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COLLISION AVOIDANCE DYNAMICS AMONG HETEROGENEOUS AGENTS: THE CASE OF PEDESTRIAN/VEHICLE INTERACTIONS

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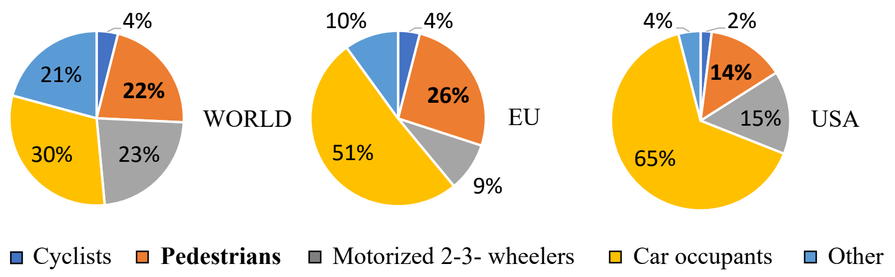
1. INTRODUCTION

As shown by the WHO [6], 1.2 million people are killed on roads every year. **Pedestrian fatalities** corresponds to 22% of the overall traffic victims.



Pedestrian-car accidents are caused by:

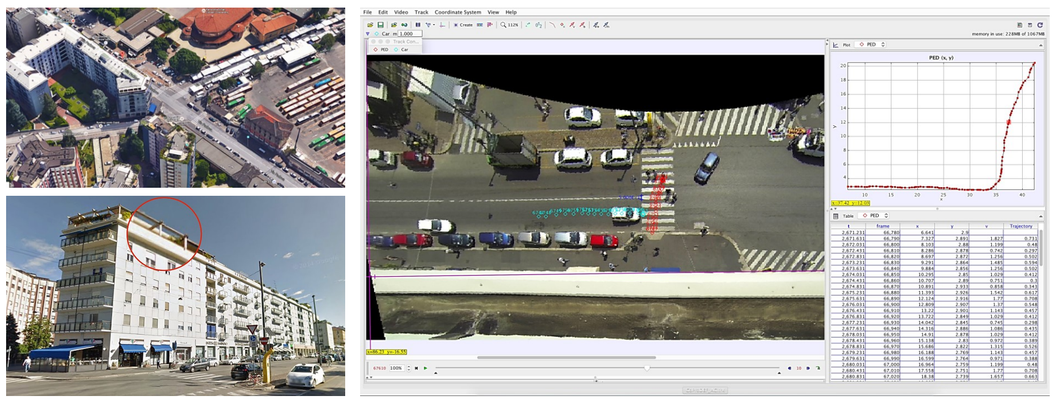
- Non-compliance to traffic laws;
- Environmental factors (e.g., traffic volumes, cross-walk location);
- Perceptive and attentional skills;
- Attitude and sense of control towards hazardous situations.

Computer-based simulations of urban traffic [3, 5] can support to the activity of engineers and planners in the design of efficient and safe transportation networks.

In this work we present a novel simulation model that allows simulating pedestrian/vehicle interactions at non-signalized intersections. The model is designed according to the results of a video-recorded observation [4].

2. DATA COLLECTION

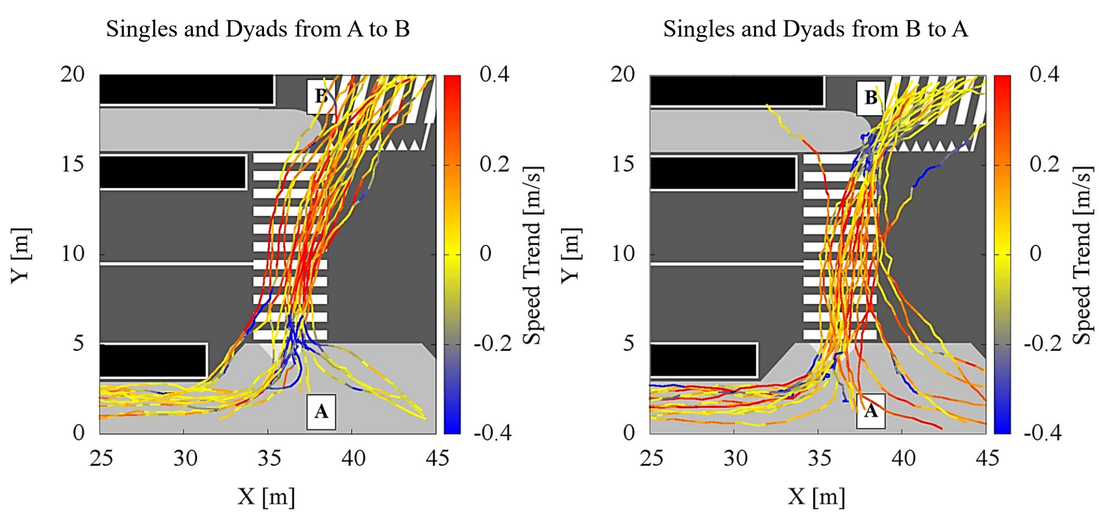
The observation was performed in 2015 at a non-signalized intersection in Milan (Italy), characterised by a high number of pedestrian/car accidents in the past years.



- 1379 vehicles, 18.890 veh/min, 67% cars, 33% other;
- 585 pedestrians, 8.013 ped/min, 65% singles, 26% dyads, 9% other;
- LOS at TWSC non-signalized intersections: LOS A.

Type of pedestrian/vehicle interactions	Compliant	Non-compliant
Pedestrians from the near side-walk	191 (46.14%)	223 (53.86%)
Pedestrians from the far side-walk	230 (57.69%)	168 (42.21%)

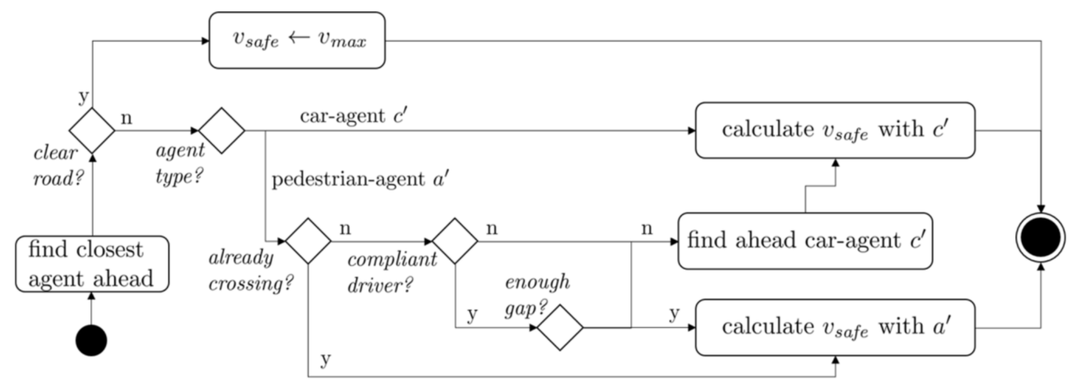
Video-tracking Analysis on pedestrians' speed:



- **Approaching**: the pedestrian travels on the side-walk with a stable speed (Speed MA – CA $\in [-\epsilon;\ +\epsilon]$);
- **Appraising**: the pedestrian approaching the cross-walk decelerates to evaluate the safety gap (Speed MA - CA $< -\epsilon$);
- **Crossing**: the pedestrian decides to cross and speed up (Speed min).

3. MODEL

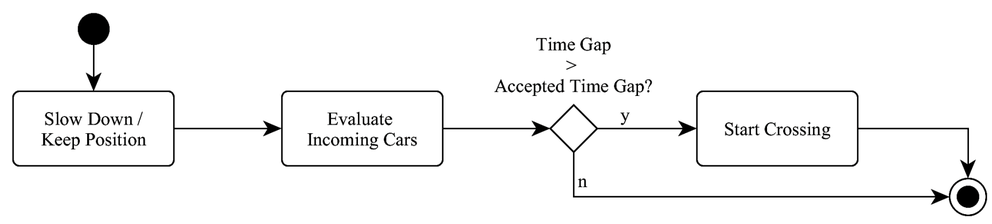
The model [1] simulates non-signalized cross-walks by means of heterogeneous agents, namely **pedestrians** and **vehicles**, moving in different environments (continuous and 1-dimensional for cars; discrete and 2-dimensional for pedestrians). Agents share the necessary information for managing their interactions.



The motion of cars is an extension of the Gipps's model [2], in which the speed of each vehicle is updated considering, firstly, internal parameters of the agent:

- Maximum acceleration a for each time-step of the simulation;
- Maximum breaking capabilities, which determines v_{safe};
- Speed limit of the road v_{max}.

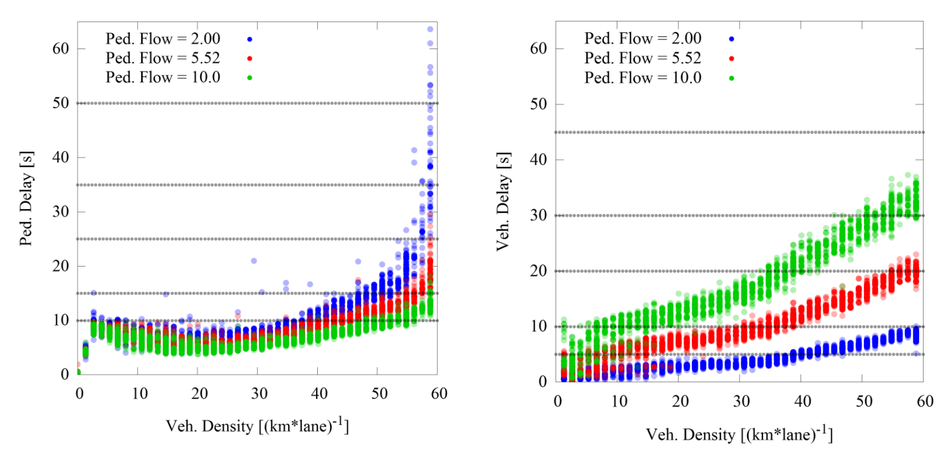
In case of pedestrian/car interactions, car-agents can be also non compliant according to a probability of 0.5 (according to the field observation).



Pedestrians behaviour is founded on the concept of *time gap*, which describes the time needed by the incoming car-agent c_i to reach the pedestrian-agent position, considering the current speed v_{c_i}.

4. RESULTS

We consider four situations associated to different pedestrian crossing ratios: (i) 0 ped/min, (ii) 2 ped/min, (iii) 5.52 ped/min (according to the field observation) and (iv) 10 ped/min. In all cases the speed limit was set to 35 km/h, based on the empirically observed velocities (despite the limit of 50 km/h).



Results highlights the **LOS** of the cross-walk, for either pedestrians and vehicles, resulting from the simulation of each configured scenario.

- Increase of vehicular traffic → worsening of pedestrian and vehicle LOS.
- Increase of pedestrian crossing ratio (• • •):
  - → platooning of pedestrians;
  - → improvement of pedestrian LOS;
  - → worsening of vehicle LOS.

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