Social and Physical Pedestrian Sizes and Their Impact On the Decision-Based Modeling

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Introduction

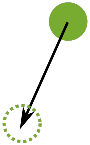
- Agent-based modeling
- Concept of the agent size based on the proxemics theory
- Author's **decision-based model** and its rules
- Pedestrian size as the one of the significant model features
- Time and spatial development of the pedestrian **social size**
- Impact of the pedestrian **physical size** on the results

Phases of the Decision-Making - In General

- Strategic phase
  - Defines the global plan of the pedestrian (at the beginning)
- Tactical Phase
  - Represents finding of course action (at each time step, for several time steps)
- Operational Phase
  - Finds the specific next position taken by the pedestrian to reach the goal (at each time step, for one time step)

Operational Phase - Blind Velocity

- Blind direction = the optimum direction (minimalizes pedestrian distance to the selected checkpoint)
- Blind speed = is projected into the blind direction, pedestrian accelerates from initial speed until the desired one is achieved



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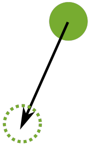

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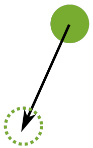
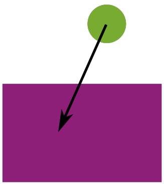
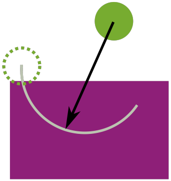




Operational Phase - Collision Avoidance

- If the blind velocity fails, the pedestrian needs to change the blind direction or the blind speed
    - By pedestrian rotation with maximum course change angle $\varphi \in (0, 2\pi\rangle$
    - By slowing down of the pedestrian, i.e. shortening the blind distance



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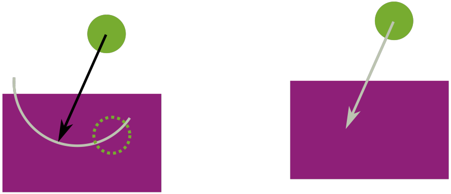

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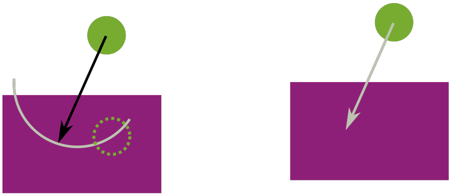

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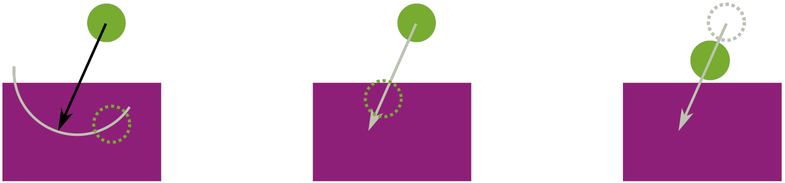
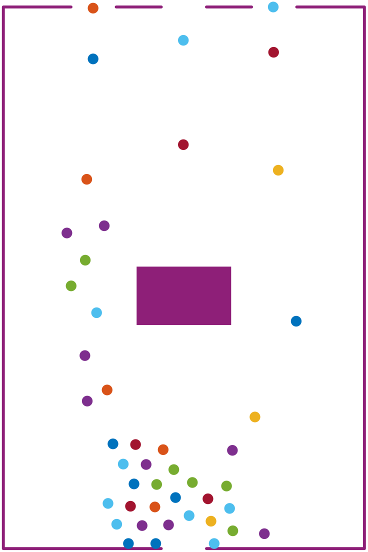


Operational Phase - Dense Crowd Behavior

- Pedestrian reduces their initial size until the specific threshold value (physical size) is fulfilled
- Their sizes are reduced only to themselves - they see each other still at the initial size
- When the exit area is stuck, the pedestrian looks in the view angle and if there is a free space, accelerates with crisis acceleration a_{crisis}
- Random sequential update



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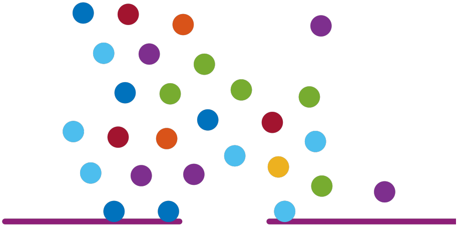

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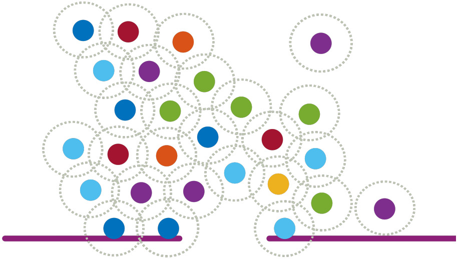

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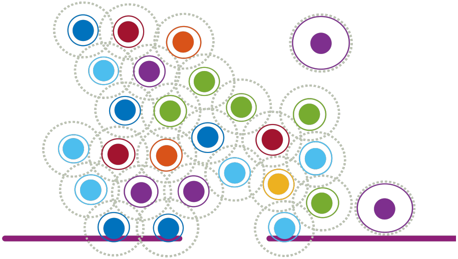

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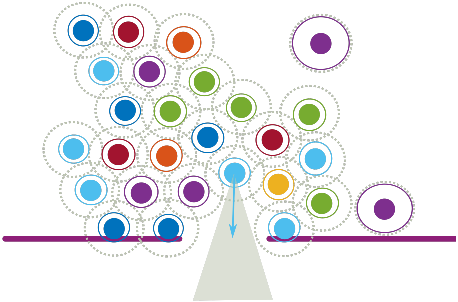

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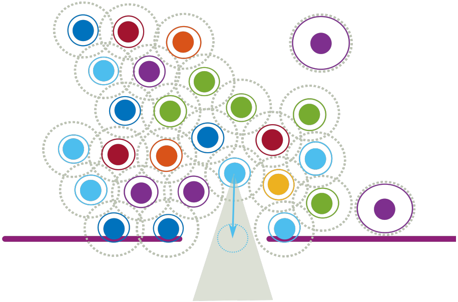

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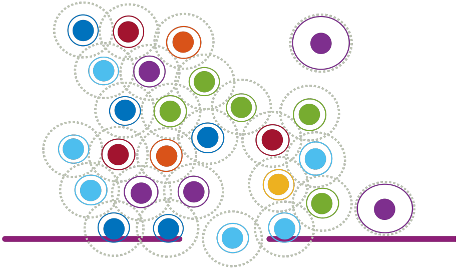
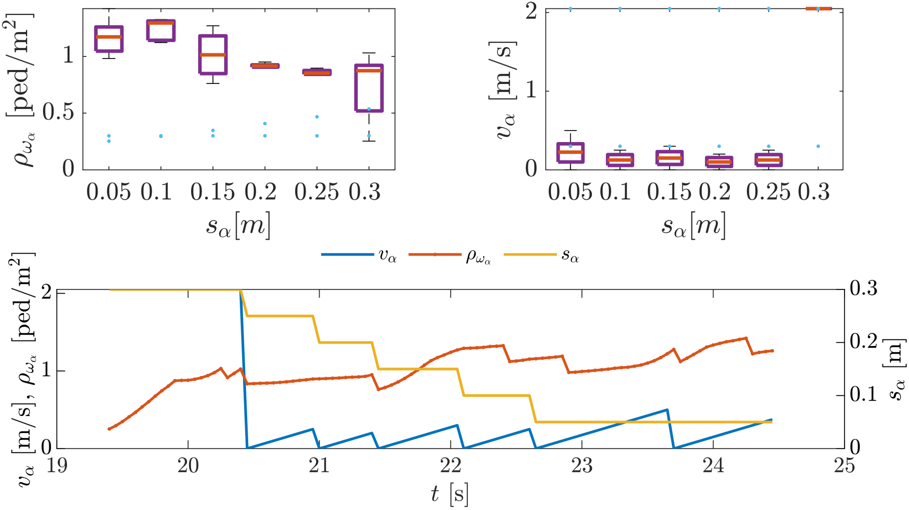


Social and Physical Pedestrian Size - Definition

- **Initial size** $s > 0$ as the parameter of the pedestrian
- **Physical size** $\tau_s > 0$ as the parameter of the pedestrian
- **Social size** $s_\alpha(t) > 0, \forall t > 0$, of the pedestrian $\Rightarrow$ social compression
- It is fulfilled $0 < \tau_s \leq s_\alpha(t) \leq s$
- Pedestrian is not allowed to expand again (considering our experimental data used for calibration; this rule is easily upgradable)
- Simulation for 336 parametric sets, each of them in 10 iterations with inflow 1.5 ped/s and experimental time 120 s
- $s \in \{0.1, 0.11, \dots, 0.3\}$, $\tau_s \in \{0.05, 0.06, \dots, 0.3\}$ and $\tau_s < s$

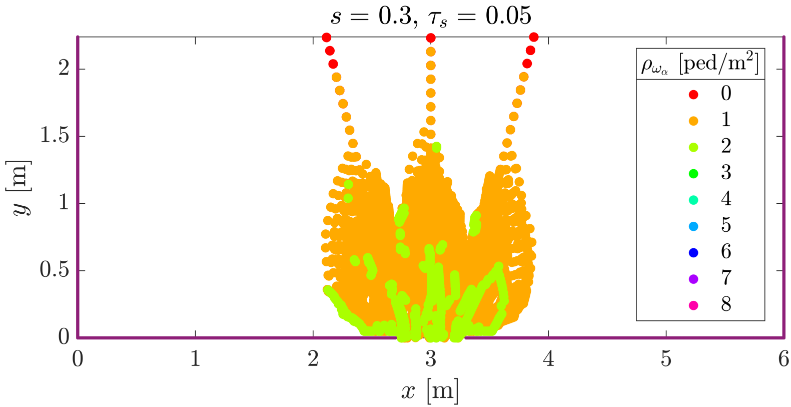
Social and Physical Pedestrian Size - Microscopic Insight

- Time development of pedestrian size and their individual density



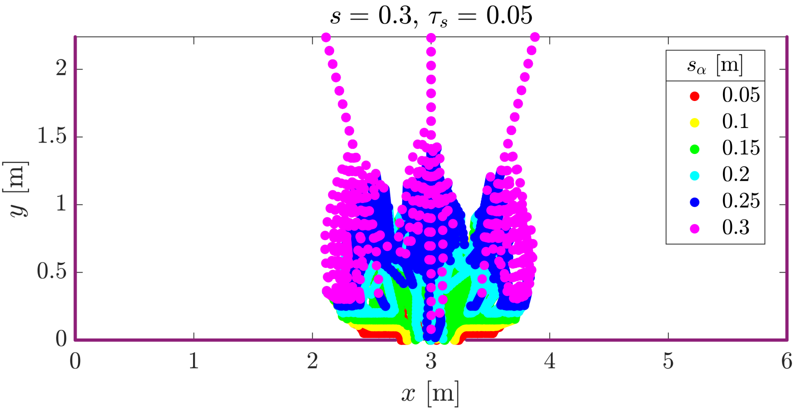
Social and Physical Pedestrian Size - Microscopic Insight

- Spatial localization of pedestrian individual density



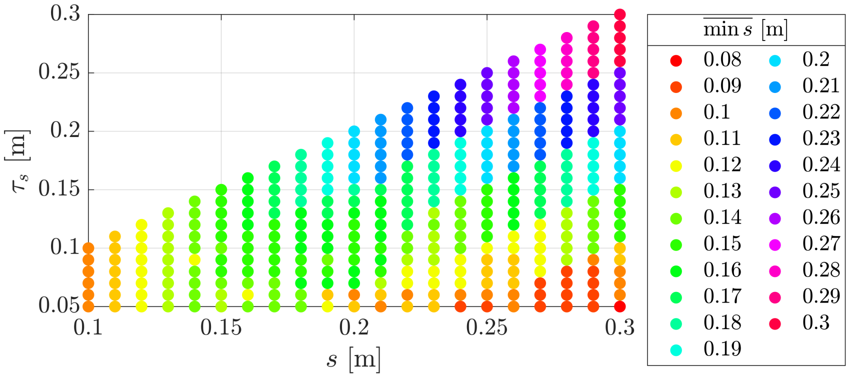
Social and Physical Pedestrian Size - Microscopic Insight

- Spatial localization of pedestrian social size



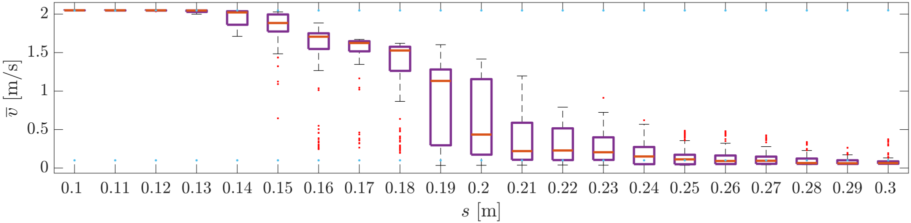
Social and Physical Pedestrian Size - Microscopic Insight

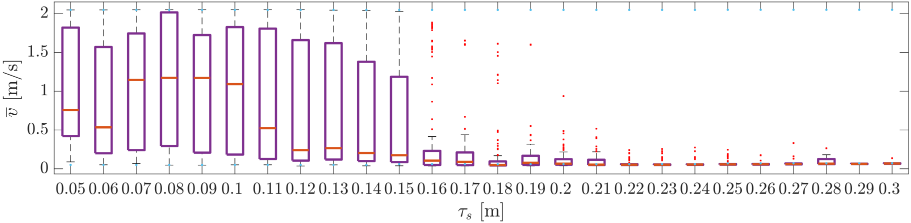
- Minimum pedestrian size for each parametric setting



Social and Physical Pedestrian Size - Macroscopic Insight

- Mean speed (mean over both pedestrians and time)





Conclusions

- Concept of pedestrian size in the agent-based modeling
  - Initial size
  - Physical size
  - Social size
- Social size properties
- Impact of the physical size on the outcome
- The same results are expected in any other model

Thank you for your attention.