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Distance vs time-to-collision pedestrian models: verification and validation

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Abstract.

A recent study inferred from a large collection of experimental data that the interaction between agents is better described in terms of the *time-to-collision* than the *distance*. The pair distribution of the distances, i.e. the probability of two agents to have a certain distance, was found to strongly depend on the relative velocity, whereas the time-to-collision accurately parametrizes its pair distribution. In this work, the difference between these underlying quantities is investigated, by following a modelling approach. Two minimal first-order models are proposed; one based on the time-to-collision and the other one on the distance. The responses of a uni-directional stream of pedestrians to an obstacle are qualitatively different for the two models (see the figures). In the distance-based model, the agents move towards the obstacles and avoid the collision by moving to the sides. The region behind the obstacle is depleted. The other crowd is more irregular and adapts to the obstacle by leaving a low density corridor at the level of the obstacle. The agents do not interact with the obstacle in the steady-state. A similar setup is often used to investigate viscous fluids or granular matter but experiments with pedestrians have been conducted as well. The results showed a strong difference between pedestrians and granular systems, especially regarding the existence of anticipation strategies. Based on a comparison to experimental data, we identify further indications whether crowds are better described in terms of the distance or the time-to-collision.

***Keywords*: modelling, time to collision, minimal model, fundamental diagram, verification and validation, anticipation**

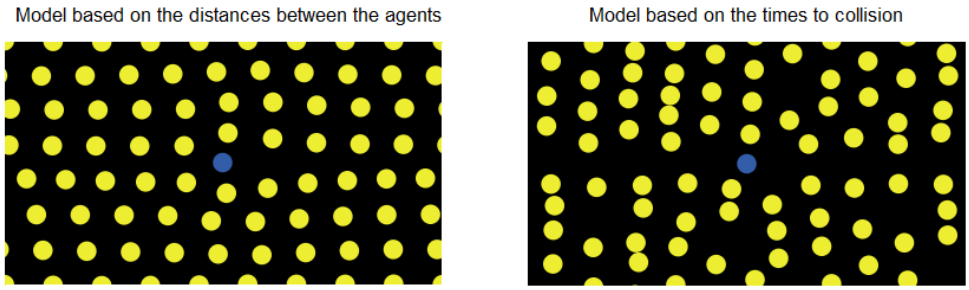

Figure: Screenshots of the dynamics obtained in presence of an obstacle using the model based on the distances between the agents (left panel) and the model based on the times to collision (right panel)