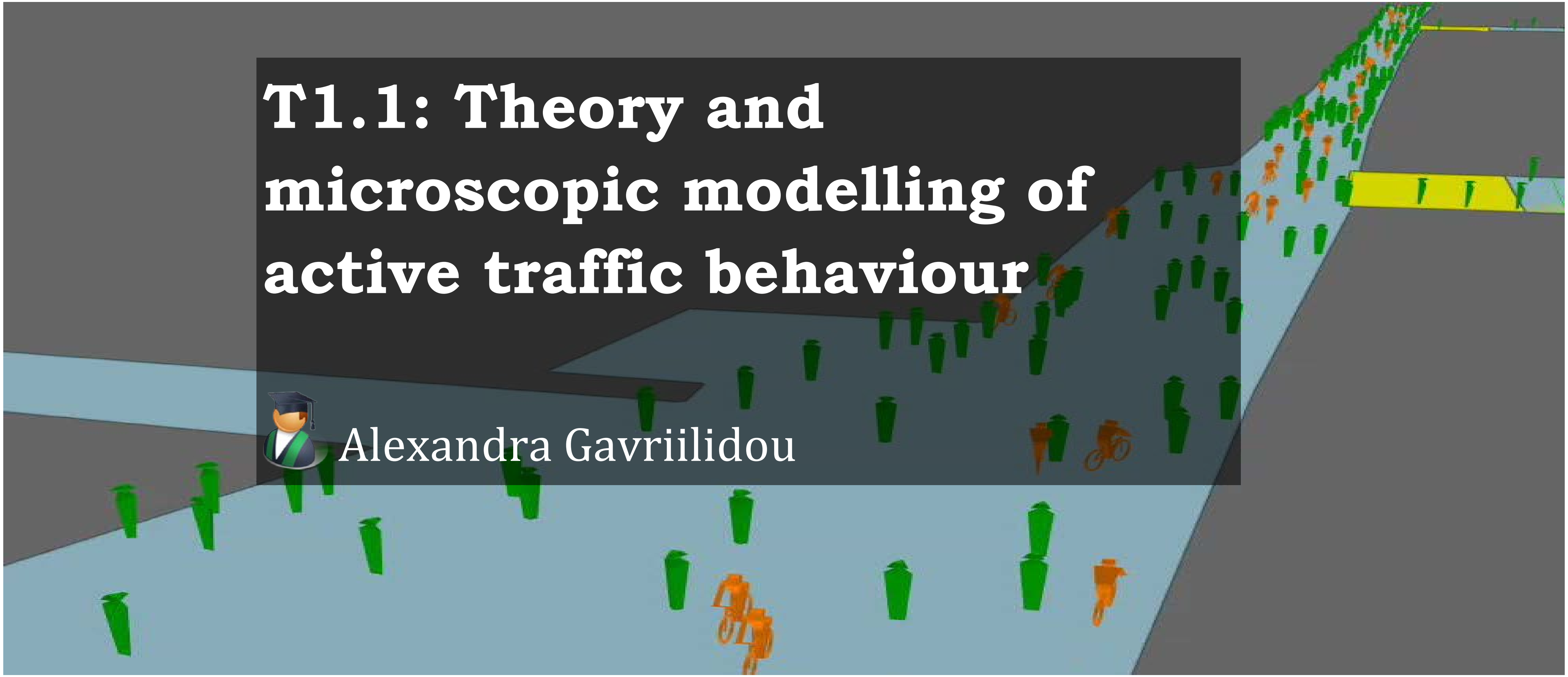
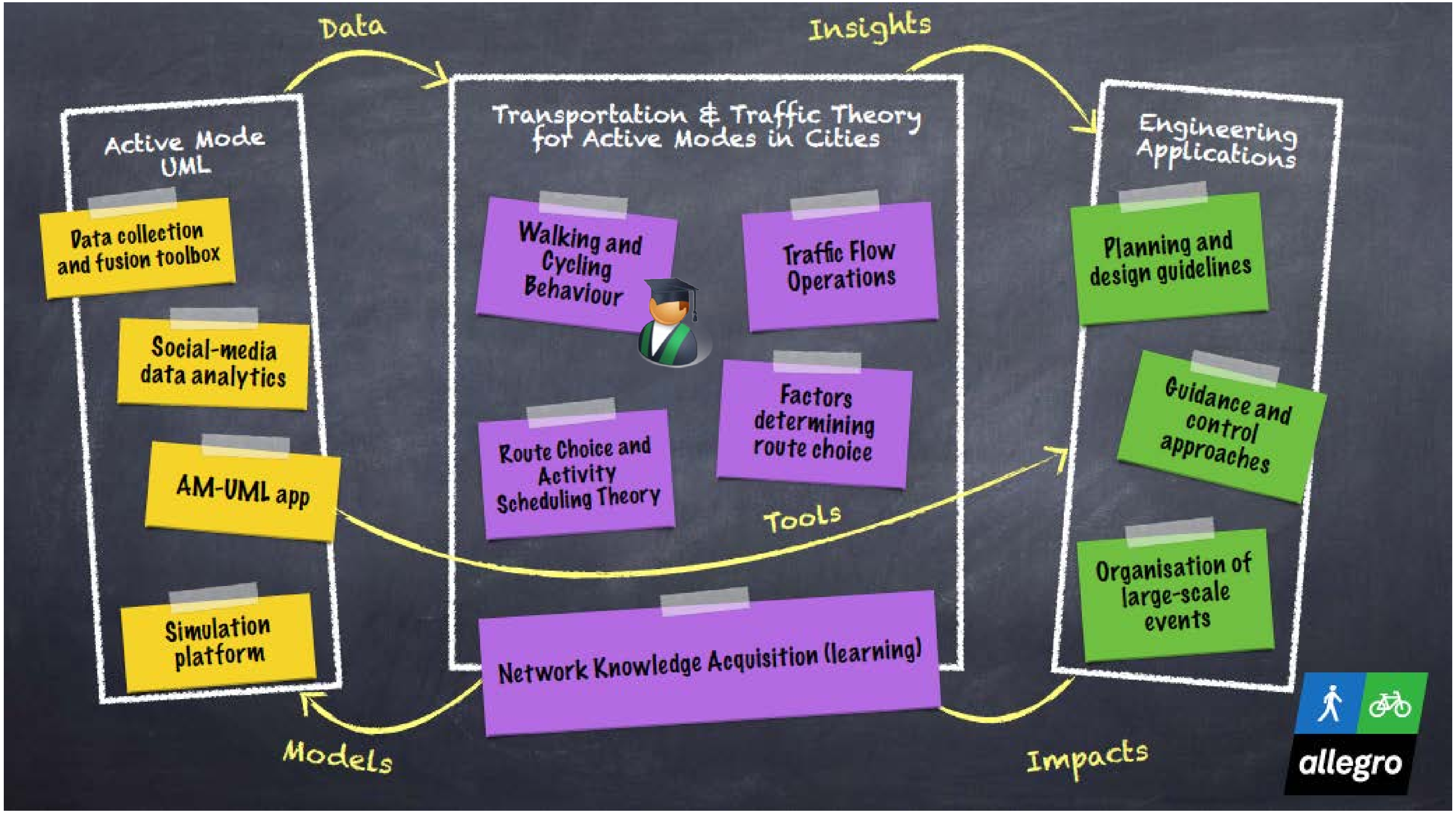


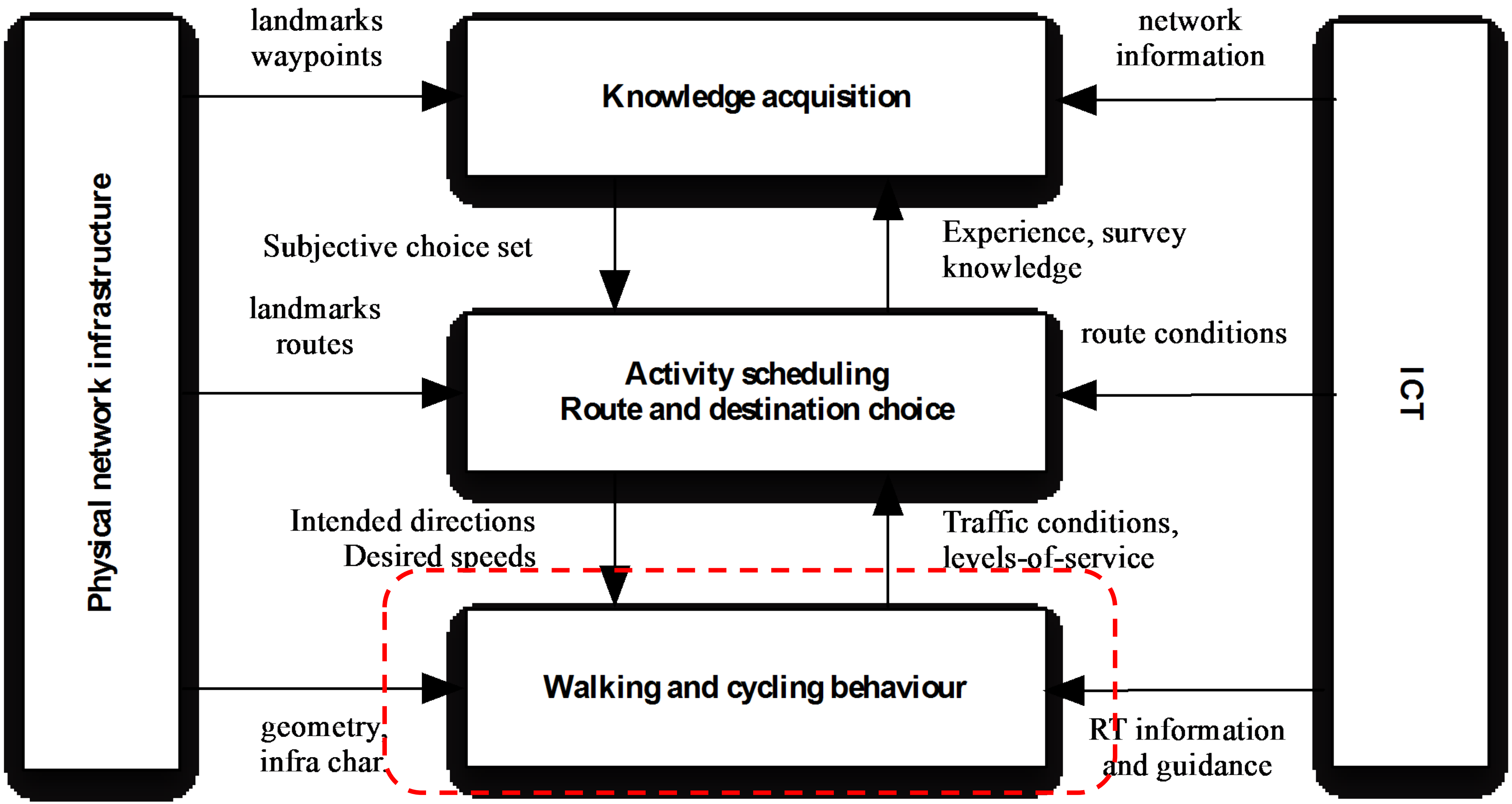
T1.1: Theory and microscopic modelling of active traffic behaviour

Alexandra Gavriilidou

Positioning T1.1 in ALLEGRO



Behavioural levels



Objective

- Understanding and modeling individual walking and cycling behavior, involving the interactions with infrastructure and other traffic participants

active mode traffic operations …involving:

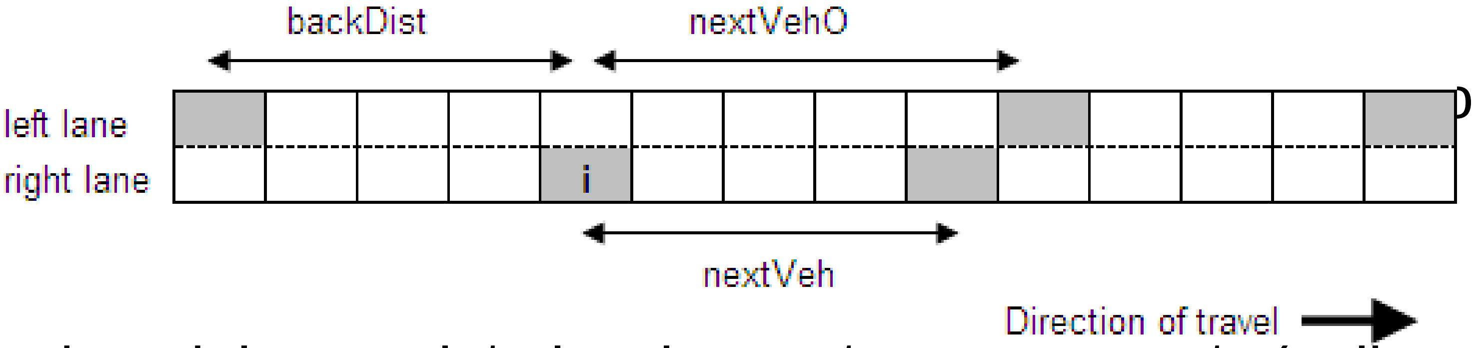
- the *split second* decisions
- *motion and interaction*
- *tactical choices* people make based on observed traffic conditions

Research questions

- Which are the main behavioral hypotheses that underlie the split-second decision making of pedestrians and cyclists?
- What characterizes the interactions between pedestrians and cyclists? What are the key (social) drivers describing these interactions?
- Which mathematical constructs can be used to formalize this theory (e.g. game theory)?
- What is the predictive validity of such a model? That is: to what extent can microscopic walking or cycling behavior be predicted?

Mathematical modelling approaches and simulation

- In the last few decades several streams of microscopic and mesoscopic walker models have been developed:
  - Cellular Automata: describe the movement of agents through a simulated environment using a discrete representation of both space and time.
  - Social Force orce-based interactions



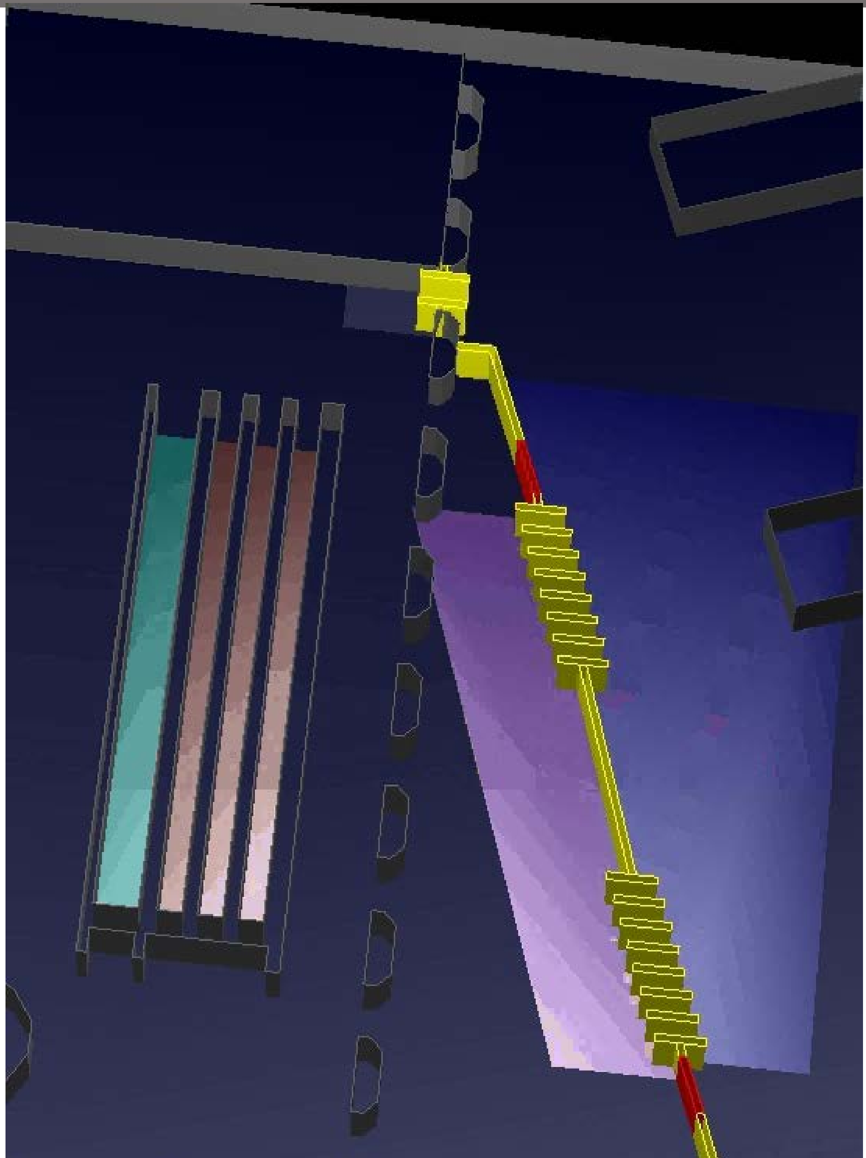
  - Velocity-based models: simulate local operative movements (collision avoidance) by means of the optimization of time to collision with other pedestrians and objects at any point in time.

Nomad: application of differential game theory

- Pedestrians minimise **predicted walking cost (effort)**, due to straying from intended path, being too close to others / obstacles and effort, yielding:

$$\vec{a}_i = \frac{\vec{v}_i^0 - \vec{v}_i}{\tau_i} - A_i \sum_j \exp\left[-\frac{R_{ij}}{B_i}\right] \cdot \vec{n}_{ij} \cdot \left(\lambda_i + (1-\lambda_i)\frac{1+\cos\phi_{ij}}{2}\right)$$

- This simplified model is similar to Social Forces model of Helbing
- Model results in reasonable macroscopic flow characteristics (capacity values and fundamental diagram) as well as sell organisation



Optimal control cyclist model

Find the control where cycling behaviour is desired, and preferable optimal

Identify cycling ‘costs’

- Straying from the optimal path

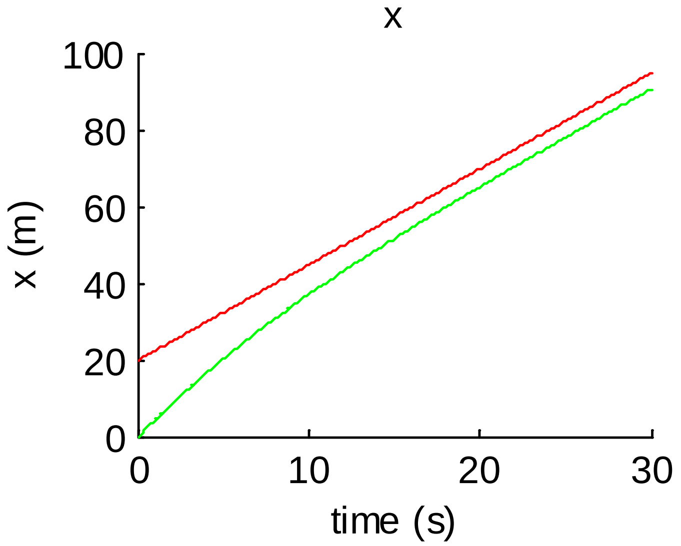
$$L^{stray} = \frac{1}{2} c_1^{v} (v_c - v_0)^2 + \frac{1}{2} c_1^{\varphi} (\varphi_c - \varphi_0)^2$$

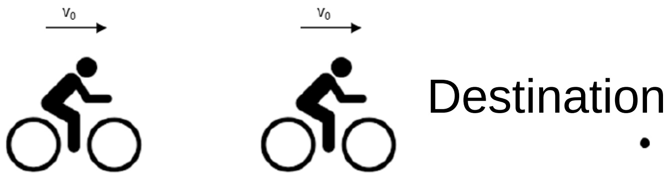
- Maintain current speed and cycling direction

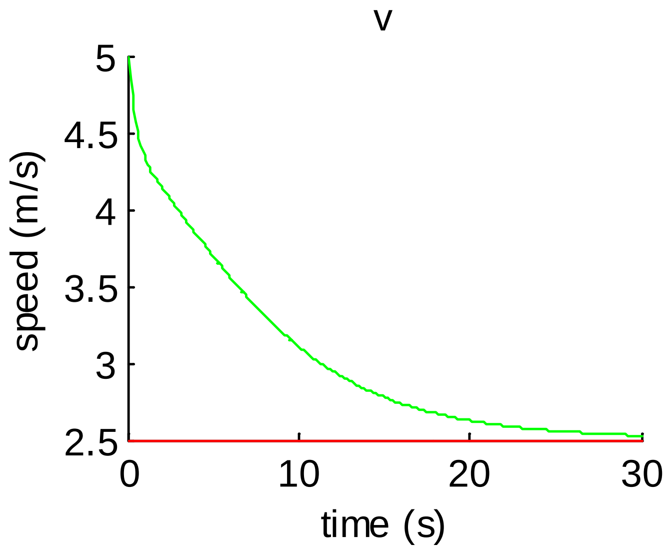
$$L^{eff} = \frac{1}{2} (c_2^{a} a^2 - c_2^{\omega} \omega^2)$$

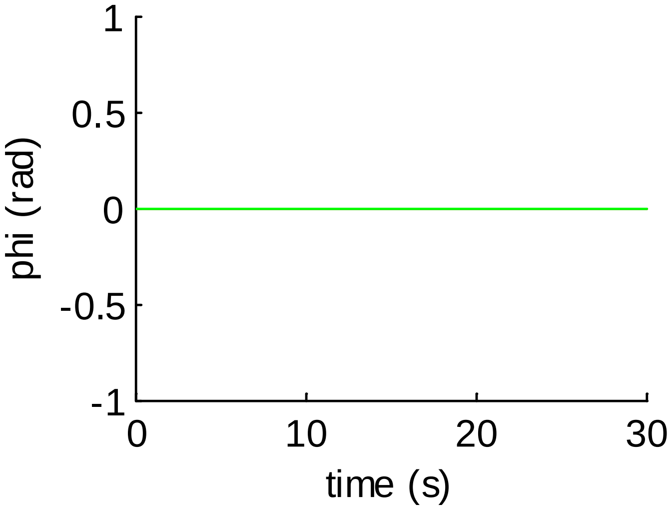
- Proximity costs

$$L^{prox} = c_3 \sum_b exp\left(-\frac{\|\vec{r_c} - \vec{r_b}\|}{v_c \cdot R_0}\right)$$



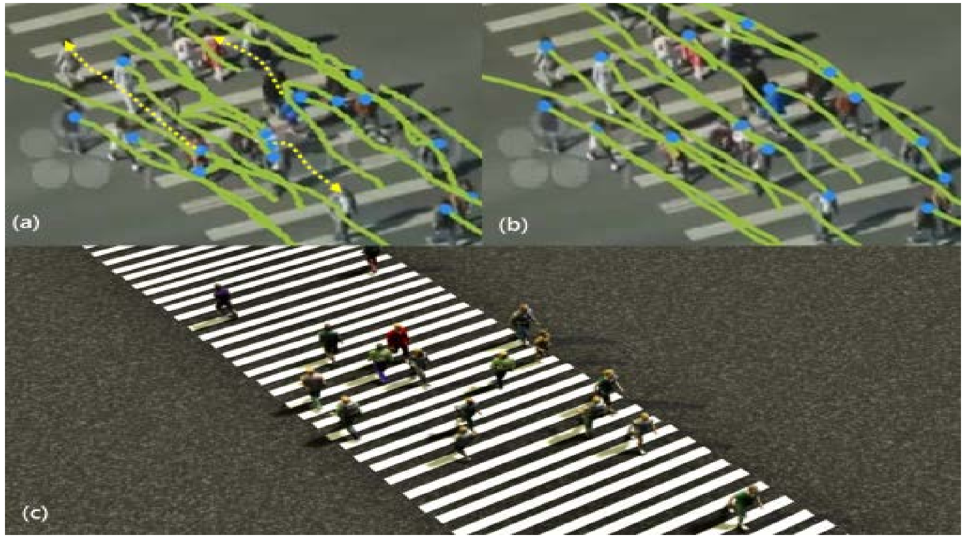


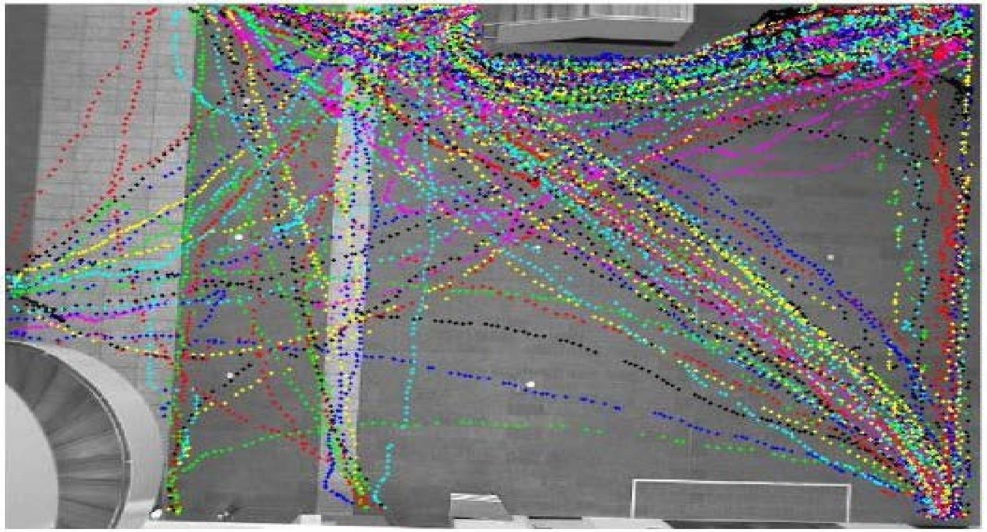




Data needs

- Detailed trajectory data
- Infrastructure characteristics
- Pedestrians and cyclists’ characteristics
- Traffic flows and counts
- Environmental characteristics





Questions