Single-file Pedestrian Dynamics with Follower Interactions

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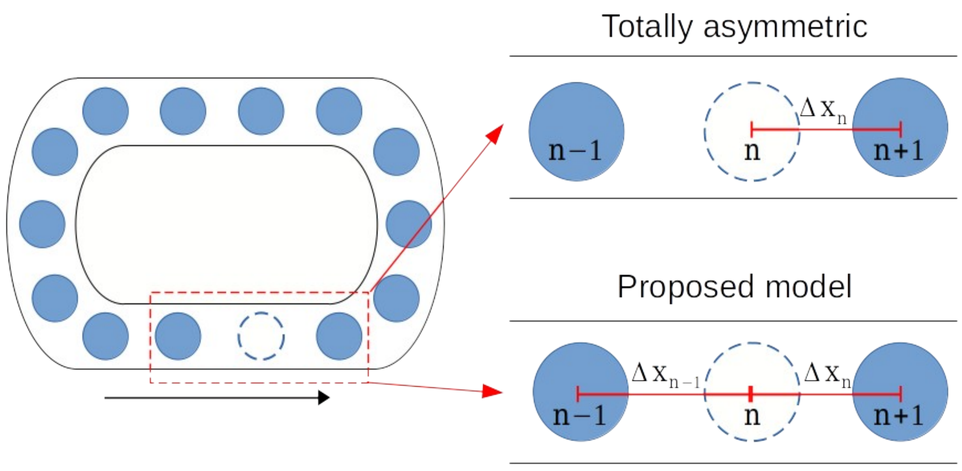
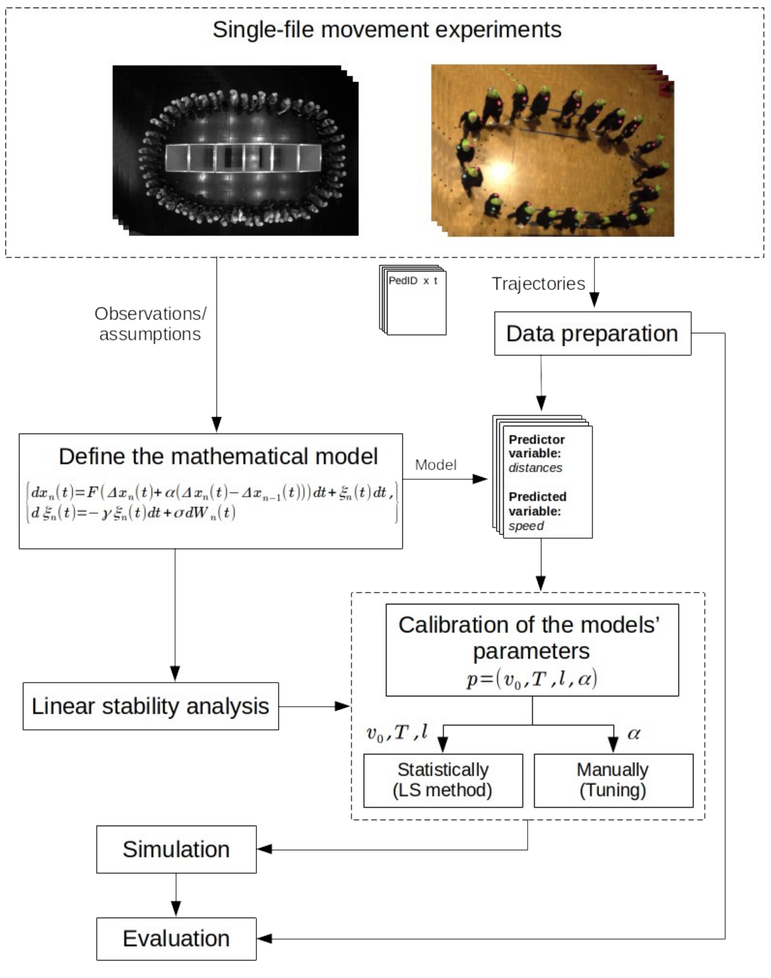
Introduction and Motivation

- We present a microscopic stochastic speed model for single-file motion that takes into account the distance with the follower in the interaction.
- Existing pedestrian models which are generally totally asymmetric have problems with overlap (collision) and backward movement [1, 2].
- Introducing the distance behind into the interaction enhance the dynamics and describe more realistic stop-and-go waves.
- The modeling approach is motivated by car-following models presenting stability improvement when the vehicle behind is taken into consideration [3], pedestrian collective coordination in single-file movements [4], and statistical analysis using algorithms devoid of bias (feed-forward neural networks) [5].



Methodology



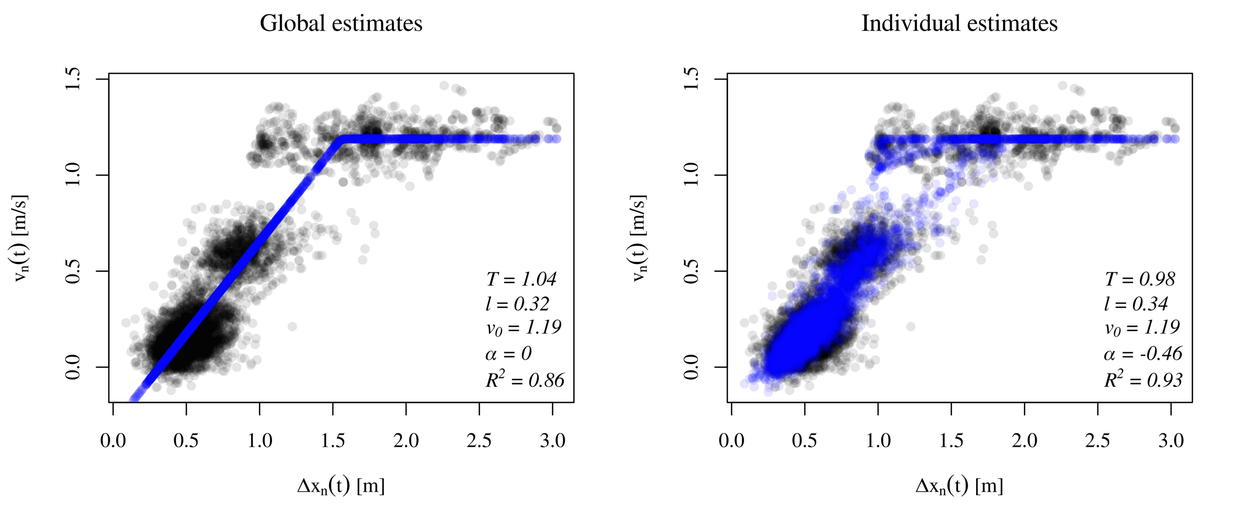
Proposed Model

- First-order optimal velocity model depending on a combination of the distances ahead and behind.
- Additive stochastic noise based on the Ornstein-Uhlenbeck process.

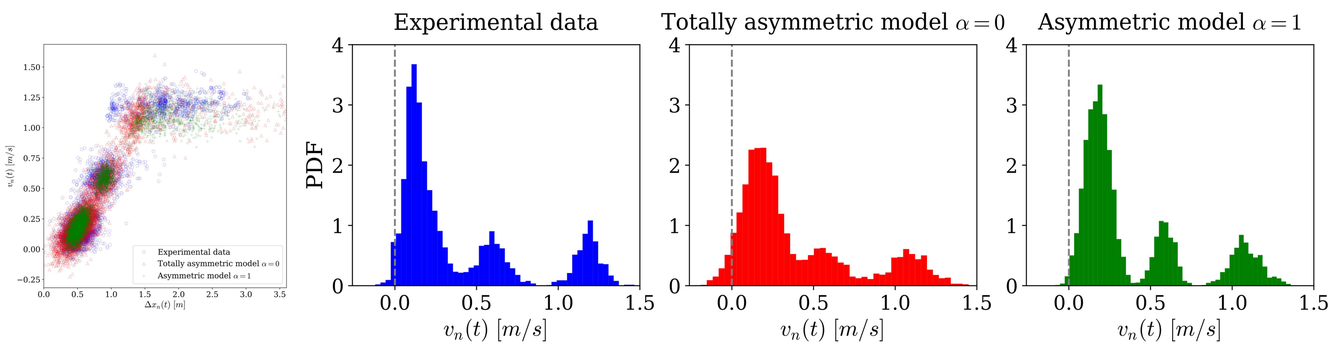
$$\begin{cases} dx_n(t) = F\big(\Delta x_n(t) + \alpha\big(\Delta x_n(t) - \Delta x_{n-1}(t)\big)\big)\,dt + \xi_n(t)\,dt\,, \\ d\xi_n(t) = -\gamma\,\xi_n(t)\,dt + \sigma\,dW_n(t) \end{cases}$$

Parameter Calibrations

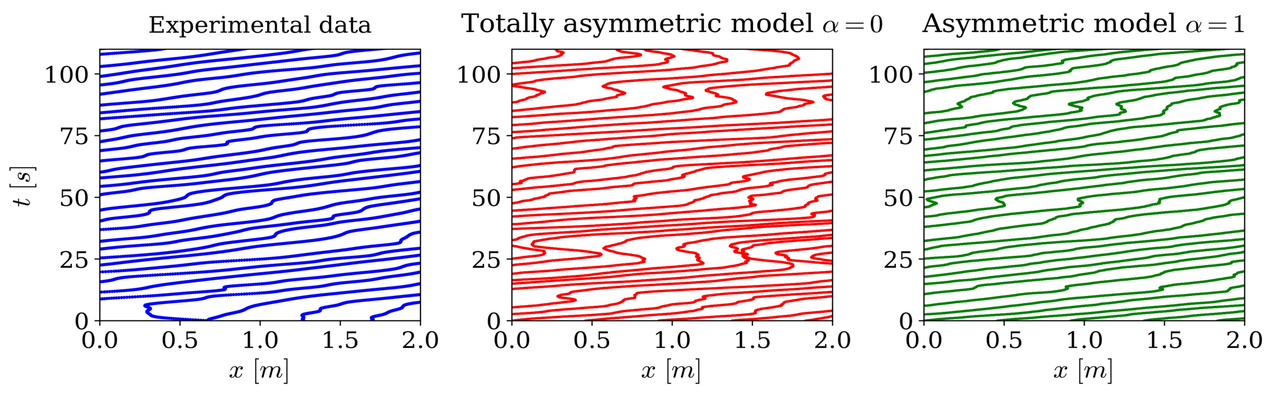
- **Statistically:** using experimental data and least square methods.
- **Manually:** manually tuning the parameters using simulations.



Simulation Results and Discussion



- The asymmetric model better shapes the data points than the totally asymmetric modes.
- The speed distribution is more realistically estimated in comparison to the totally asymmetric model.



- The simulated trajectories from the proposed model show less backward movement compared to the totally asymmetric models.

References:

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