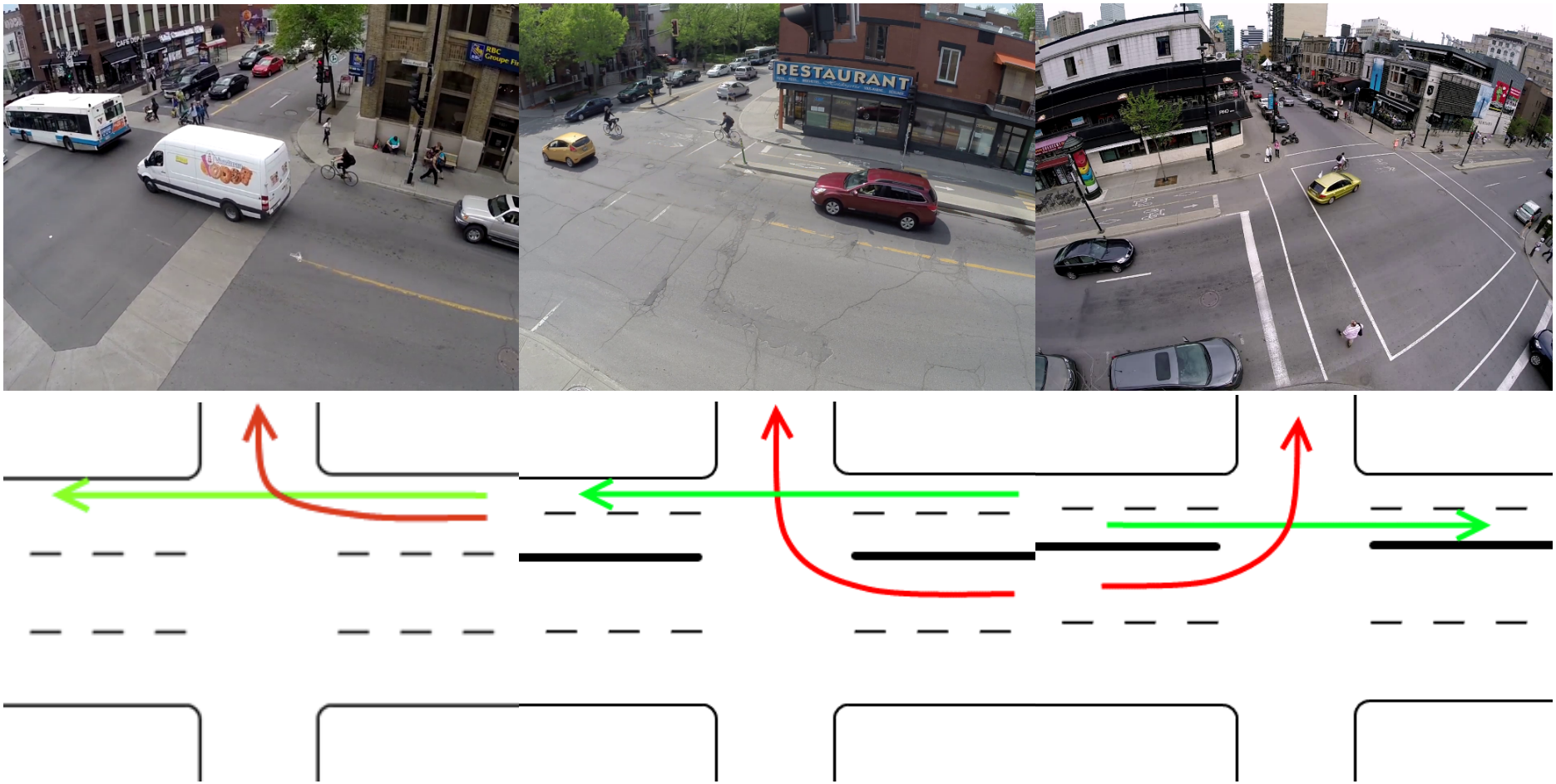
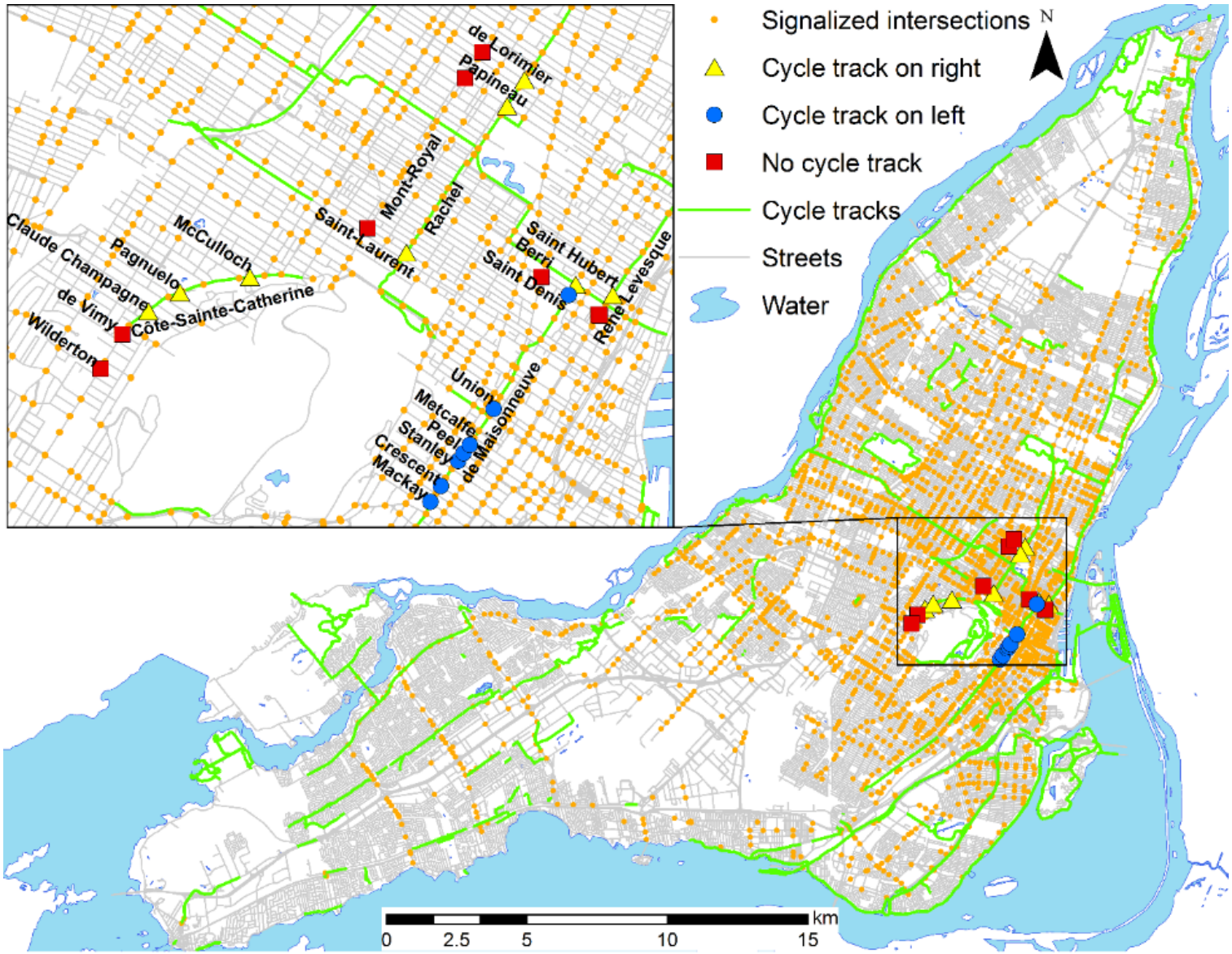
Outline

Turning Vehicle Interactions with Cycle Tracks



Site Selection

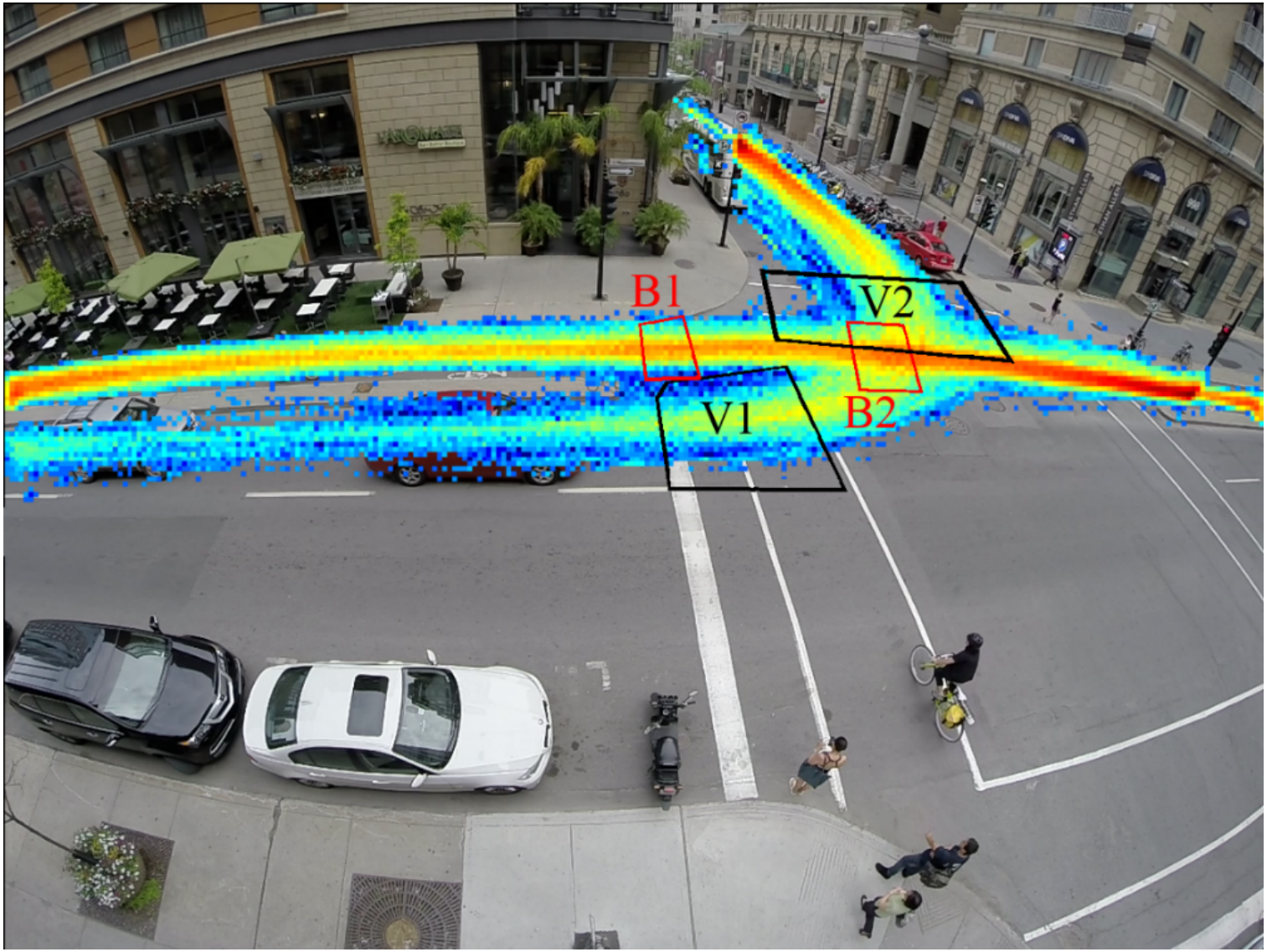


Site Selection

	# intersections	Duration
Cycle track on the right	8 intersections	37 h
Cycle track on the left	7 intersections	22 h
No cycle track	8 intersections	31 h
Total	23 intersections	90 h

Videos were collected on weekdays during the evening peak period from 3pm to 7pm

Road User Selection



Interaction Attributes

- Each cyclist arriving to the intersection is an observation
- PET is the dependent variable and is discretized into 4 categories
  - $PET \leq 1.5\ s$: dangerous interaction
  - $1.5\ s < PET \leq 3\ s$: mild interaction
  - $3\ s < PET \leq 5\ s$: interaction
  - $PET > 5\ s$: no interaction
- Tested independent variables
  - Cycle track on the right side
  - Cycle track on the left side
  - Number of lanes on the road
  - Presence of bus stops at the intersection
  - One way street
  - Turning-vehicle and cyclist flows per hour
  - Bicycle and vehicle flow 5, 15 and 30 s before and after the arrival of each cyclist

Three PET Ordered Logit Models

	Model I. Cycle track on the right vs. no cycle track			**Model II. Cycle track on the left vs. no cycle track**			**Model III. Cycle track on the right vs. cycle track on the left**		
	Coef.	Std. Err.	Sig.	Coef.	Std. Err.	Sig.	Coef.	Std. Err.	Sig.
Cycle Track on Right	0.395	0.181	0.03	-	-	-	-	-	-
Cycle Track on Left	-	-	-	Not Significant			-0.513	0.131	0.00
Bicycle Flow for 5s before to 5s after	Not Significant			0.088	0.038	0.02	0.066	0.034	0.05
Turning-Vehicle Flow for 5s before to 5s after	-2.771	0.132	0.00	-3.265	0.090	0.00	-3.131	0.080	0.00
Number of Lanes on the Main Road	-0.151	0.078	0.05	Not Significant			Not Significant		
Number of Lanes on the Turning Road	Not Significant			0.324	0.146	0.03	0.457	0.178	0.01
Cut-off 1	-6.599	0.353	0.00	-7.372	0.301	0.00	-7.621	0.323	0.00
Cut-off 2	-4.233	0.273	0.00	-3.807	0.223	0.00	-4.125	0.265	0.00
Cut-off 3	-3.150	0.256	0.00	-2.102	0.211	0.00	-2.479	0.258	0.00
Number of Observations	2880			4803			6567		
Log likelihood	-804			-1876			-2330		

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Conclusion

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- Automated video analysis is feasible for large scale safety analysis

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- Compare safety of one-way and two-way cycle tracks
- Study the discontinuities of the cycling network and nighttime safety, using video analysis and a thermal camera

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Questions?


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