UNIVERSITY OF LEEDS
Institute for Transport Studies (ITS)

COMPUTATIONAL VEHICLE/PEDESTRIAN INTERACTION MODELS

ESR 13 - Amir Hossein Kalantari

Supervisors

Prof Gustav Markkula

Prof Natasha Merat

Prof Marco Dozza

04 Oct 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement 860410

Objectives

- Employ game-theoretic (GT) models to see how pedestrians interact with vehicles (AVs) in different crossing scenarios.

✓ Identifying the proper modelling candidates to build a computational framework.

✓ Planning, designing and conducting a controlled study using human-in-the-loop simulated environments to provide validation tools for game-theoretic models.

✓ Planning and conducting a naturalistic study.

❑ Comparing the findings of the controlled study with the naturalistic data and using both datasets to improve the computational framework performance.

Overview

Study 1
- A distributed simulator study (DSSd) (desktop driving sim + HIKER)
- A GT model fit to the existing dataset

→ TRB conference paper

Study 2 → A DSS (UoLDS + HIKER) → One paper under review; One in prep

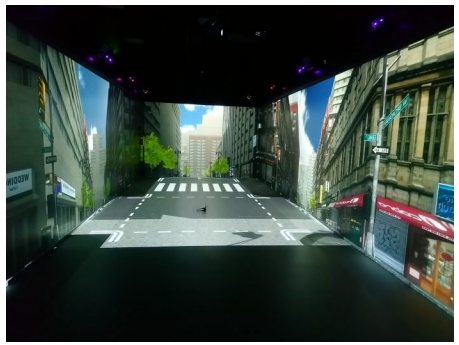
Study 3 → A Naturalistic study → Secondment @ Viscando + Chalmers

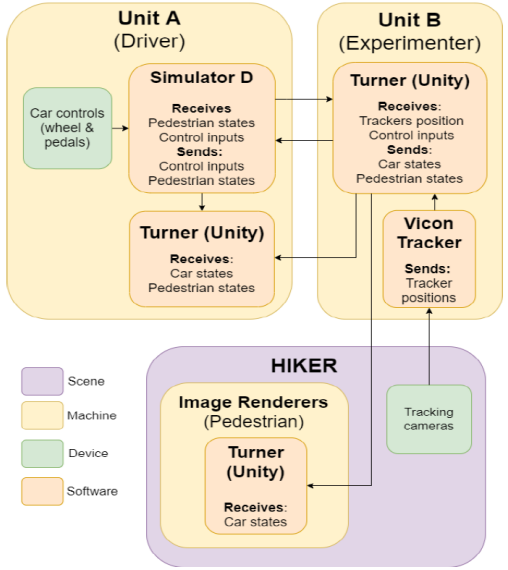
Modelling
- Identifying and extending a GT model from the literature: Wu et al.
- Fitting the model to two datasets (DSSd, DSS)
- Combining a conventional GT + behavioural GT

→ New comp framework

Study 2: DSS

UNIVERSITY OF LEEDS
Institute for Transport Studies (ITS)

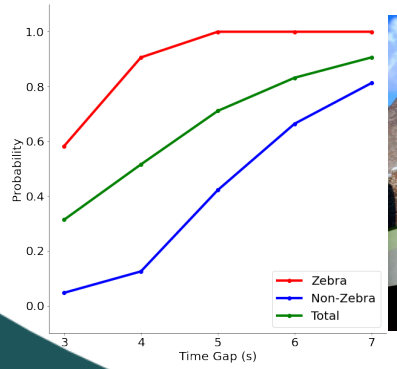


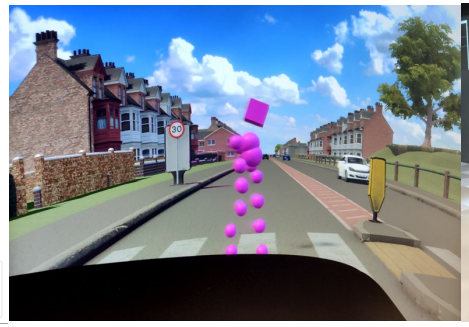


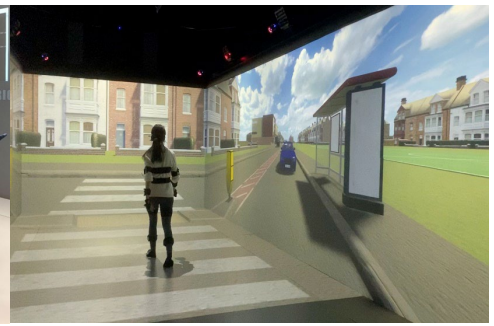
Gender Pairs		Driver: *M = 31.53, R = 21-50, SD = 1.72*	
		Female	Male
Pedestrian:	F	8	8
M = 25.09	M	8	8
R = 19-34			
SD = 0.87			

- **Time gap (3-7 s)**
- **Crossing location type (Non zebra, Zebra)**
- Social Value Orientation
- *Sensation-Seeking*
- *Total Waiting time*
- *Demographics*
- *Subjective evaluation*

Interaction outcome







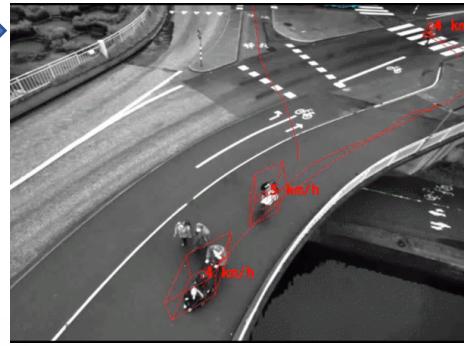
Kalantari, A. H., Yang, Y., Garcia, J., Lee, Y., Horrobin, A., Solernou, A., … Markkula, G. (2022, August). Who goes first? A distributed simulator study of vehicle-pedestrian interaction. https://doi.org/10.31234/osf.io/3ypkd

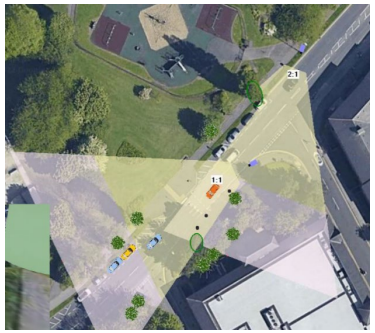
Study 3: Naturalistic data

viscando™ Leeds CITY COUNCIL

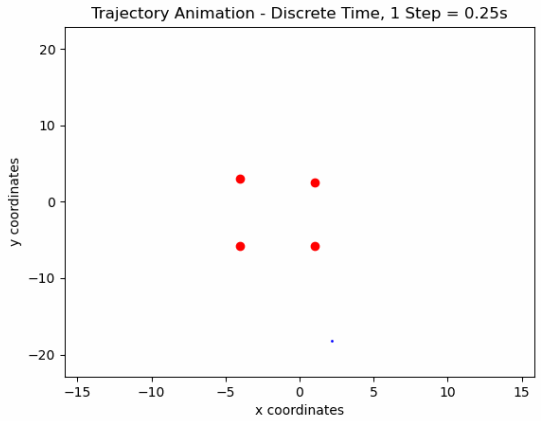
UNIVERSITY OF LEEDS
Institute for Transport Studies (ITS)

Preliminary observation & selection





Data curation and algorithm for detecting 1-1 interactions



- TTA
- Waiting time
- Demographics
- Crossing type (staggered zebra vs zebra vs midblock)
- Crossing duration
- Vehicle-ped spatial distance
- Other metrics (PET, etc.)

SHAPE-IT

Computational framework

UNIVERSITY OF LEEDS
Institute for Transport Studies (ITS)

Conventional GT

Wu et al. Model

	Pedestrian cross	Pedestrian wait
Vehicle pass	$-\mathrm{k} - \mathrm{act}_1,\ -\mathrm{k} - \mathrm{act}_2$	$k + \mathrm{at}_1,\ \mathrm{k} - \mathrm{at}_2$
Vehicle wait	$\mathrm{k} - \mathrm{at}_1,\ \mathrm{k} + \mathrm{at}_2$	$\mathrm{k} - \mathrm{at}_1,\ \mathrm{k} - \mathrm{at}_2$

	Pedestrian cross	Pedestrian wait
Vehicle pass	$-\mathrm{k(n)} - \mathrm{act}_1,\ -\mathrm{k\,(n)} - \mathrm{act}_2$	$\pm k(n) + \mathrm{at}_1, -\mathrm{a}(t_1 + t_2)$
Vehicle wait	$-\mathrm{a}(t_1 + t_2), \pm\mathrm{k(n)} + \mathrm{at}_1$	$-amt_1, -amt_2$

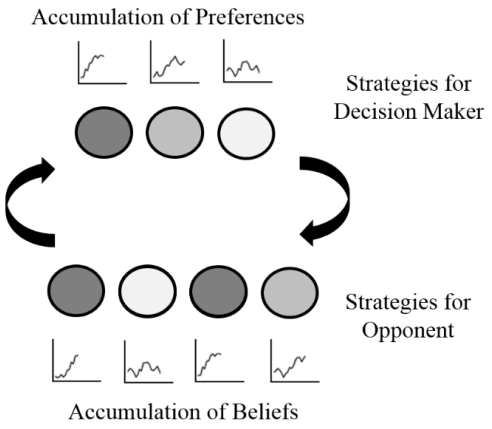
SVO-extended

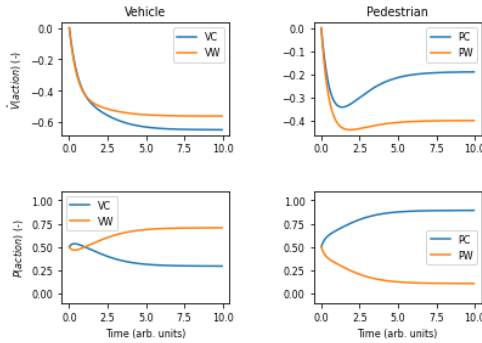
*Wu, W., Chen, R., Jia, H., Li, Y. and Liang, Z. (2019). Game theory modeling for vehicle–pedestrian interactions and simulation based on cellular automata. International Journal of Modern Physics C, **30**(04), pp.1-21.*

Stochastic Sampling

Behavioural GT

The Dual Accumulator Model





Golman, R., Bhatia, S., & Kane, P. B. (2020). The dual accumulator model of strategic deliberation and decision making. Psychological review, 127(4), 477.

SHAPE-IT

Conclusions

- DSSd could generate a gap acceptance dataset with respect to both AV and HD conditions that is close to the reality.
- DSS could simulate scenarios where traffic agents interactively communicate with each other, demonstrating behaviours that are qualitatively in line with those observed in naturalistic studies.
- Our findings showed that kinematic cues, including vehicle speed and time gap, had a stronger influence on pedestrians' crossing behaviours at unmarked crossings, than personality traits such as AISS and SVO.
- Both SVO-extended and revised GT models outperformed the original model regarding both aggregate and individual data.

Thank You!

A.H.Kalantari@leeds.ac.uk