Probabilistic Map-based Pedestrian Motion Prediction Taking Traffic Participants into Consideration

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Motivation

Predicting different behaviors of pedestrians by considering constraints.

Constraints:

- Intrinsic transition model.
- Semantic map (goal-oriented prediction).
- Dynamic environments (collision check).

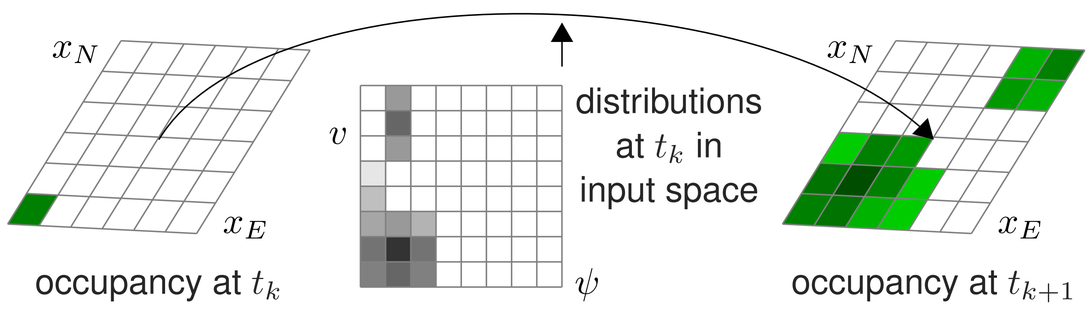
Basic Idea

Offline computations: Abstract continuous dynamic model by Markov chains

$$\dot{x}_E = v\cos\psi,\ \dot{x}_N = v\sin\psi \ \rightarrow\ p\left(t_{k+1}\right) = \Phi p\left(t_k\right).$$

Online computations: Compute the probability distributions of the inputs velocity and orientation by considering constraints recursively.

Example: Propagation of one cell of the occupancy grid:



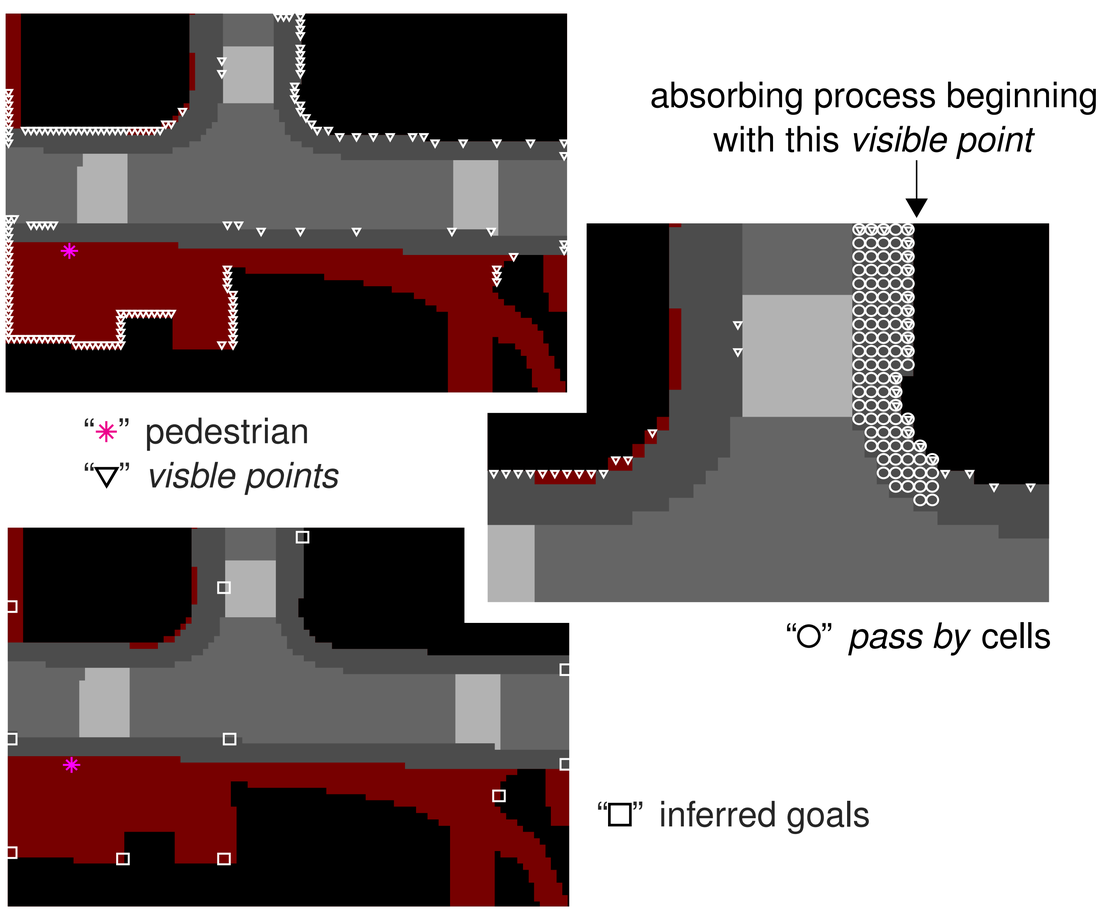
Goal-oriented Prediction

Controlling the transition of the input orientation in a more rational direction regarding a semantic map.

Procedure:

1. Determine the positions of potential goals of a pedestrian.
2. Derive stochastic policies for the orientation related to each goal.
3. Compute the a posteriori probabilities of inferred goals by leveraging the past trajectory of the tracked pedestrian using Bayes' rule.

Example: Determing the positions of potential goals:

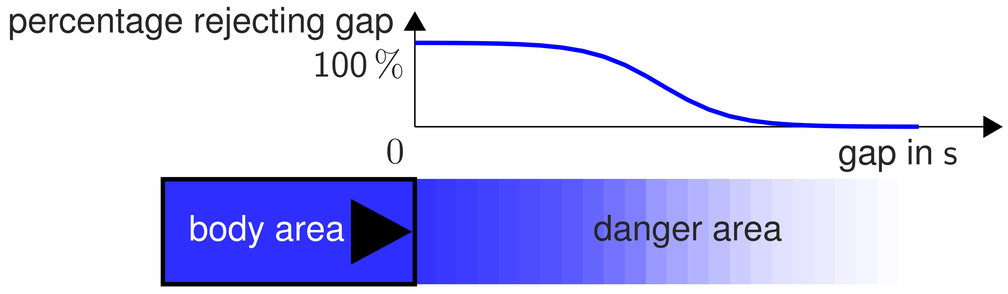


Collision Check

Adapting the motion prediction of pedestrians by evaluating their collision probability with other traffic participants.

Procedure:

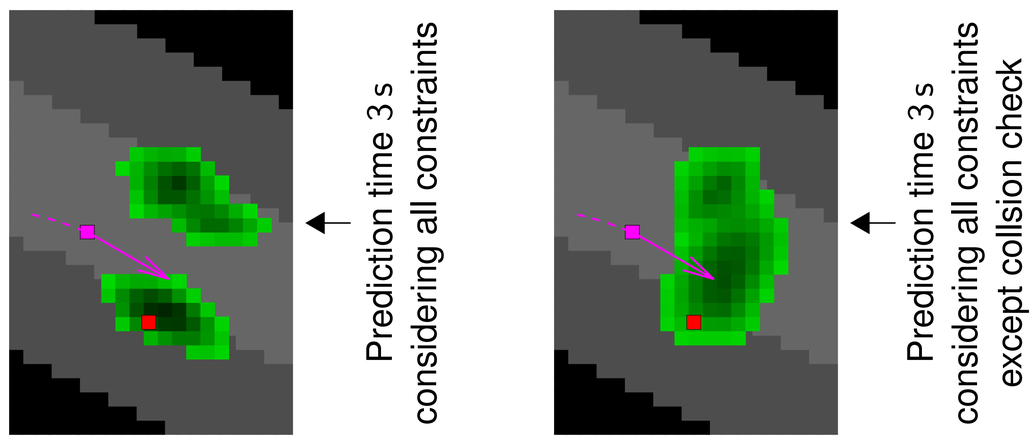
1. Predict occupancy grids of other traffic participants and the danger areas caused by them.



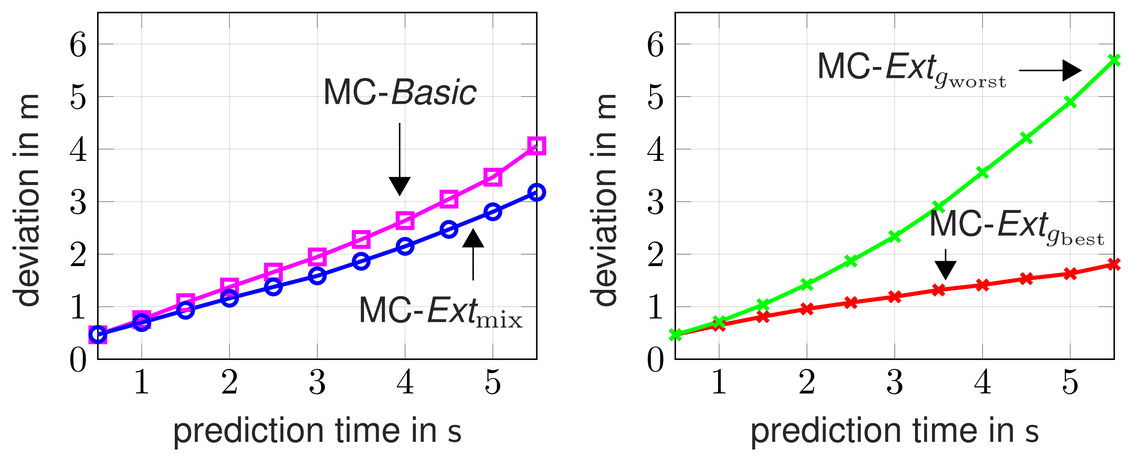
2. Compute the evolution of occupancy grids of the pedestrian using different inputs from different positions.
3. Compute the collision probabilities for given inputs and positions.
4. Update the input distributions and use them for the propagation in the next step.

Evaluation

Simulation example:



Average position deviations:



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