How Many Ways to Crash?

TRB Annual Meeting

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Collaboration with Karim Ismail, Clark Lim and Tarek Sayed
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Outline

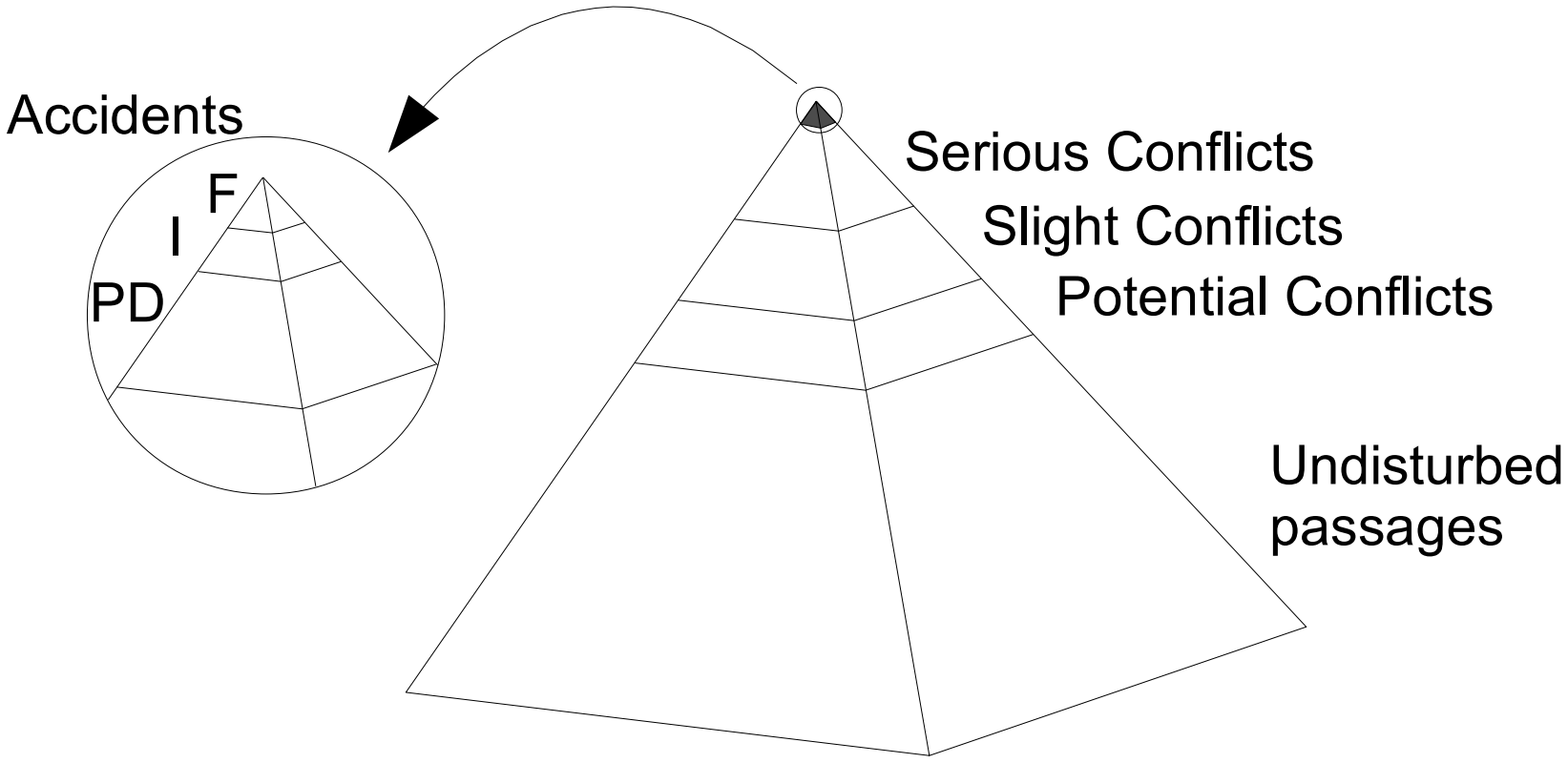
Road Safety Analysis

- Limits of the traditional approach based on historical collision data:
  - Problems of availability and quality,
  - Insufficient data to understand the mechanisms that lead to collisions,
  - Reactive approach.
- Need for proactive approaches and surrogate safety measures that do not depend on the occurrence of collisions.

Surrogate Safety Measures

- Research on surrogate safety measures that
  - bring complementary information,
  - are related to traffic events that are more frequent than collisions and can be observed in the field,
  - are correlated to collisions, logically and statistically.
- A traffic conflict is “an observational situation in which two or more road users approach each other in space and time to such an extent that a collision is imminent if their movements remain unchanged” [Amundsen and Hydén, 1977].

The Safety/Severity Hierarchy



Various severity measures.

The Collision Course

- A traffic conflict is “an observational situation in which two or more road users approach each other in space and time to such an extent that a collision is imminent if their movements remain unchanged”.
- For two interacting road users, many chains of events may lead to a collision.
- It is possible to estimate the probability of collision if one can predict the road users’ future positions.

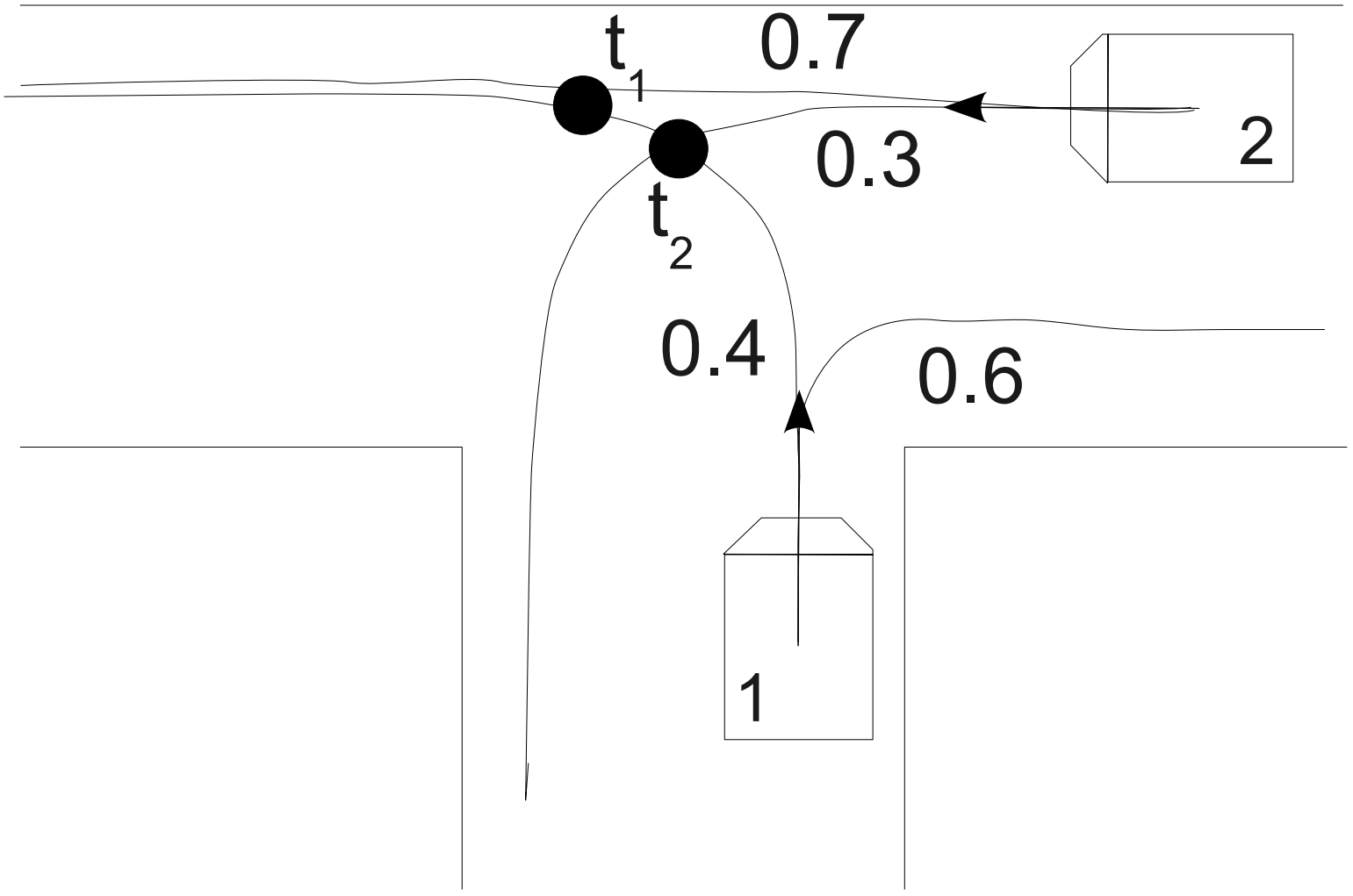
What about Evasive Actions?

- Necessary by construction for traffic conflicts.
- The severity of a traffic conflict does not depend on the characteristics of the evasive action (e.g. the Swedish traffic conflict technique).
- The emphasis on evasive actions is most likely related to the traffic conflict collection techniques: emergency evasive actions are relatively easy to identify by observers in the field.
- Future work: understand why collisions are avoided, and the link between interactions with and without a collision.

Movement Prediction

- Learn road users' motion patterns (including frequencies), represented by actual trajectories called prototypes
- Match observed trajectories to prototypes and extrapolate

A Simple Example



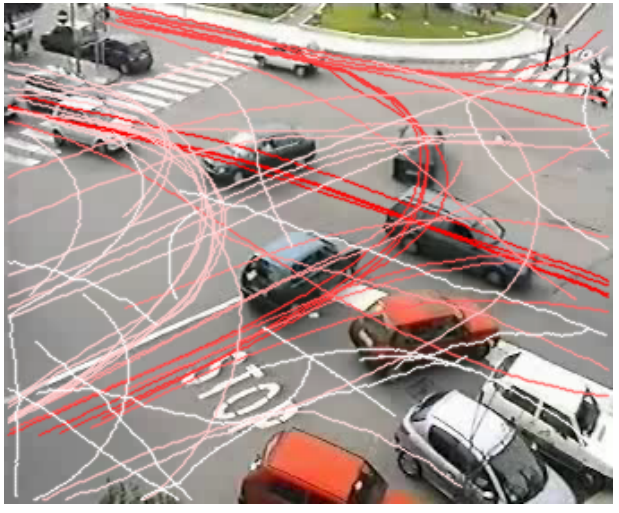
Collision Points

Using of a finite set of extrapolation hypotheses, enumerate the collision points CP_n. Severity indicators can then be computed:

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

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

Motion Pattern Learning



Traffic Conflict Dataset, Vancouver	Reggio Calabria, Italy
58 prototype trajectories (2941 trajectories)	58 prototype trajectories (138009 trajectoires)

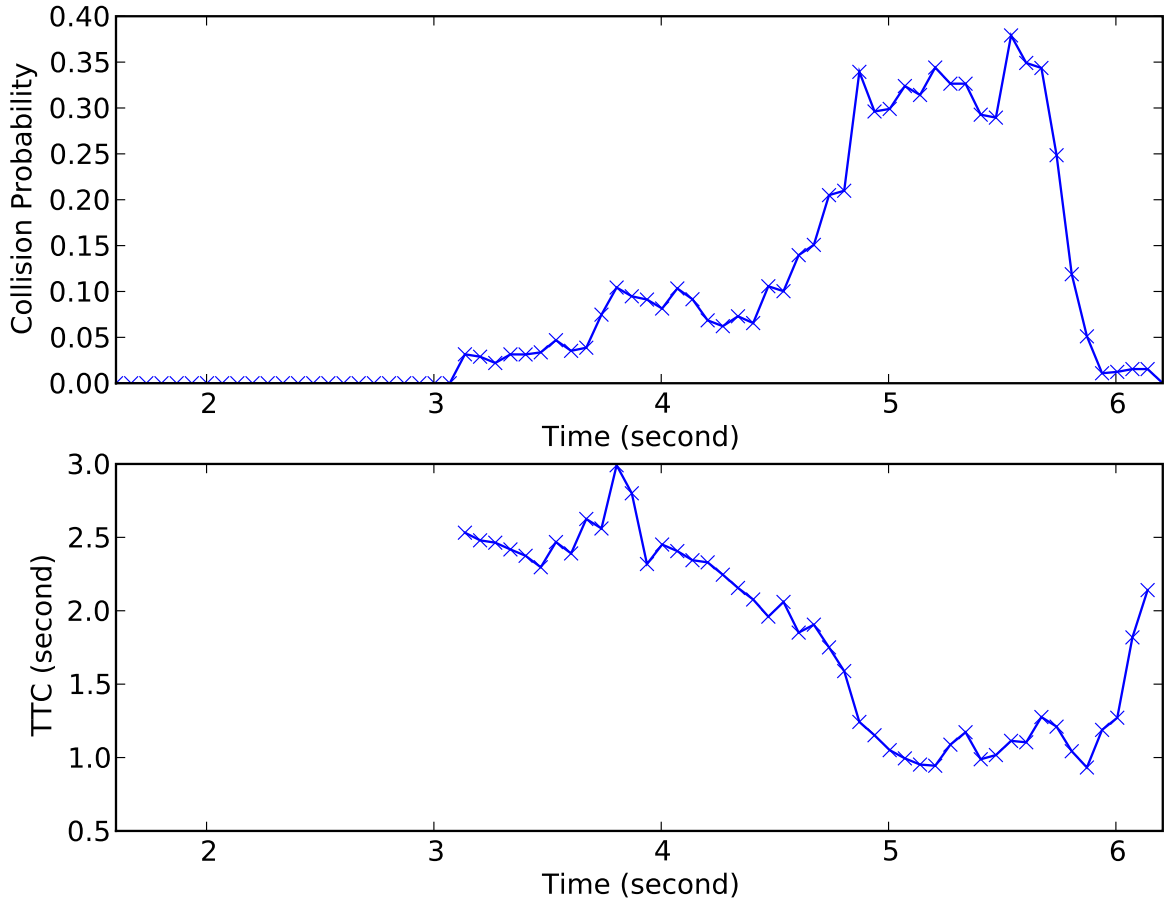
Road User Tracking

Motion Prediction

Motion Prediction

Motion Prediction

The Severity Indicators

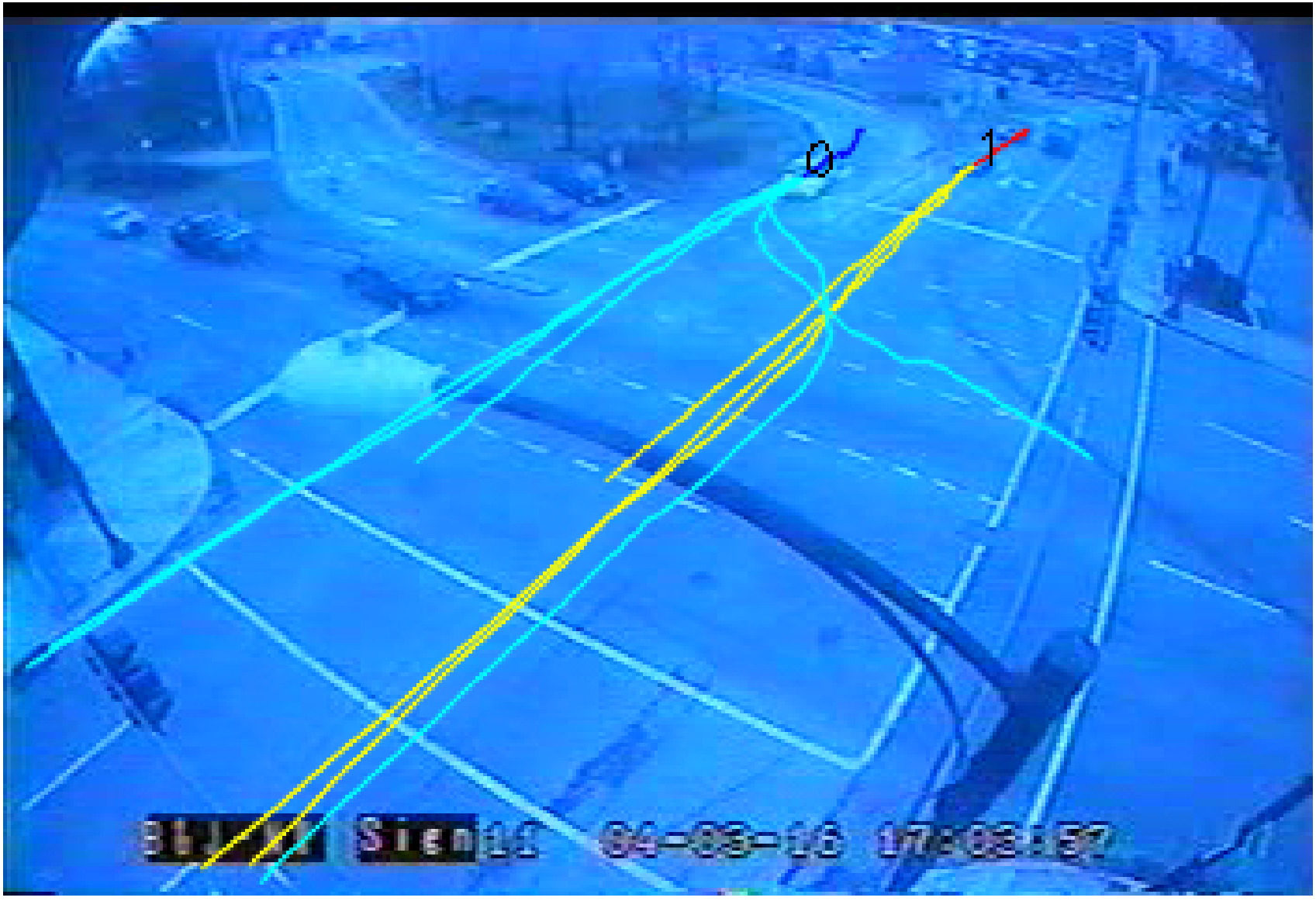


Parallel conflict, Kentucky dataset

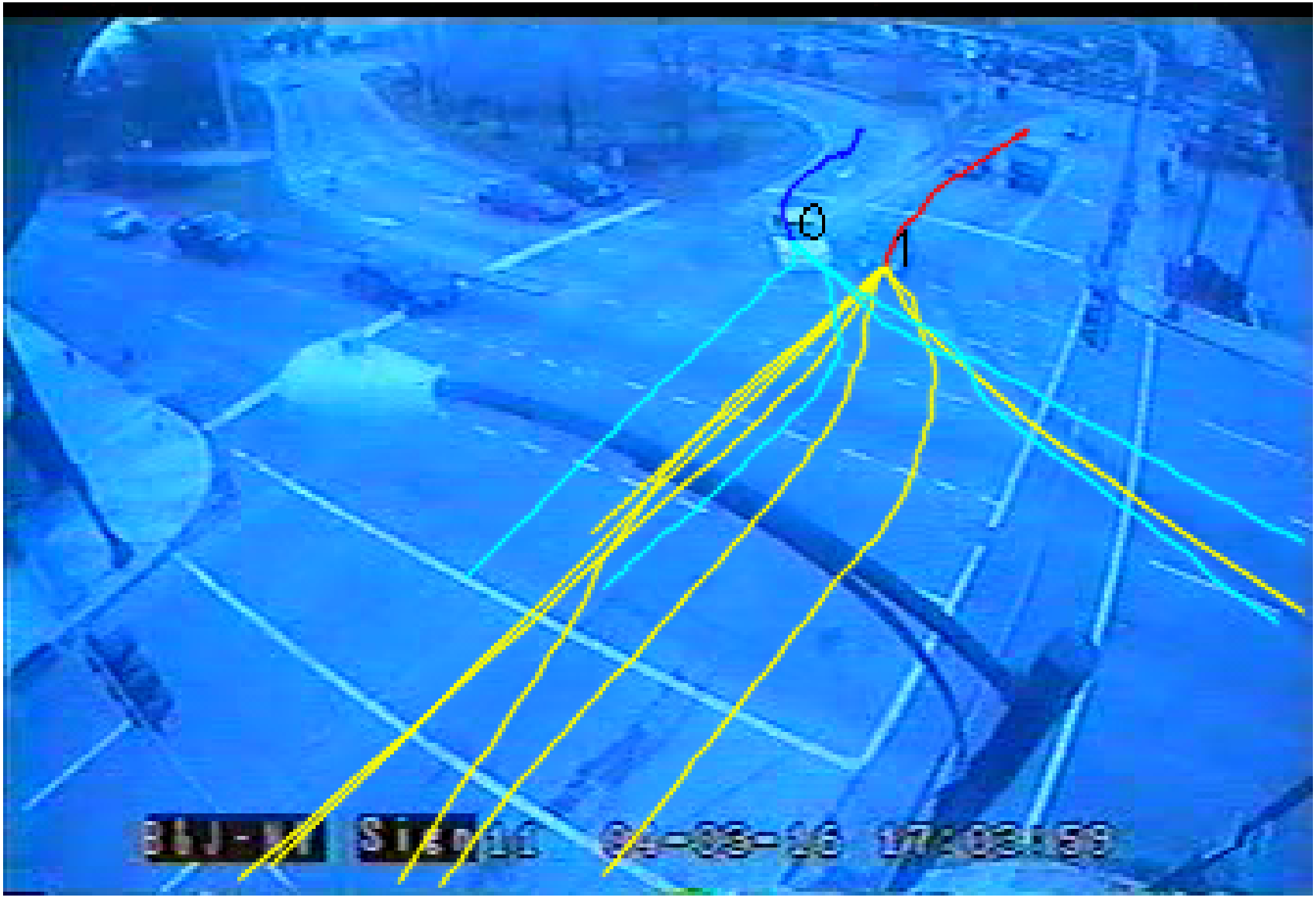
Road User Tracking

Motion Prediction

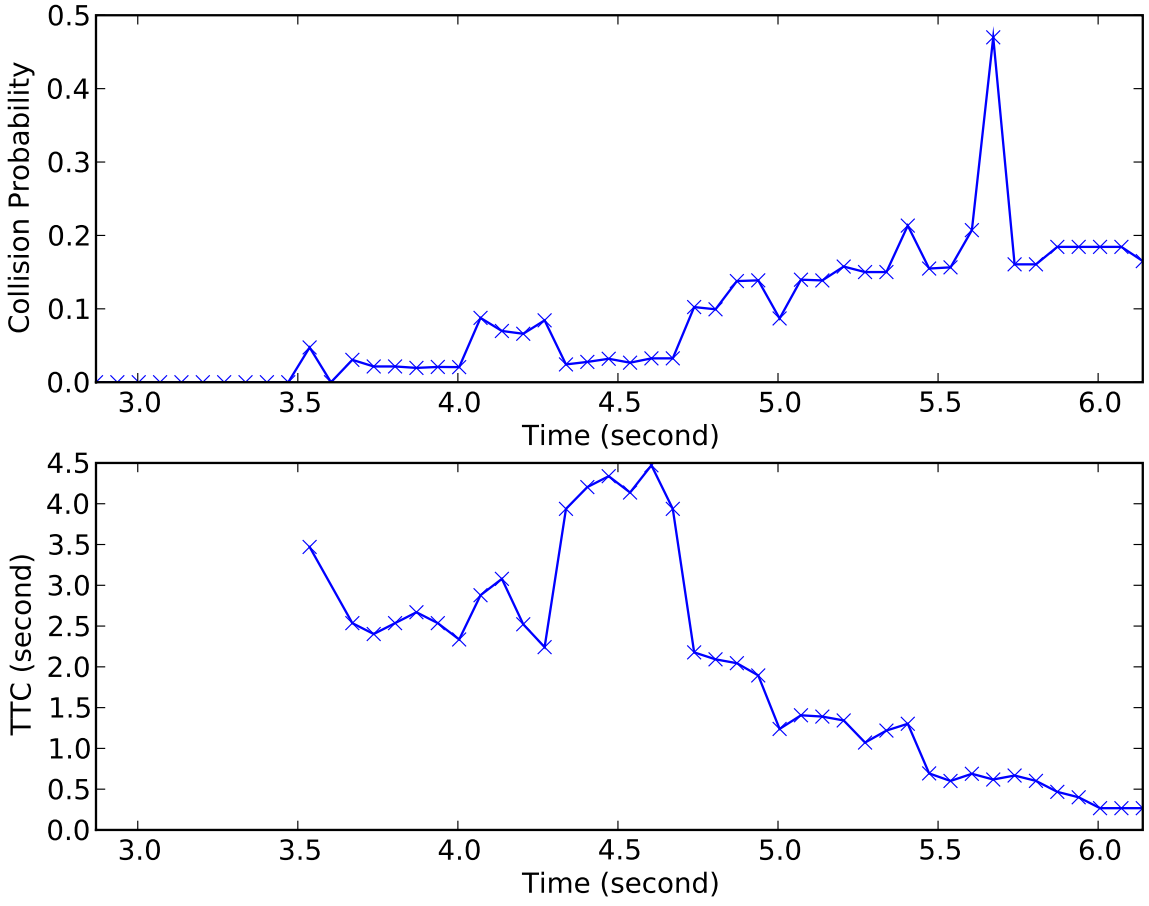
Motion Prediction



Motion Prediction

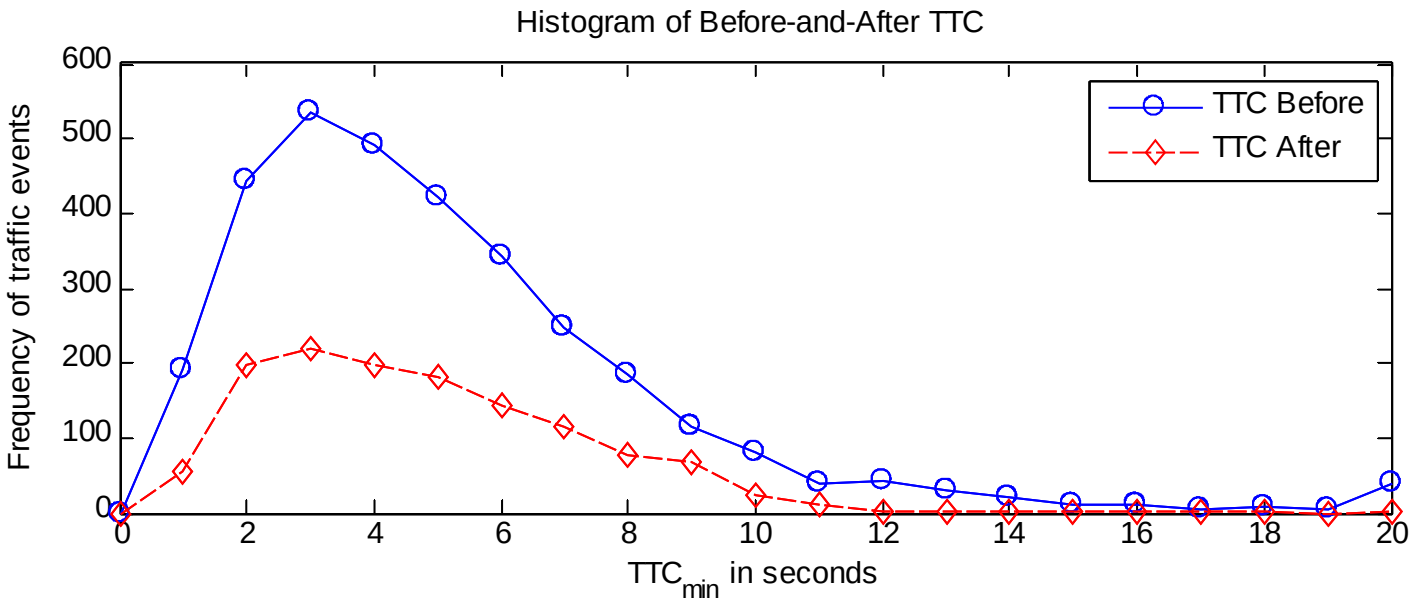


The Severity Indicators



Parallel collision, Kentucky dataset

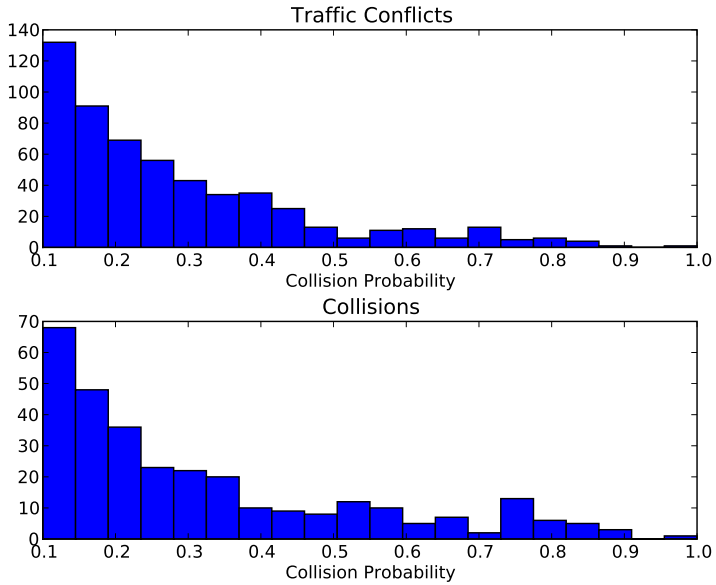
Distribution of Severity Indicators



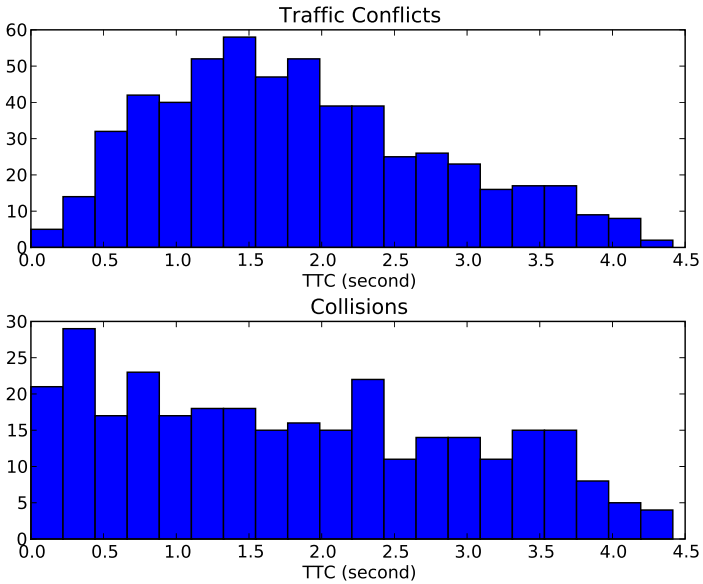
Before and after study, Oakland, CA.

Distribution of Severity Indicators (2)

Maximum Collision Probability

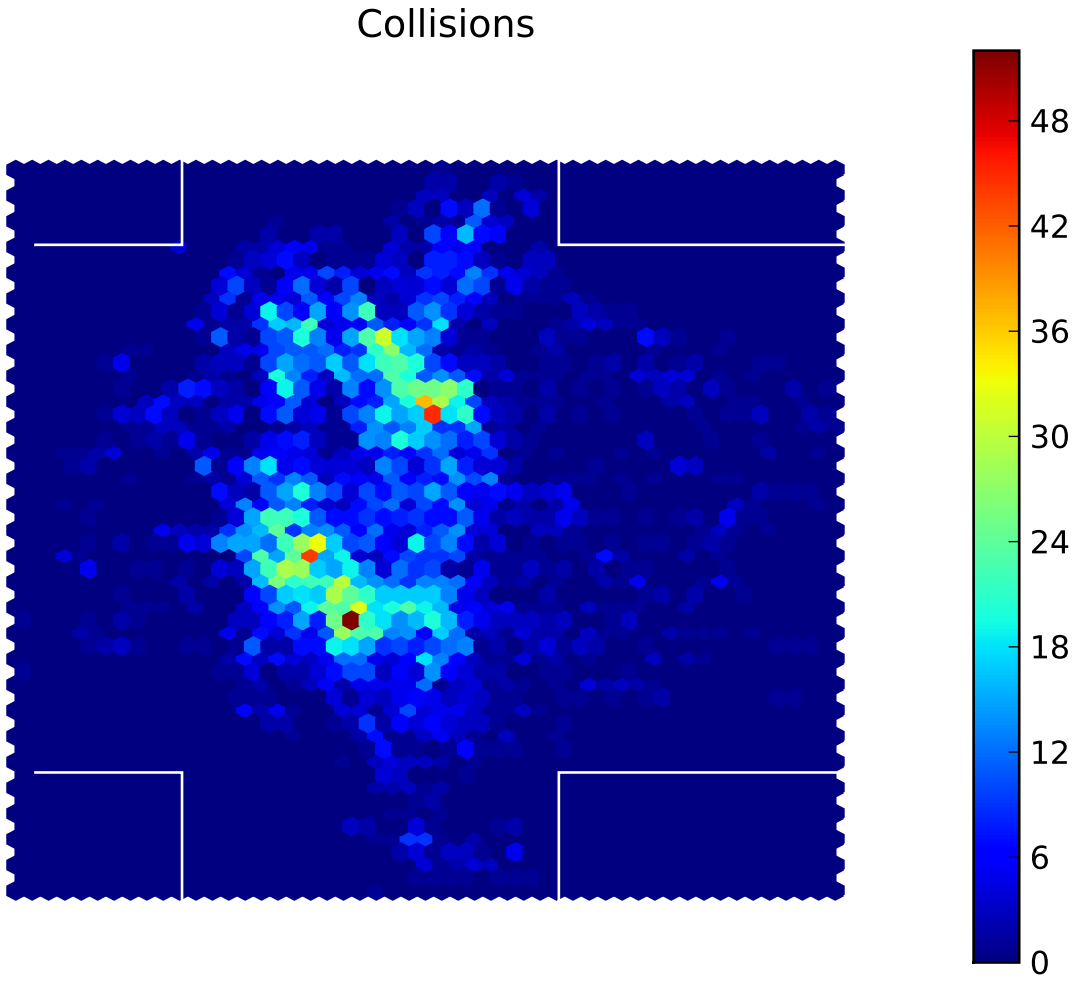


Minimum TTC



Kentucky dataset.

Spatial Distribution of the Collision Points



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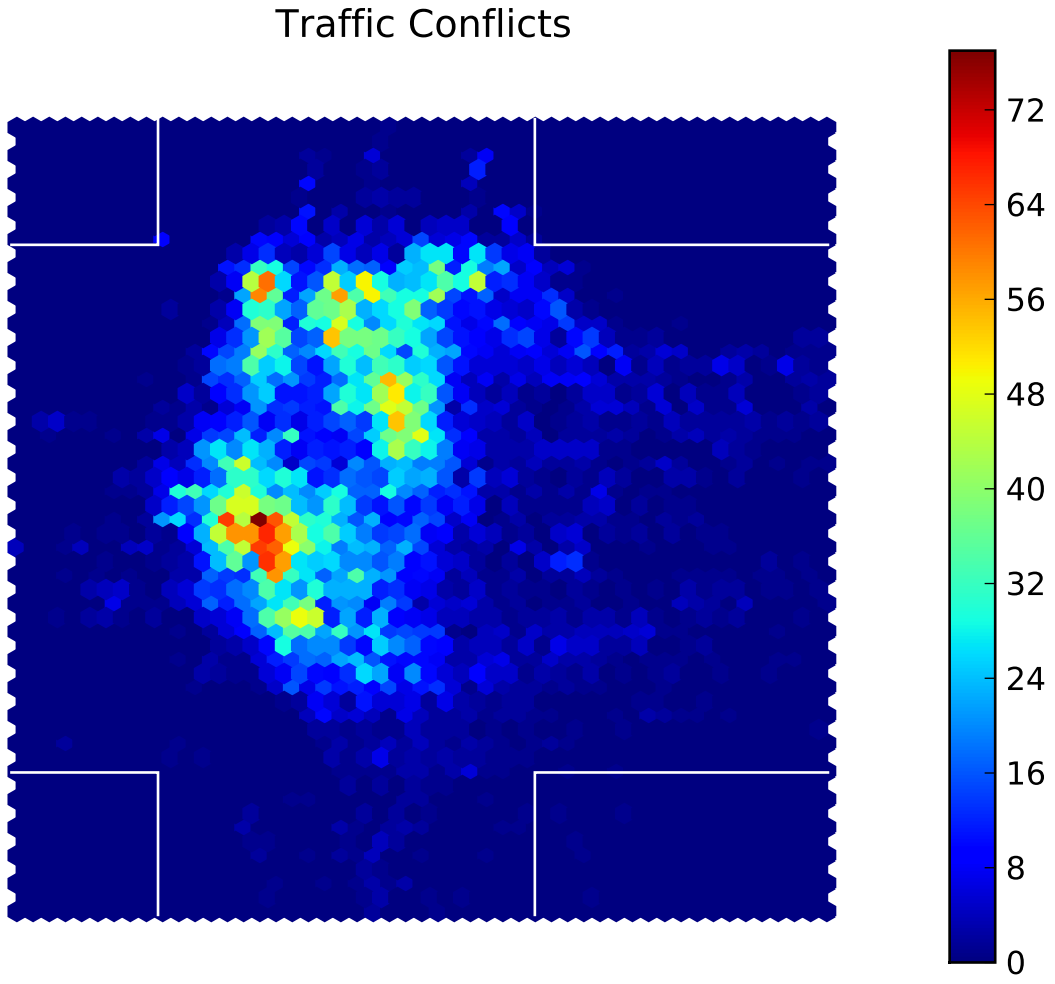

Kentucky dataset.

Conclusion

- Tools and framework for automated road safety analysis using video sensors
- Data mining and visualization for safety analysis
- Future work:
  - Validation of proactive methods for road safety analysis (Clark Lim and Tarek Sayed at UBC)
  - Understanding and modelling of the mechanisms that lead to accidents (École Polytechnique de Montréal)
- Need for more open science: data and code sharing

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Questions ?


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